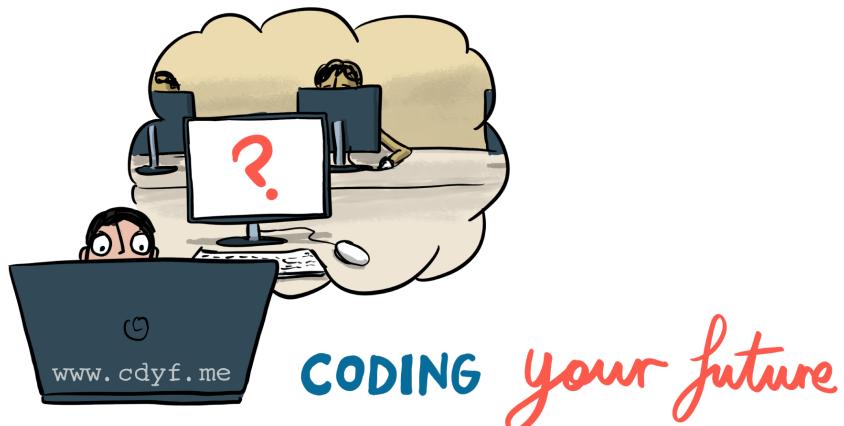


Coding Your Future: A Guidebook for Students

Duncan Hull at the University of Manchester and illustrated by Bryan Mathers at Visual Thinker

Contents

Welcome to your future



Hello and welcome to Coding Your Future, the guidebook that will help you to design, build, test, debug and code your future in computing. This guidebook is aimed at students in higher education, both those studying Computer Science as part of their degree or those from other disciplines with an interest in computing.

This guidebook supports second year teaching at the University of Manchester, but it DOES NOT MATTER:

- what *stage* of your degree you are at, from first year through to final year
- what *level* you are studying at, foundation, undergraduate or postgraduate
- what *subject* you are studying, provided that you are computationally curious
- what *institution* you are studying at, this book is University and institution agnostic
- *where* in the world you are studying

So there is probably something in this guidebook for every student of computing around the world.

0.1 Visualising your future

A lot of literature about what comes after University can be dry, dull, textbook-y and boring with few illustrations and conversations.

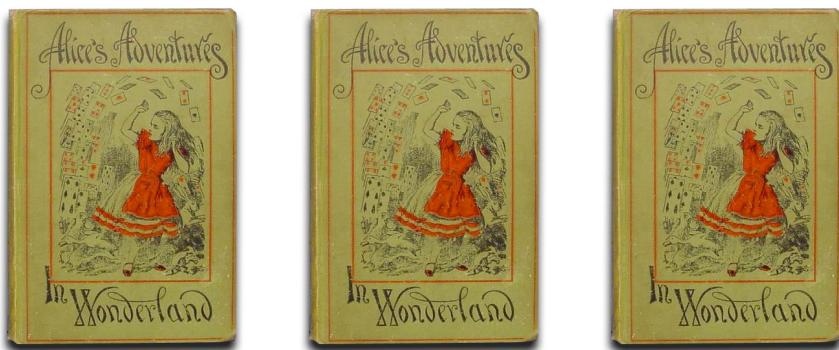


Figure 1: The cover of the 1898 edition of the novel *Alice's Adventures in Wonderland*. Public domain image via Wikimedia Commons w.wiki/327E

In the novel *Alice's Adventures in Wonderland* (?), the heroine Alice is looking at book her sister is reading:

Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do: once or twice she had peeped into the book her sister was reading, but it had no pictures or conversations in it, “and what is the use of a book,” thought Alice “without pictures or conversations?” – See gutenberg.org (?)

So this book uses pictures and conversations wherever possible to help you understand and visualise your future.

0.2 Your future aims

This guidebook aims to help you develop stronger habits of mind, body and soul using five key ingredients:

1. **Code:** Instructions contained in this guidebook

2. **Data:** Facts, statistics and images collected together for your analysis
3. **You:** Activities for you to do in addition to reading
4. **Futures:** Possible futures for you to think about. Try not to dwell on the past. Think about the future. (??)
5. **Me:** Hello, my name is Duncan. I'm your tour guide here. If you're feeling a bit lost, follow me.



Figure 2: Hello my name is Duncan. If you're feeling a bit lost, follow me. Image adapted from “Hello my name is sticker” by Eviatar Bach, public domain w.wiki/32RV

Coding your future explores techniques for making career decisions, job searching, submitting applications and competing successfully in interviews and the workplace.

Alongside these practical engineering issues, this guidebook also encourages you to *design your future* by taking a step back and reflecting on the bigger picture. You will apply computational thinking techniques, to reflect on who you are, what your story is, how you communicate with other people and what your experience is. As there is a computational theme, you will also need to reflect on what your inputs and outputs (I/O) are, both now and in the future. You'll also need to think about what recipes (or algorithms) you might start experimenting with

This guidebook tackles professional issues in computing, for those with and without Computer Science degrees in the early stage of their careers.

0.3 What you won't learn

What you won't learn This guidebook will NOT teach you how to write code, there's already lots of fantastic resources to help you do that. We discuss some of them in chapter on computing your future.

0.4 Learning your future

So what *will* you learn from this guidebook? After reading this guidebook, watching the videos and doing the exercises you will be able to:

1. Improve your self-awareness by describing who you are, what motivates you and your strengths and weaknesses
2. Decide on a job search strategy and identify employers, sectors and roles that are of interest to you
3. Improve your written communication skills both for job applications and communicating with other people
4. Plan and prepare competitive written applications using standard techniques including CVs, covering letters, application forms and digital profiles
5. Compete successfully in interviews and assessment centres by preparing for technical and non-technical questions
6. Plan further steps in your career such as promotion, postgraduate study & research, alternative employment and longer term goals
7. Search and navigate a large “wordbase” (this guidebook and the work it cites). A wordbase is like a codebase, only written predominantly in natural language.

0.4.1 Your future prerequisites

As the title of this guidebook implies, there is a computational flavour here, but you do not have to be studying Computer Science to benefit. There are two main target audiences for this guidebook:

1. Undergraduate and postgraduate students studying Computer Science as a major or minor part of their degree. This includes software engineering, artificial intelligence, human-computer interaction (HCI), information systems, health informatics, data science, gaming, cybersecurity and all the other myriad flavours of Computer Science
2. Undergraduate and postgraduate students studying *any* subject, with little or no Computer Science at all. You are curious to know about what

role computing could play in your future career because computing is too important to be left to Computer Scientists.

So the prerequisites for this book are that you are studying (or have studied) at University where English is one of the main spoken languages. You *may* have some experience already, either casual, voluntary or otherwise, but this book does **not** assume that you have already been employed in some capacity.

0.4.2 Gutting your future

Don't read this book, gut it! Reading this book from cover to cover like a novel is not recommended. That would be foolish.



Figure 3: Don't read this book, gut it like a fish. Gutting fish in Isla Margarita image by Wilfredor via Wikimedia commons w.wiki/_23m

Instead of reading this book, I suggest you follow the advice given to historian William Woodruff about reading books when he was at University:

“You don’t READ books, you GUT them!” (?)

So, gut this book like a fish. Identify the chapters that are most useful to you (the flesh), and skip the rest (the guts). Which chapters are flesh and which are guts will depend on what stage of the journey you are at. This guidebook is designed to be as “guttable” as possible. To aid gutting, the version published at cdyf.me has a built in search and tables of contents. Before you can gut the fish, you’ll need an anatomical map shown in figure ??.

0.5 Mapping your future

This guidebook is split into three parts. The first part is on designing your future while the second is on building and testing your future shown in the

map in figure ???. The final part is a help section, for rebooting your future. Let's look in a bit more detail at the content of each of the three parts of this guidebook:

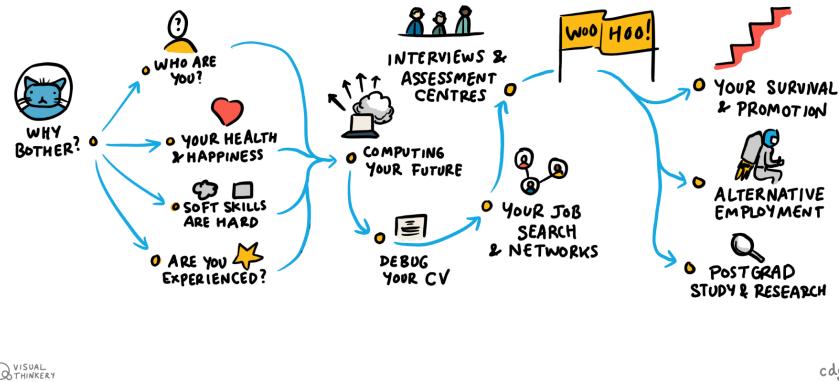


Figure 4: Mapping your future: Each yellow dot on this diagram is a chapter in *Coding Your Future*. The chapters on the left tackle design issues like *who are you?* Chapters on the right tackle the practicalities of executing and testing your career choices, such as *debugging your CV*. Mapping your Future artwork by Visual Thinkery is licenced under CC-BY-ND

0.5.1 Designing your future

The first six chapters of this guidebook look at what engineers call *design*. When you build anything, a bridge, a piece of software, a car or a plane you'll need to do some design like the blueprint in figure ??

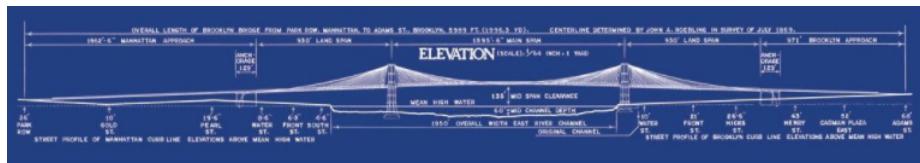


Figure 5: Designing your future is about drawing up a blueprint, like this one for the elevation of the Brooklyn Bridge in New York. What does your blueprint look like? The chapters on designing your future will help you fill in the details.

Building a career isn't that different to building anything else, you'll need to do some design work and it will probably be iterative. Designing things often

involves asking tricky questions. So when you're designing your future you'll need to cover the following:

1. Bothering with your future looks at why you should bother reading any of this book
2. Knowing your future challenges you to reflect on who you are, what makes you unique and why you are here
3. Looking after your future encourages you to take care of your mental and physical health
4. Writing your future explores your soft skills, and how they complement your hard skills and why employers value them so much
5. Experiencing your future asks you to reflect on your work experience and help identify where you can improve it
6. Computing your future looks at the role computing can play in your career, with or without a Computer Science degree

0.5.2 Building and testing your future

The next six chapters look at building and testing your future, what engineers like to call *implementation*, *execution* or *construction* shown in figure ??



Figure 6: Just like the Manhattan Bridge, your future will be easier to build once you've done some design. Even a sketch will do. Design questions are covered in the first part of this guidebook: designing your future. Picture of the Manhattan bridge under construction in 1909 adapted from a public domain image via Wikimedia commons w.wiki/32Rg

Once you've started to answer the design questions in the first part, you can start to implement (or build) your career and think about what the next steps will be.

1. Debugging your future looks at debugging your written communication such as covering letters, application forms and digital portfolios.

2. Finding your future, looks at where and how can you look for interesting opportunities
3. Speaking your future, looks how can you turn interviews to your advantage and negotiate any offers you receive
4. Surviving your future looks at the next steps. Once you've landed a job, how will you survive and thrive outside (and after) University
5. Researching your future discusses if a Masters degree or a PhD right for you?
6. Broadening your future encourages you to broaden your horizons. Maybe you want to start your own business and employ others or you'd like to work in the non-profit or public sector? Perhaps you could be a freelancer or contractor? The possibilities are endless.

0.5.3 Supporting your future

The third part of this book, contains supporting material that will help the design, build and test phases described above. You'll need good support to help with the stresses and strains of building your future shown in ??



Figure 7: The Clifton Suspension Bridge in Bristol has supporting chains which can move when heavy loads pass over the Avon valley bridge. You'll need good support to cope with the stresses and strains of building your future. Clifton suspension bridge picture adapted from original by Nic Trott via Wikimedia commons w.wiki/32tu

1. Ruling your future provides *Ten Simple Rules for Coding your Future*, this book in a nutshell
2. Reading their future invites you to put yourself in the employers shoes by reading some CVs
3. Moving your future looks at opportunities outside of capital cities like London
4. Listening to your future invites you to hear students stories of their transition from education to employment
5. Actioning your future gets you to think about your actions by emphasising verbs on your job applications

6. Scheduling your future invites you to set aside an hour each week for tackling the issues described in this book
7. Reading your future everything we've cited in this guidebook, because books are good for your soul

0.6 Your future themes

This guidebook aims to help you build a bridge from where you are now to where you'd like to be in the future. Each chapter of the book contains the following recurring themes:



Figure 8: The iconic Golden Gate Bridge in California, adapted from an original picture by Frank Schulenburg (CC BY-SA) on Wikimedia Commons [w.wiki/37kY](https://commons.wikimedia.org/w/wiki/37kY)

1. **Learning** your future: What you will learn from any given chapter
2. **Watching** your future: videos and animations for you to watch
3. **Listening** to your future: audio and podcasts for you to listen to
4. **Speaking** your future: articulating from a script or by improvisation
5. **Discussing** your future: breakpoints invite you to stop your code from executing and think about the variables and parameters you are using. Can they be improved? Reflect and discuss.
6. **Reading** your future: reading stuff because its good for your mind, body and soul
7. **Writing** your future: written exercises using natural language
8. **Quizzing** your future: quick quizzes to be done in real-time live scheduled sessions (synchronously) and in your own time (asynchronously)
9. **Assessing** your future: activities to be assessed by yourself, your peers, an employer or an academic (depending on who and where you are)
10. **Challenging** your future: coding challenges are designed to take you out of your comfort zone by encouraging you to experiment with your thoughts, discussions and actions
11. **Signposting** your future: the most useful resources that I recommend you read, listen to or watch

0.7 Acknowledgements

The content of this book is based on hundreds of conversations I have had with students of (mainly) Computer Science and Maths with some Physics and Engineering, since 2012. I've also spoken to many of their employers too.

0.7.1 Standing on the shoulders of students

First and foremost, I'd like to thank all the students who have helped with this book, both directly and indirectly.

“If I have seen further it is by standing on the shoulders of students.”
(?)

So, if you have studied some flavour of Computer Science at the University of Manchester since 2012, there's a high probability you have contributed to this book. Thank you for having the courage to tell me your stories. Thank you for being ambitious, hard working, talented, fearless, creative, inspirational and listening to me. It has been my pleasure and privilege to work with you all.



Figure 9: Posing on the BBC Breakfast red sofa with the winning student team at the BBC / Barclays University Technology Challenge (UTC) in MediaCityUK, Salford, Greater Manchester

I'd especially like to thank industrial experience (IE) students who have completed a year in industry as part of their degree as well as those who have done summer internships, either as part of the Master of Engineering (MEng) program or otherwise, particularly Luke Beamish and Petia Davidova. In addition, the PASS leaders and facilitators, UniCSmcr.com, HackSoc, CSSoc and Manchester Ultimate Programming members have all been influential on the content of this book. I've learned heaps by manually trawling through thousands of your CVs too, so if you've shown me a copy of your CV, thanks! If you sent me a CV and I didn't reply, I apologise. There are limits to what is humanly possible. The chapters on debugging your future (self assessment) and reading

their future (peer assessment) are based on the most common bugs (or are they features?) I've seen in CVs.

So, thank you students for being studious.

0.7.2 Thanks to employers

Thanks to all the organisations who have employed students from the Department of Computer Science as either summer interns, year long placements or graduates. A big chunk of this guidebook documents their experience of employers and their graduate recruitment programs.

Thanks to Niall Beard and Sharif Salah at Google for introducing me to Google's Technical Writing course. (?)

So, thanks employers for employing our students.

0.7.3 Thanks to colleagues

I've also had significant support from colleagues in the Department of Computer Science (@csmcr) and support staff at the University of Manchester. (@ManUniCareers, @alumniUoM, @OfficialUoM)

I would especially like to thank Jim Miles for encouraging me to write a book shortly after he offered me a job. I thought he was joking (about the book) but it actually turned out to be another one of Jim's great ideas. Thanks Jim.

I'd also like to thank the only three people in the whole world who've had the misfortune of reading all of my PhD thesis; Robert Stevens, Anil Wipat and Steve Pettifer. I suspect it was as painful for you to read as it was for me to write it. Thanks Robert for your relentless patience and giving me a well timed, well aimed kick up the arse (to write this book) in the Midland Hotel, Manchester at the May ball.

Thanks to Carole Goble for re-teaching me how to write by covering drafts of my MSc thesis in red ink (and swear words ¹) and Steve Furber for playing bass in our "boy band" Tuning Complete.

0.7.3.1 Thanks to academic staff

Thanks to past and present academic colleagues, PhD students and teachers at the University of Manchester who have contributed to this guidebook and the environment it was written in. We are bound together by the power of weak ties alongside stronger forces and friendships. They include (in alphabetical order):

¹the swear words didn't appear until the sixth or seventh draft

Pinar Alper, Sophia Ananiadou, Mikel Egaña Aranguren, Constantinos Astreos, Terri Attwood, Sam Bail, Robin Baker, Richard Banach, Riza Batista-Navarro, Michael Bada, Niall Beard, Sean Bechhofer, Lynne Bianchi, Helena Björn van Praagh, Stewart Blakeway, Petrut Bogdan, Caroline Bowsher, Linda Brackenbury, Judy Brewer, Nick Brown, Mihai Bujanca, Oscar Corcho, Christian Brenninkmeijer, Andy Bridge, Andy Brass, Andy Brown, Gavin Brown, Terry V. Callaghan, Grant Campbell, Angelo Cangelosi, Peter Capon, Andy Carpenter, Nicola Carrier, Barry Cheetham, Ke Chen, Sarah Clinch, Ian Cottam, Brian Cox, Paul Dobson, Clare Dixon, Danny Dresner, Nick Drummond, Warwick Dunn, Doug Edwards, Iliada Eleftheriou, Anas Elhaig, Suzanne Embury, Michael Emes, Alvaro Fernandes, Jonathan Ferns, Michele Filannino, Nick Filer, Paul Fisher, Steve Furber, Andre Freitas, Aphrodite Galata, Matthew Gamble, Jim Garside, Kristian Garza, Chris Gilbert, Danielle George, Richard Giordano, Birte Glimm, Carole Goble, Rafael Gonçalves, Antoon Goderis, Roy Goodacre, Bernardo Cuenca Grau, Peter R. Green, Keith Gull, John Gurd, Luke Hakes, Robert Haines, Guy Hanke, Simon Harper, Phil Harris, Jonathan Heathcote, Lloyd Henning, Gareth Henshall, Andrew Horn, Farid Kahn, Matthew Horridge, Ian Horrocks, Toby Howard, Roger Hubbald, Jane Ilsley, Jules Irene, Daniel Jameson, Caroline Jay, Mirantha Jayathilaka, Huw Jones, Simon Jupp, Yevgeny Kazakov, John Keane, Douglas Kell, Catriona Kennedy, Rachel Kenyon, Joshua Knowles, Dirk Koch, Christos Kotselidis, Ioannis Kotsopoulos, Oliver Kutz, Alice Larkin, Peter Lammich, John Latham, Kung-Kiu Lau, Margi Lennartsson Turner, Dave Lester, Peter Li, Zewen Liu, Phil Lord, Mikel Luján, Darren Lunn, Matthew Makin, Nicolas Matentzoglu, Paul Mativenga, Erica McAlister, April McMahon, Merc and members of the Manchester University Mountaineering Club (MUMC), Simon Merrywest, Eleni Mikroyannidi, Colin Morris, Norman Morrison, Georgina Moulton, Boris Motik, Christoforos Moutafis, Tingting Mu, Ettore Murabito, Mustafa Mustafa, Javier Navaridas, Aleksandra Nenadic, Goran Nenadic, Steve McDermott, Jock McNaught, Mary McGee-Wood, Pedro Mendes, Sarah Mohammad-Qureshi, Tim Morris, Jennifer O'Brien, Tim O'Brien, Steve Oliver, Pierre Olivier, Mario Ramirez Orihueta, Stuart Owen, Ali Owruk, Pavlos Petoumenos, Luis Plana, Jackie Potter, Malcolm Press, Colin Puleston, Paul Nutter, Dario Panada, Michael Parkin, Bijan Parsia, Jon Parkinson, Norman Paton, Jeff Pepper, Steve Pettifer, Rishi Ramgolam, Allan Ramsay, Alasdair Rawsthorne, Farshid Rayhan, Alan Rector, Giles Reger, Graham Riley, David Robertson, Jeremy Rodgers, Clare Roebuck, Jeremy Rodgers, Mauricio Jacobo Romero, Nancy Rothwell, William Rowe, Oliver Rhodes, David Rydeheard, Graham Riley, Daniella Ryding, Ulrike Sattler, Ahmed Saeed, Pejman Saeghe, Rizos Sakellariou, Pedro Sampaio, Sandra Sampaio, John Sargeant, Andrea Schalk, Viktor Schlegel, Renate Schmidt, Jonathan Shapiro, Vangelis Simeonidis, Liz Sheffield, Bushra Sikander, Kieran Smallbone, Alastair Smith, Stian Soiland-Reyes, Irena Spasic, David Spendlove, Robert Stevens, Alan Stokes, Shoaib Sufi, James Sumner, Peter Sutton, Neil Swainston, John H. Tallis, Paul Taplin, Federico Tavella, Chris Taylor, Tom Thomson, Dave Thorne, David Tolui, Tony Trinci, Dimitri Tsarkov, Daniele Turi, Jake Vasilakes, Laura

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Optimists will tell you that “everyone has a book in them...”, but pessimists like Christopher Hitchens will add that “...in most cases that’s exactly where it should remain”. (?)

Despite Hitchens amusing trademark cynicism shown in figure ??, I am an optimist when it comes to the power of natural languages.



Figure 10: Christopher Hitchens explains the difference between autobiography and memoir (?)

0.7.3.2 Thanks to professional services staff

Thanks also to the superb support staff (past and present) from professional services, especially the Academic Support Office (ACSO), Student Support Office (SSO) and external affairs office in the Kilburn building. Professional services staff continue to make all the magic of teaching and learning possible: Alyx Adams, Cassie Barlow, Jennie Ball-Foster, Emma Bentley, Christine Bowers, Karen Butterworth, Chris Connolly, Ellie Crompton, Jean Davison, Gavin Donald, Miriam Cadney, Chris Calland, Ben Carter, Hannah Cousins, Holly Dews-nip, Tammy Goldfeld, Penney Gordon-Lanes, Amelia Graham, Iain Hart, Kath Hopkins, Lynn Howarth, Yvonne Hung, Susie Hymas, Radina Ivanova, Alex Jones, Jessica Kateryniuk-Smith, Mike Keeley, Stephanie Lee, Dominic Laing, Gill Lester, Jez Lloyd, Ruth Maddocks, Cameron Macdonald, Tony McDonald,

Karon Mee, Anne Milligan, Rachel Mutters, Matthew Oakley, Alyson Owens, Chris Page, Melanie Price, Chris Rhodes, Graham Richardson, Martin Ross, Julian Skyrme, Elaine Sheehan, Angela Standish, Martine Storey, Bernard Strutt, Jannine Thomas, Joseph Tirone, Daisy Towers, Anna Warburton-Ball, Richard Ward, Sarah White, Elizabeth Wilkinson, Andrew Whitmore, Lisa Wright and Mabel Yau.

And Wendy. We all miss you and love you Wendy. #JusticeForWendy Fight the Power! (?)

So, thank you colleagues for being collegiate. You all make the University of Manchester a *fantastic* place to work, even during a global pandemic.

0.7.4 Thanks academia

Beyond Manchester there is a wider academic community that have influenced this guidebook:

- Thanks to Sally Fincher and Janet Finlay whose report Computing Graduate Employability: Sharing Practice (?) has had a big influence on this guidebook.
- Thanks to David Malan (@malan) for CS50 which continues to be an inspiration to me and many others. (???) Thanks to Cristian Bodnar for inviting David to run CS50 in Manchester in 2017 which was a great introduction to David's work (?)
- Thanks to Laurie Santos (@lauriesantos), for *The Science of Well-being* (TSOWB) (?) which was been a significant influence on this book had a gradual but dramatic effect on my personal and professional life
- Thanks to Hadley Wickham (@hadley) and Garrett Grolemund (@garrettggman) for *R for Data Science* (?) which helped me get started with R and bookdown. If you're reading this page in some kind of web browser, the stylesheet used here is re-used from r4ds.had.co.nz
- Thanks to Athene Donald at Occams Typewriter and Stephen Curry at Reciprocal Space for writing entertaining and inspiring blogs
- Thanks to Jessica Wade for inspiration
- Thanks to Jonathan Black (@JonathanPBlack) for his book *Where am I Going, Can I Have a Map?*, (?) his *Financial Times* columns (?) and videos.
- Thanks to David Alan Walker for his book *Energy, Plants & Man* which inspired the conversations and pictures idea behind this book.

So thanks academics for being academic.

0.7.5 Thank you Bath

As a graduate of the Postgraduate Certificate in Education (PGCE) in Science at the University of Bath (graduated 2011), I have been heavily influenced by the fantastic work of PGCE science course leaders Caroline Padley (Physics), Steve Cooper (Chemistry), Malcolm Ingram (Biology) and fellow students on the course.



Figure 11: Panorama of the world heritage site and Georgian City of Bath, Somerset. Image cropped from an original by David Iliff available under CC BY-SA 3.0 license via Wikimedia Commons at [w.wiki/32BS](https://commons.wikimedia.org/wiki/File:Bath,_Somerset,_England,_UK,_panorama_(cropped).jpg)

Thanks Bath for the initial teacher training (ITT), the medicinal Aquae Sulis and the beautiful Cotwolds Area of Outstanding Natural Beauty (AONB).

0.7.6 Thank you Shaftesbury

Thanks to Stuart Ferguson, David Booth, Chris Almond, David Ball, Caroline Dallimore, Mr Travers, Caroline Moss and all the other staff and students at Shaftesbury School who hosted my first PGCE teaching placement. Thanks also to my fellow Shaftesbury/Bath trainees Katharine Platt, Harriet Edwards, Vicky Dury and Joan Shaw for sharing their hard won knowledge through peer learning. Thanks Joan for keeping me awake on the long and winding west country highways to and from deepest darkest Dorset. Thanks for sharing the heavy burden of driving too.

So thanks Shaftesbury for lessons on top of Gold Hill and the Hovis Advert, one of Britain's best-loved adverts. (?)

0.7.7 Thank you Swindon

Thanks to headteacher Clive Zimmerman, his team of staff, Mr M. Carter , Mr K. Thomas and the students of Greendown Community School (now Lydiard Park Academy) in Swindon, Wiltshire for hosting my second PGCE teaching placement. It was fun teaching you about waves using Alom Shaha's jelly babies and kebab sticks shown in figure ??.

Gold Hill is a steep cobbled street in the town of Shaftesbury in the English county of Dorset. The view looking down from the top of the street has been described as "one of the most romantic sights in England."

Gold Hill, Shaftesbury



Figure 12: Shaftesbury is the home of Gold Hill and Shaftesbury School. Image of Gold Hill by Sean Davis via Wikimedia Commons w.wiki/32gw made with the Wikipedia app.



Figure 13: A wave machine demonstration by Alom Shaha with Physics and jelly babies. What's not to like? (?)

So thanks Swindon for being great and western and Swindon Town Football Club, the best football team in the whole of Wiltshire .

0.7.8 Thank you schools

Thanks to all the schools who interviewed (but rejected me) for my Newly Qualified Teacher (NQT) year. Doing interview lessons, meeting your students and your senior leadership teams was a gruelling but fascinating magical mystery tour of the UK education system, both public and private. Although unsuccessful, these interviews were very productive failures:

- Wrightlington School, Radstock, Somerset, see their amazing Orchid project wsbeorchids.org run by Simon Pugh-Jones
- The Cooper School, Bicester, Oxfordshire, see their teacher in my pocket project
- St John's Marlborough, Wiltshire - not to be confused its posher and more famous next door neighbour Marlborough College
- Oasis Academy, Brislington, Bristol
- Redland Green School, Redland, Bristol
- The John of Gaunt School, Trowbridge, Wiltshire
- Didcot Girls' School, Didcot, Oxfordshire
- Cheltenham Ladies' College, Cheltenham, Gloucestershire²
- Blackburn College, Lancashire "I read the news today, oh boy! Four thousand holes in Blackburn, Lancashire" (?)

So thanks schools, for schooling.

0.7.9 Thank you Stockport

Thanks to headteacher Joanne Meredith, her team of staff and the students at St. Annes R.C. High School, Stockport for hosting my Newly Qualified Teacher (NQT) year. Thanks to Keith Doran and other members of the *alternative staff room* for your emotional, moral and practical support throughout the year. According to the *Manchester Evening News*, St. Anne's is "the forgotten school" (??), see figure ??, but I'll never forget you or the lessons you taught me.

So thanks Stockport for being Stockport, the magnificent Stockport Viaduct and for The Hatters! It's all that matters, Stockport Hatters.

²As a newly trained Jedi knight, freshly armed with a PGCE, I was anxious for my first teaching job and momentarily considered using my pedagogical powers on the "dark side" of the force: private education. (?) Forgive me for I have sinned!

The school has gained
the sobriquet 'The
Forgotten School' and
had nine head-teachers
in ten years.

St Anne's RC
Voluntary Academy



Figure 14: Good governance is crucial to good schools. Many schools like St. Anne's, and the hundreds of children they educate every year, need help from skilled people like you on their governing boards. Why not serve your local community as a “critical friend” on the governing board of a school? Take a look at governorsforschools.org.uk. Fair use image via Wikimedia Commons w.wiki/33Xs made with the Wikipedia app

0.7.10 Thank you Moravians

Thanks to Thsespal Kundan, Principal of the Moravian Institute in Rajpur, Dehradun, Uttar Pradesh, India for hosting me and my friend Doug fresh out of high school on a gap year. We learnt heaps as visiting supply teachers of English and Mathematics, thanks to an introduction from a mutual contact Angus Barker.



Figure 15: The Moravian Institute lies in the foothills of the Himalayas between Dehradun in the Doon Valley and the hill station of Mussoorie. Situated between the Yamuna and Ganges, the institute was founded in 1963 by the late Reverend Eliyah Thsetsan Phuntsog of the Moravian Church in Ladakh, Jammu & Kashmir state to provide education for Tibetan refugees fleeing from their homeland across the Himalayas.

So thanks Moravians (and Angus) for a life changing and formative experience.

0.7.11 Thanks to influencers

Some of the most important influences on this guidebook are people I've only met very briefly (in person), virtually (online only) or not at all (yet).

- Thanks to Gayle Laakman McDowell (@gayle), for her cracking series of books (????) which have been very useful resources both for students I've worked with and me personally
- Thanks to Yihui Xie (@yihui) for bookdown.org, the software used to produce this book alongwith the comprehensive and well-written documentation on using it. [?; ?; ?;]
- Thanks to Bronnie Ware for her *The Top Five Regrets of the Dying* (?) which helped me to re-align my priorities when they were all out of kilter
- Thanks to blokes on the interwebs whose words I've enjoyed reading including Tim Bray at ongoing, Paul Downey at whatfettle.com, Paul Graham at paulgraham.com, Peter Norvig at norvig.com and Neil Saunders at What you're doing is rather desperate. Your writing is existence proof that engineers and scientists should also be good communicators.

- Thanks to Sophie Milliken for *From Learner to Earner: A recruitment insider's guide for students wanting to achieve graduate job success (?)* which draws useful distinctions between graduate jobs and graduate schemes

So, thanks influencers for being influential.

0.7.12 Thanks to githubbers

Thanks to everyone who has contributed via github. I will credit *any* github contributors here, small or large. Even the typos, it all counts. You can easily add yourself to this roll call by correcting my delibreate mitsakes.

Keith Mitchell (@apiadventures), Jan Machacek (@janm399), Zee Somji (@ezeethg), Tsvetankov (@Tsvetankov), teobalmos (@teobalmos)

If you'd like to contribute via github you can:

- raise an issue at github.com/dullhunk/cdyf/issues/new
- click on the `edit this page` on any page at cdyf.me which will initiate a pull request
- `git clone https://github.com/dullhunk/cdyf.git` the repository to submit pull requests from your setup
- submit a pull request github.com/dullhunk/cdyf/pulls

So, thanks githubbers for cloning, forking, pulling, adding, committing and pushing.

0.7.13 Thank you Bryan

Many of the illustrations for this book have been drawn by the very talented Bryan Mathers @BryanMMathers shown in figure ??.

Bryan is an artist, visual thinker and entrepreneur, who also happens to have a Bachelors degree in Computer Science from the University of Glasgow. His combined skills in art, science and engineering made him the perfect fit for illustrating this guidebook. You can find out more about Bryan at bryanmathers.com and visualthinkery.com. I'm *sooo* glad we randomly bumped into each other at a conference shown in figure ??.

So, thanks Bryan for your witty illustrations, this book wouldn't be the same without your visual thinkery.



© Bryan Mathers

Figure 16: Bryan Mathers Self portrait by Visual Thinkery is licensed under CC-BY-ND

0.7.14 Thanks to my friends

Thanks to my friends, especially those who I've enjoyed singing, dancing and live music with. I hope we can sing and dance together to live music again before too long.

So, thank you friends for your friendship.

0.7.15 Thanks to my family

To my mum, dad, brother, sister, wife, son, . . . and extended family: I'm lucky to have been taught by you and that you've always been there when I needed you. . . .

So, thanks to all my family for your unconditional love. Σ

0.8 About me

Hello, my name is Duncan Hull and I wrote this guidebook for students at the University of Manchester where I'm a lecturer (Assistant Professor) in the Department of Computer Science.

So what's *my* story? Like many people, my path has been what Helen Tupper and Sarah Ellis call a "squiggly career" rather than classic linear one. (?) I've been gainfully employed as a paperboy, supermarket cashier, shelf stacker, sausage factory worker, pork pie filler, chef, dogsbody, field assistant, database administrator, deli counter server, consultant, matchday steward, envelope stuffer, high school teacher, postdoc, research scientist, software engineer, lecturer, external examiner, tutor and academic.

I've done a range of voluntary work too, serving as a competition judge, fundraiser, rabble rouser, code club & coderdojo leader, digital council member, school governor, curator, librarian, beer drinker, wikipedia trainer, journal clubber and editor. But as Ronnie Lane and Ronnie Wood once said:

“I wish that I knew what I know now, when I was younger.” —
Ronnie Lane (?)

This guidebook documents some of what I know now, that I wish I'd known, when I was younger. If you're starting your career, I hope you find these insights useful. I've sat on both sides of the interview table, as interviewer and interviewee. I have had some spectacular failures, alongside some modest successes, and have included personal stories where they are relevant.

Most of what I have learned about employment comes from listening to, and watching students interact with employers as they take the first tentative steps

in their careers. I've documented some of what they taught me, so reading this book may help you learn from some of their successes and failures.

0.9 Legal stuff

I am not a lawyer (IANAL) but any opinions expressed in this guidebook are my own and not representative of my current employer, the University of Manchester and therefore do not represent University policy. Also:

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So now that we've dispensed with the formalities, let's look at why should you bother reading this guidebook in the first place.

Part I

**DESIGNING YOUR
FUTURE**

Chapter 1

Bothering with your future

The first half of this book is about designing your future. So before we get started, let's tackle a fundamental design issue. Why the hell would you want to bother with your future? Why should you bother with reading this pesky guidebook when you have so many other things on your plate right now:

- You are a busy person, YES!
- Your time is a precious and finite resource, YES!
- You could be spending that precious time right now in lots of other ways, YES!
- There are mountains of self-help guides and courses already, YES!
- Do you really need *yet another* guidebook? YES!

You need this guidebook because it is different to all the other guidebooks! It will help you design, test, build, code and debug your future in computing. Come with me down the rabbit-hole in Figure ?? and let me explain...

1.1 What you will learn

After reading this chapter you will be able to:

- Identify and decide which parts of this book you are going to read
- Set your expectations for using this guidebook
- Travel down the rabbit hole into the underworld of work



Figure 1.1: Shall we go down the rabbit hole? Rabbit Hole learning by Visual Thinkery is licensed under CC-BY-ND

1.2 Let's go down the rabbit hole

In the novel *Alice's Adventures in Wonderland* (?), the heroine Alice follows a white rabbit down a hole. What she discovers is a strange underground world populated by weird and wonderful characters. The world of work can sometimes be a mysterious underworld where you adventure in wonderland accompanied by colourful characters.

You will spend lots of time in this wonderland, potentially as much as 80,000 hours of your life. (??) So join me down the rabbit hole, it's fun (honest), and sooner or later you'll have come down here anyway.

1.3 Your future is your responsibility

When Andy Stanford-Clark started working at IBM, fresh out of University, his boss gave him the following advice:

“Nobody cares about your career except you.” —Anon (?)

Andy is now Master Inventor and Chief Technology Officer (CTO) at IBM in the UK so it was probably good advice. Another, slightly more positive way of putting the advice is, the person who cares *most* about your career is you. So while there are people who can help design and build your future, ultimately it is **YOU** who has to take responsibility for the implementation (if you like, the code). The sooner you get coding the better.

At University, there are lots of people can help design and build your future: peers, academic staff, friends, your careers service, employers and your wider network but ultimately it is *your* responsibility to sort out whatever comes next. That might sound obvious but don't wait for somebody else to do it for you, because it probably won't happen.

1.4 Your degree is not enough

You've worked incredibly hard to get the grades you needed to get into University. You've spent (or are spending) a significant amount of time and money studying whatever it is you are studying at University.

Under these circumstances, you might be tempted to believe that the world owes you something in return for your hard work. Unfortunately that's not the case.

At some point during or after your study, you might find yourself applying for a graduate job or graduate scheme. EVERYONE applying for these opportunities

will have a degree or be rapidly on their way to getting one. So having a degree isn't going to set you apart much from your competition. Even having a first class degree (??) may not distinguish you that much from your competitors. Some employers would rather not know (or don't care) what University you went to, so your education might not make you stand out as much as you might like anyway. (?)

What **will** distinguish you from your competitors will be your experience, your projects, your communication skills and any awards or honours you might have picked up along the way. If you think that your degree will be enough to get you the job you want, bear in mind that:

1. There are more and more graduates, the UK for example recently passed the milestone of 50% of young people going into higher education. This compares to just 15% of over 18s who stayed in higher education in 1980 (?)
2. The increase in the number of graduate schemes and graduate jobs has not kept pace with this growth in graduates which means that each graduate job or graduate scheme has more and more graduates applying for it
3. There are lots of graduates in your discipline, for example around 9,000 every year in Computer Science alone in the UK. What makes you different from the other 8,999 computer scientists graduating in your year?

Computing is one of the largest subject areas in UK higher education, and is taught in almost every institution, graduating around 9,000 students every year –Sally Fincher (?)

Now, don't be disillusioned by the statistics because a degree can open doors to many careers in computing. What the data in Figure ?? show is that you'll need to look beyond your formal education to distinguish yourself from your competition. Your degree can certainly help you start a career, but it is typically not enough by itself.

1.5 Maximising your future

Studying at University is a significant investment of your time and money. Hopefully, you've picked a subject that stimulates and challenges you intellectually while allowing you to find and develop your unique talents. But there's another reason that you probably chose to study at University and that was to improve your job prospects. This guidebook will:

1. Help you maximise the return on the substantial investment of time and money (ROI) you've put into your study

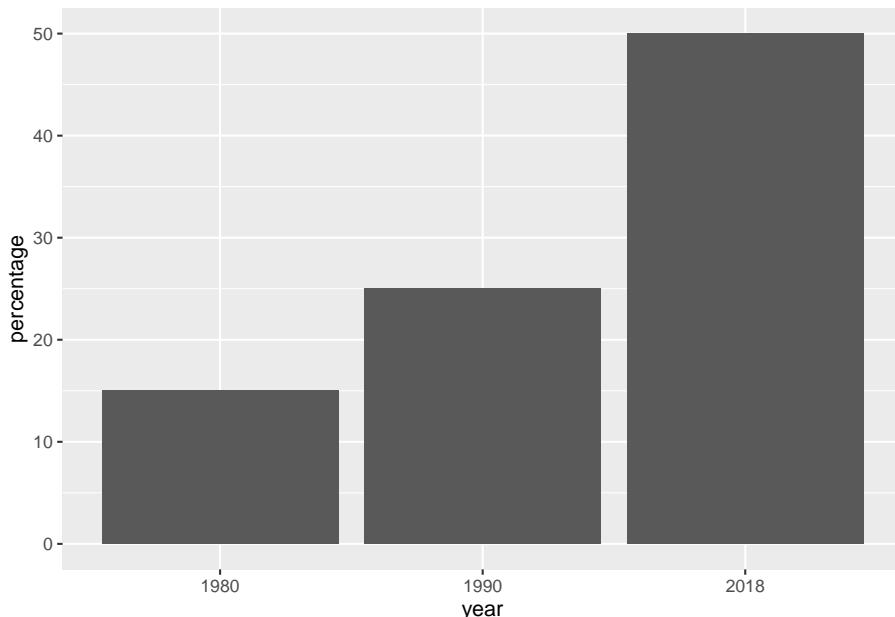


Figure 1.2: Percentage of young people in the UK going into higher education between 1980 and 2018. Over the last forty years, the proportion of young people going into higher education has more than doubled from 15% in 1980 to over 50% in 2018. Data taken from BBC news article on the symbolic target of 50% at university reached (?)

2. Give you an overview of important professional issues that are sometimes neglected or sidelined in University curricula
3. Highlight and review essential resources beyond this guidebook that will help with the above

All of the resources that can help you are scattered around in lots of different places. There are books, there are videos, there are podcasts, there are websites and jobs boards. There are online courses, blogs, social media, newspaper columns, journal articles, marketing material and many other good resources. It is overwhelming.

1.6 Too late when you graduate

You might be tempted to postpone making difficult career decisions. I'll do it tomorrow. I'll do it next week. I'll do it next year. I'll finish this assignment. I'll finish this exam. I'll finish this semester. Procrastination is a part of the human condition (?):

“I’ll get my degree out of the way first then worry about jobs and careers when I finish University” –Pro Crastinator

It probably doesn't help that many of issues described and discussed in this book are typically not closely integrated into the curriculum in Higher Education. You'll often find them on the edges, or completely outside of, standard University curricula. Broadly speaking, the professional issues described in this book are usually covered by pastoral support systems, counselling services, careers services, trade organisations, professional bodies, student unions and their societies,.

Despite being sidelined, these issues matter and it is in your own selfish interests to start thinking about them right now. According to recent estimates by *Investors in People*, the average person spends **80,000 hours** working during their lifetime. (?) So, *whatever* you end up doing after University, you'll be spending a lot of time doing it. Difficult decisions often get sidelined but it is never too early to start thinking about them and doing something. The sooner you start thinking about them the better decisions you'll make about what comes next. It's too late when you graduate.

That doesn't mean you have to know EXACTLY what you want to do when you finish. Lots of students don't and I certainly didn't when I graduated. I'd done a gap year teaching in India, two summer internships (in Sweden and the United States) and a year-in-industry in the UK and I *still* graduated with **no clue** as to what I wanted to do next! The important thing is that you make a start, and sometimes knowing what you **don't** want to do is just as valuable as knowing what you do.

Computer scientists call this problem “search space reduction”, (?) because you have a feasible region of future possibilities and you need to narrow down the candidates. You could think of coding your future as an optimisation problem. Start optimising now because it’s too late when you graduate.

1.7 Yes, this WILL be on the exam

Students love to ask their teachers “*will this be on the exam*”? The short answer is **YES** (and **NO**)! Yes, this will be on the exam, but NO the exam won’t be set by your University. Unlike other courses you’ve done, the examinations for this course aren’t set by your University but by employers. Roughly speaking, there are three kinds of examinations that you’ll need to get good at, shown in Table ??

Table 1.1: Examining your future: The “exams” used by employers, what gets assessed and the grades you can get

Examination	What examiners are assessing	Grade
CV, application form covering letter	<ul style="list-style-type: none"> • Should we invite you to interview ? • Can you communicate well in writing? 	pass/fail
Interview	<ul style="list-style-type: none"> • Should we offer you a job? • Can you communicate well verbally? • Can you communicate well nonverbally? 	pass/fail
Employee performance	<ul style="list-style-type: none"> • Should we promote you? • Should we give you a pay rise? • Should we extend your contract? 	pass/fail

So, *yes*, this will be on the exam, but *no*, the exams are obviously not set, administered, invigilated and marked by academics at your University. The exams are set by employers and the results are **brutally binary**:

- **PASS:** you’ve got the interview, job or promotion or...
- **FAIL:** none of the above. Next!

One of the challenging things about employers exams are, they typically do not have the bandwidth to give applicants useful feedback, other than a simple pass

or fail. When it comes to job applications software engineer Gayle Laakmann McDowell calls this the “black hole”. The gravitational force of employers black holes is so strong that no CV or Resume can escape, we’ll say more about this in chapter on debugging your CV.

GIMME SOME CREDIT

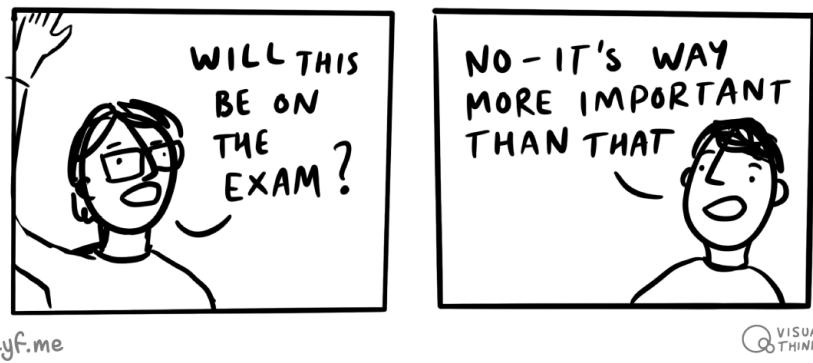


Figure 1.3: *no* this will not be on the exam set by University, but *yes* it will be on the exams set by employers. Some of the most important exams you sit at (and after) University are set by employers. This guidebook will help you prepare for those exams and increase your chances of passing them. Gimme some credit figure by Visual Thinkery is licensed under CC-BY-ND

It’s a similar story with interviews, if you fluffed and interview question or came across badly, it can be really difficult to find out from the employer what you did wrong.

1.8 Practicing your future

There are practical exercises, for you to get your hands dirty with. Each chapter incorporates activities including individual exercises, group exercises, quizzes and points for wider discussion. Just reading a guidebook won’t get you very far, you’ll need to do the activities in this book to get the most out of it.

1.9 Navigating your future

There are **lots** of resources out there that offer self-help, career advice and techniques for self-improvement. It can be hard to know where to start, or even how to find your way around the mountains of advice.



Figure 1.4: There are tonnes of resources out there offering advice on the huge range of professional issues. You can't read them all, but this guide will help you navigate the resources that will be most interesting and useful to you

Lots of professional advice is readily available, but how will you navigate it? This book signposts you to what I think are the most important resources, each chapter has a signposts section, and they are all gathered together in the signpost at the end alongside everything (yes, EVERYTHING!) that this guidebook cites in the References.

1.10 Crediting your future

Get credit for your contributions. As well as being openly accessible on the web, this book is open source too. What this means is, you can contribute in several ways

- View the entire book source on github at github.com/dullhunk/cdyf
- Click the **Edit this page**, which appears on the right hand side of every chapter with the octocat logo
- Raise an issue github.com/dullhunk/cdyf/issues/new
- Submit a pull request github.com/dullhunk/cdyf/pulls, If you're not familiar with pull requests, see makeapullrequest.com
- Email me suggestions for improvements if you don't want to use github

Any corrections or suggestions that get included will be fully acknowledged in the acknowledgements, unless you tell me otherwise. We welcome all improvements, however small.

All the written content for this guidebook is licensed under CC-BY-NC-ND, see the license.

1.11 Your future is different

I wrote this guidebook because I needed a resource for students to help them design, build, test and debug their futures. I wanted a single resource that could help students compete for jobs while at University, or shortly after graduating. I could not find anything suitable that met all the requirements of the students I was teaching. So I wrote this one which contains some new material and recommends the best resources if you want to know more. These are found in the signposts sections of each chapter.

This book aims to combine these perspectives and to be different from existing resources in the following ways:

1.11.1 Your future is signposted

Some career resources claim (or imply) that they are the *all you will need* to solve a particular problem or worse: solve *all of your problems!* Just buy this book, do this course, watch this video, listen to this podcast and all your problems will go away! Rather than continue this trend, this book **signposts** some of the most useful resources.

Scientists call this **citation**, rather than signposting. I've signposted and cited sources in this guidebook so that you can :

1. Check and verify any facts and claims I make in this book for yourself
2. Go and consult the original sources if you think they might be useful

While this guidebook cites lots of resources, some of them are more important than others. Each chapter summarises these in a signposts section. You'll find everything else in the references section. The University of Manchester has physical and electronic copies of many (but sadly not all) of the books listed here.

We're not suggesting that you read *all* these books right now, but that if a particular chapter has piqued your interest, these signposts are good places to keep going, if you haven't already read them. I hope you'll find these signposts handy for navigating the mountains of advice. Not all who wander are lost.

1.11.2 Guiding your future

This guidebook to your future accompanies a course that has been co-designed by students for students, with input from academics and employers. It unites several disparate themes into one coherent story, from fundamental questions about identity and wellbeing through to more applied and practical advice on job hunting, career progression and life after University. Resources that do this

are typically scattered around in many different places. There is usually no narrative to tie them all together to help students navigate the mountains of advice as embark on the first stages of their careers.

Although this is a course guidebook used in the second year undergraduate teaching, you don't need to be enrolled on the course to benefit from reading it, watching the videos and doing the exercises and coding challenges.

1.11.3 Your future is constantly updated

You are reading the alpha version, the Minimum Viable Product (MVP) of this guidebook. That's software engineer talk for saying it isn't finished yet. Subsequent versions, will be continuously and iteratively released on a daily and weekly basis. They will include:

- More quizzes for better interactivity
- More videos on the Coding your Future YouTube channel
- Audio podcasts in the Coding your Future
- More illustrations throughout the book
- Improved content, finish incomplete chapters
- Fix bugs and typos
- Your suggestions for improvements and corrections, via github etc

I'm taking a Release Early, Release Often (?) approach to publishing this guidebook, you could call it agile book development. (?)

Agile: make it up as you go along. Waterfall: make it up before you start, live with the consequences.

— Paul Downey (@psd) February 19, 2015

1.11.4 I'm deliberately writing in first person narrative

A lot of scientific and technical writing is written in the third person or passive voice, which is fine for academic writing, but can alienate readers. I have opted to use first person narrative where possible as it is shorter, and hopefully more engaging for you to read. (?) Where relevant, I've told stories to illustrate key points.

1.11.5 Your future has no paywall

You don't need to pay anything to read this book online because its openly available, see the license terms (CC-BY-NC-ND). Publishing this guidebook

online makes it findable and accessible, something that isn't true of lots of knowledge locked up inside other books.

Because this guidebook is online, it is searchable, browsable and linkable. You can link to whatever level you like, top level, chapter level and to every section and subsection level. Everything important has a Uniform Resource Locator (URL).

1.11.6 Your future has audio & video

This book is not just words and pictures, but includes audio and video as well, especially:

1. videos produced by third parties that are worth watching
2. audio produced by third parties that are worth listening to, either individual episodes or whole series
3. short videos produced by me, which augment the written content of this book, see the [Coding your Future YouTube channel](#)
4. the [coding your future](#) podcast which interviews undergraduate students

1.12 Engaging your future

I've tried to make the content of this book as engaging as possible by including pictures and conversations. *Your future* is deliberately playful and light-hearted. If you think it can be improved, let me know. I always welcome constructive feedback, especially when it comes via a pull request.

Let's go Captain pic.twitter.com/LN33dh5dip

— VeraM (@FonikhSoupia) July 22, 2020

1.13 Signposting your future

Each chapter in this book has a signposts section, highlighting key reading, watching or listening you could do next. This chapter has addressed the question of **why should you bother coding your future?** The answer is that your future is your responsibility and no-one else's. There are lots of people who can help shape your future, but none more than yourself. Software engineer Robert C. Martin argues this point in his book *The Clean Coder: A Code of Conduct for Professional Programmers*. (?)

What's good about *The Clean Coder* is that it is short (only 200 pages), well written and to the point. The main part of the book covers professional issues

in software engineering, some of which I discuss in surviving your future, so *The Clean Coder* is an essential signpost for chapter 10 as well.

1.14 Summarising your future

If all that was too long, didn't read (TL;DR) for you, then you'll be relieved to hear that each chapter (including this one) has a TL;DR summary.

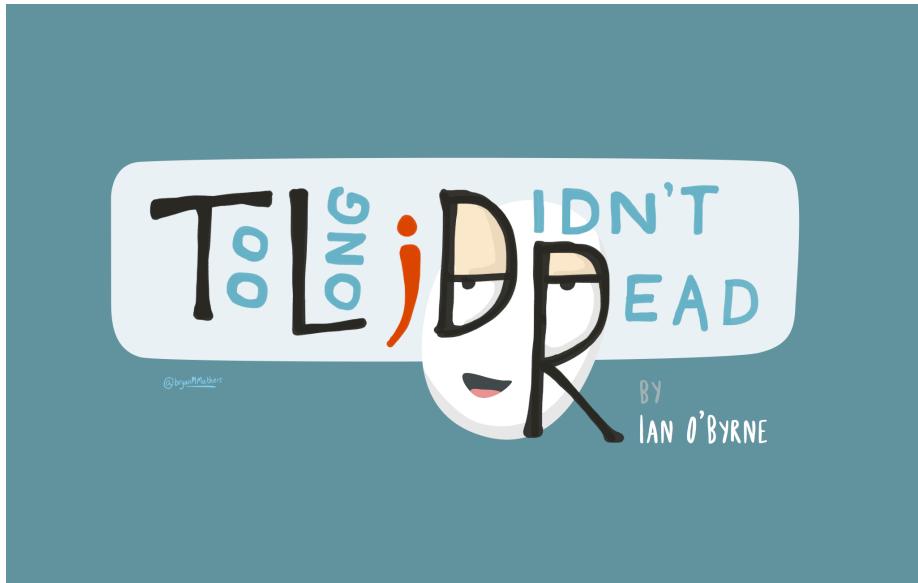


Figure 1.5: Too long, didn't read? TL;DR by Visual Thinkery is licensed under CC-BY-ND

The TL;DR for this chapter is, you should read this guidebook because it will help you design, build, test, debug and code your future in computing.

Chapter 2

Knowing your future

Hello, who are you? What's your story? What are you good at, what do you like doing and what do you value? What are your hopes and dreams for the future? Tell me about your education and who you are. What unique talents are you finding and developing during your education? How are you striving to become the best possible version of you?

2.1 What you will learn

Reading this chapter and doing the activities will help you to

- Improve your self-awareness, knowing yourself better will help you to know your future more clearly
- Describe what you know: what is in your **head**,
- Describe what have you done: (**hands**)
- outlining some of your values: what is in your **heart**
- Identify your protected characteristics
- Check and be grateful for any privileges that you may have

2.2 What's your story, coding glory?

“If you are human, you love stories. Why? We’re hardwired to love stories because they help us understand our world and are essential to our evolution. We use stories to organise and communicate our surroundings and our past, present and future” —Heather Box and Julian Mocine-McQueen (?)

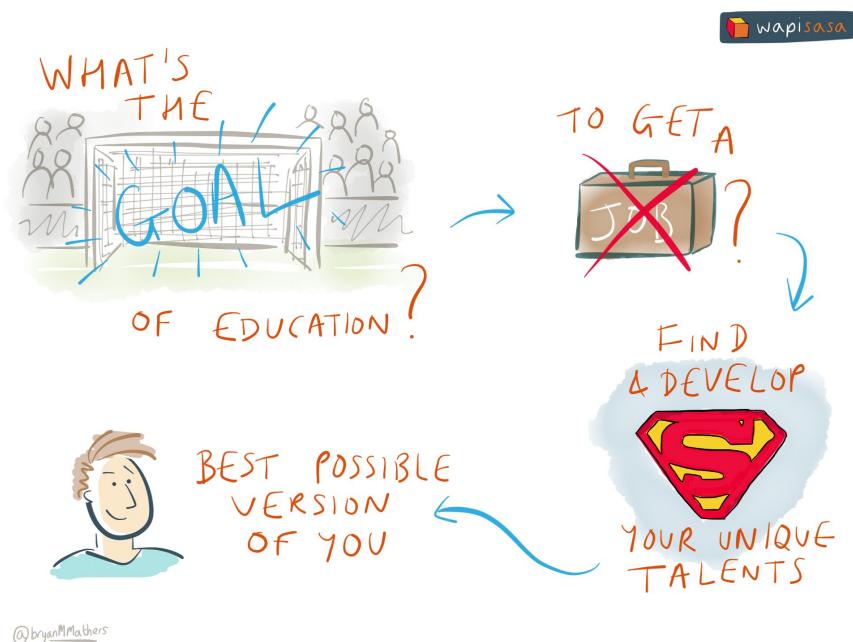


Figure 2.1: Your education is a crucial part of your story and who you are. The purpose of your education is not just to get you a job but to find and develop your unique talents. What are you unique talents? How are you developing them? Goal of Education sketch by Visual Thinkery is licensed under CC-BY-ND

Self-awareness, understanding who you are, is important for leading a healthy and happy life, and likely to be an important factor in your future success. One way to develop self-awareness is to think about what your story is. (?) How did you get here, where are you going, what has inspired you? Who is the authentic you? (?) What are your hopes and dreams? By starting to answer these questions you will gain a better understanding of who you are. This includes strengths, weaknesses, motivation and values. (?)

Universities offer many opportunities for self improvement, self discovery and developing your unique skills. One way to build your self-awareness is to reflect on your knowledge, values and skills. In Waldorf education this is characterised as “head, heart and hands”. (?)

1. **Head:** What do you *know*?
2. **Heart:** What do you *value*, what motivates you?
3. **Hands:** What can you *do*? What have you *done* so far? What will you do in the future?

Answering these questions will help you understand your story.

2.3 Ikigai: What is the meaning of life?

Many of the learning outcomes described above are non-trivial. You may have good self-awareness and be able to describe aspects of who you are in a matter of minutes. Other personality traits make take longer to realise. You can develop better self-awareness by describing four attributes shown in Figure ??, together these are known as your ikigai () or “reason for being”.

- what do you love doing?
- what are you good at?
- what does the world need?
- what can you be paid for?

You'll be lucky if you can find activities at the intersection of all four sets shown Figure ???. In practice, you may realistically only be able to achieve one, two or three. That said, it's still a valuable exercise to think about what is in each category for you.

2.4 Self assess your ikigai

Take a sheet of paper, draw the four overlapping rings shown in Figure ??, and spend five to ten minutes adding things in each ring.



Figure 2.2: Reasons for being, a concept in Japanese known as “ikigai”. Image by Emmy van Deurzen on Wikimedia Commons. According to ikigai, a meaningful life combines doing four things. 1. What you are good at 2. What you love 3. What the world needs and 4. What you can get paid for. Illustration by Nimbosa derived from works in the public domain by Dennis Bodor and Emmy van Deurzen, CC BY-SA 4.0 on Wikimedia Commons w.wiki/qWT

- What are your values?
- What motivates you?
- Are there things you like doing that you aren't particularly good at?
- Why does that make them enjoyable?



Figure 2.3: How well do you know yourself. Know who you are sketch by Visual Thinkery is licensed under CC-BY-ND

Thinking about your ikigai will clarify your knowledge of yourself. Some parts of your identity are so important that they are protected by legislation, in the UK and in other countries. The next section looks at those.

2.5 Your protected characteristics

Some of your characteristics are protected. The Equality Act of 2010¹ protects you from discrimination at work or in education, based on what are known as “protected characteristics”. (?). This means that:

- Your **age** should not determine how you are treated
- Your **disabilities** should not determine how you are treated
- Your **gender** should not determine how you are treated (????)
- Your **gender re-assignment** should not determine how you are treated
- Your **marriage** or civil partnership should not determine how you are treated
- Your **pregnancy** and maternity should not determine how you are treated

¹<http://www.legislation.gov.uk/ukpga/2010/15/contents>

- Your **race** (including colour, nationality, ethnic or national origin) should not determine how you are treated (??)
- Your **religion** or beliefs should not determine how you are treated
- Your **sex** should not determine how you are treated (?)
- Your **sexual orientation** should not determine how you are treated (?)

2.6 Coding challenges

This chapter has looked at some big issues around identity, by inviting you to think about some fundamental questions. Another way to think about these questions is as coding challenges. They are non-trivial questions to answer, it might take you weeks, months or even years to answer some of them. But they are worth spending time thinking about

- What are your values?
- What makes you happy?
- What do you want to get from your time at University?
- What do you want after University?
- Where do you see yourself in x years time?

The signposts in the next section may help tackle some of these coding challenges.

2.7 Signposts from here on identity

This chapter challenges you to reflect on who you are and what you're good at. We've only scratched the surface, so if you want to dig deeper you'll find the following resources useful:

- *The Top Five Regrets of the Dying*
- *What Colour is Your Parachute?*
- *How Your Story Sets You Free*
- A range of books about privilege

2.7.1 Your dying regrets?

One of *The Top Five Regrets of the Dying* (?) is that people wish they'd had the courage to live a life true to themselves, and not a life that others expected of them. Figuring out exactly who your authentic self is can be challenging. Bronnie Ware's book might help, it has some very moving, personal and insightful true stories of peoples regrets that will illuminate your own values and might just change your life. The top five regrets, outlined in the book are:

1. I wish I'd had the courage to live a life true to myself, not the life others expected of me
2. I wish I hadn't worked so hard
3. I wish I'd had the courage to express my feelings
4. I wish I had stayed in touch with my friends
5. I wish that I had let myself be happier

You need to be courageous to live a regret-free life but the alternative is to die full of regret, see Bronnie's video in figure ??.



Figure 2.4: Palliative care nurse Bronnie Ware explains the top five regrets of the dying. [@youtube-bronnie] Bronnie learned a lot from looking after people on their deathbeds, then wrote it all down in a fantastic book [@regrets].

2.7.2 Colouring your parachute

Since first being published in 1972, over ten million copies of *What Colour is Your Parachute?* have been sold. It has been translated into 20 languages and is used in 26 countries. What is good about *Parachute* is that it has some useful *self-inventory* exercises that go beyond the introductory ones in this guidebook, particularly in the context of your future career. While the style and examples can be U.S. centric, it's a classic self-help book that looks at a broad variety of issues around job hunting. The author, Richard Nelson Bolles was a Harvard educated chemical engineer and he explains how you can't possibly decide what to do in five years time in the video in figure ???. Where do you see yourself in five years time? is a question some interviewers like to ask.



Figure 2.5: Where will you be five years from now? Best-selling author Dick Bolles talks at the Googleplex about the gaps between education and employment. [@youtube-bolles]

2.7.3 What's your story?

A useful technique for developing self-awareness is to think about what your story is. Heather Box and Julian Mocine-McQueen's book *How Your Story Sets You Free* (?) takes a storytelling approach to help you gain a better picture of who you are and what you value. What's good about this book is its short, less than 100 pages and contains practical exercises which extend those in this chapter.

2.7.4 Check your privileges

Reflecting on your identity should lead you to check any privileges you might have. Being grateful for any privileges you may have is also beneficial for your mental health which we talk about in the chapter on your well-being So:

- **If you're white** a good place to start understanding your white privileges is *Why I'm No Longer Talking to White People About Race* by Reni Eddo Lodge (?) and *Superior: The Return of Race Science* by Angela Saini
- **If you're male** a good place to start understanding the privileges you have as a result of being a man is *Inferior* by Angela Saini (?)
- **If you're socially privileged** a good place to start understanding the privileges you have as a result of your class is *The Class Ceiling: Why it Pays to be Privileged* by Sam Friedman and Daniel Laurison (?). If you

were privately educated in Britain (or elsewhere) you should read *Engines of Privilege: Britain's Private School Problem* (?)

- **If you're heterosexual** a good place to start understanding the privileges you have as a result of your sexual orientation is Ben Britton's presentation on *No sexuality please, we're scientists* (?) which covers bisexuality and homosexuality, including lesbian and gay homosexuality
- **If you're gender binary** a good place to start understanding the privileges you have as a result of being gender binary is Ben Britton's presentation (?) which also covers transgender, genderqueer, non-binary and plus identities

There is a lot more to your identity than your race, class, gender and sexual orientation, see your protected characteristics.

2.8 Summarising self awareness

Too long, didn't read (TL;DR)? Here's a summary:

This chapter has looked at who you are. Being self aware, understanding your strengths and weaknesses is key to getting what you want from your career. Questions about your identity are non-trivial, hopefully this chapter has started you thinking about who you are, what motivates you and what you want out of life. You need to keep thinking about your identity because some aspects of your identity may be constantly changing.

These are fundamental design questions you'll need to address when you starting building your future. We touched on understanding any privileges you may have as being important for understanding who you are but also in being beneficial for your mental health.

In the next chapter, we'll look at mental health in more detail.

Chapter 3

Looking after your future

It doesn't matter if you are a student, an employee or even both at the same time. To be successful at studying or working, you need to take your well-being seriously. By well-being, I mean your health and happiness. Your health isn't just about your physical health but also your mental health and the two are very closely linked. It's all too easy when you are busy or stressed to neglect your well-being and then **bad-stuff™** happens. This chapter looks at your well-being, and how you can nurture and look after it. Because looking after yourself will also look after your future.

3.1 What you will learn

By the end of this chapter you will be able to:

- Identify some of the symptoms of mental ill health in yourself and your peers, particularly anxiety and depression
- Describe five self-help techniques for improving mental health
- Describe services and other people you can approach if you (or someone you know) is being affected by mental ill health and self-help isn't enough
- Schedule activities for improving mental and physical health into your daily or weekly routine
- **DISCLAIMER:** I am neither a medical doctor or a psychologist: If you're affected by mental ill health, you should speak to a trained professional. This chapter just gives you a quick overview of mental health and points you to where you can find out more.



Figure 3.1: Alan Turing was an outstanding Computer Scientist, but did you know he was also a respectable athlete too? He ran, cycled and rowed to relieve stress, (?) and came close to competing in the Olympics as a runner. This should come as no surprise, the connections between well-being and academic performance are widely documented. Image via Jonathan Swinton's biography *Alan Turing's Manchester*. (?) The copyright holder for this image has been unidentifiable or unresponsive at their self-advertised contact details.

3.2 Mental ill health

Stress can lead to many kinds of ill health. Turing was being put under lots of stress by his government bosses, people like Alastair Denniston and Stewart Menzies. (?) On describing his work for the government and why he punished himself so much in training, Alan Turing said:

“I have such a stressful job that the only way I can get it out of my mind is by running hard; it’s the only way I can get some release”
–Alan Turing. (?)

University is a positive experience for many people, however like Alan, you may also experience periods of stress. This may also be accompanied by anxiety, loneliness and depression. Financial, social and academic pressures alongside concerns about employability and an ongoing pandemic of COVID-19 can all have an impact on your wellbeing. Statistically, one in four of us will be affected by mental ill health during our lifetime. Two of the most common forms of mental ill health are:

- **Anxiety:** *persistent* feelings of unease, such as worry or fear
- **Depression:** a low mood that *lasts for a long time* and affects your everyday life

The *persistent* and *lasting a long time* are important here because while its part of the human condition to worry and feel low, that doesn't *necessarily* mean you are affected by poor mental health.

3.2.1 Anxiety

Anxiety is one of most prevalent mental health disorders and can lead to depression, increased risk of suicide. Generalised Anxiety Disorder (GAD), a common form of anxiety is explained in the video in Figure ?? and at [nhs.uk/conditions/generalised-anxiety-disorder/](https://www.nhs.uk/conditions/generalised-anxiety-disorder/). People who are affected by anxiety may struggle to function normally, and find routine everyday task difficult or impossible.

3.2.2 Depression

Millions of people around the world live with depression. If you are affected by depression it can be really hard to talk about it as there are many social stigmas around mental health. Thankfully depression is largely preventable and treatable. Recognising depression and seeking help is the first and most critical step towards recovery. To mark World Mental Health Day writer and

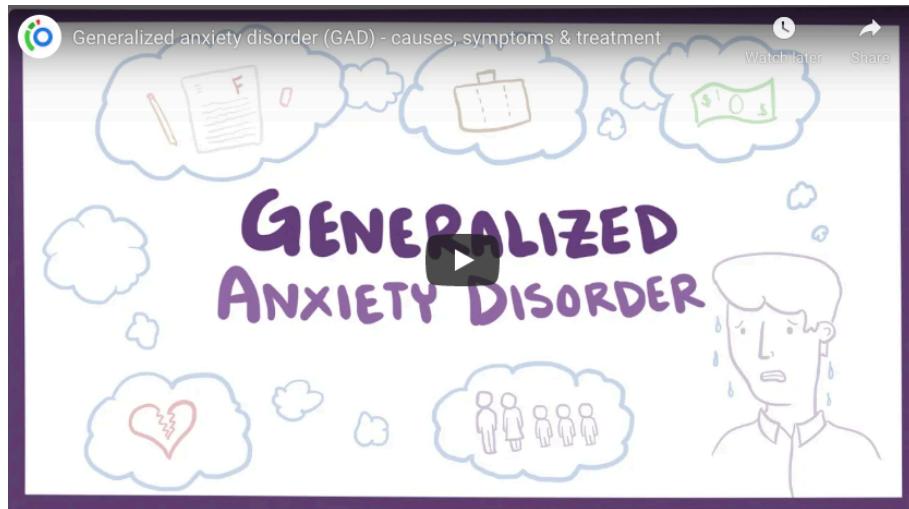


Figure 3.2: Generalised anxiety disorder is a condition characterised by excessive, persistent and unreasonable amounts of anxiety and worry about everyday things. (?) Note that the video takes an American perspective using American terminology such as DSM-5.

illustrator Matthew Johnstone tells the story of how he overcame the “black dog of depression” in the video in Figure ?? made in collaboration with the World Health Organization (WHO).

3.2.3 Drugs

Sometimes the drugs don’t work, they just make you worse. (?) Medication can help some people with their mental health. For example, when I was affected by depression, selective serotonin reuptake inhibitors (SSRIs) worked for me. But they don’t for everybody.

Some doctors prescribe benzodiazepines for anxiety, which may be effective where SSRI’s are not, but these can be addictive and have big side effects.

It is often worth considering cognitive behavioural therapy (CBT) before taking any medication. *The Science of Wellbeing* (TSOWB) at coursera.org/learn/the-science-of-well-being is an easy way to access some CBT free online. See the signposts section at the end of this chapter (?)



Figure 3.3: Matthew Johnstone explains how he overcame the affects of depression, using the metaphor of the black dog [@youtube-blackdog]

3.3 Look after yourself

Looking after yourself can serve to both prevent and treat mental health issues that can affect you in life. You might be your own worst critic, or perhaps when you're under pressure you neglect things that are proven to be beneficial for your mental health, like sleep, exercise, mindfulness and friendship. Looking after yourself means at least three things:

- being mindful of your feelings and learning to ignore your inner critic
- being kind to yourself in various ways
- deliberately scheduling protected time to do the non-work things that matter.

Harvard Psychologist Laurie Santos describes five evidence-based strategies for coping when times are really challenging and tough in the video in figure ???. Those strategies are:

1. **Exercise:** getting regular exercise improves both physical AND mental health.
2. **Gratitude:** research shows that being grateful can significantly improve your mental health. One way to do this is by keeping a gratitude journal, a log you fill in everyday of things you are grateful for (either small or big)
3. **Sleep:** actively developing healthier sleep patterns. Poor sleep hygiene can be both cause and effect of poor mental health. See the discussion of *Why we sleep (?)* in the signposts section below



Figure 3.4: It's important not to neglect your body, mind, soul and social life when you're working hard. Look after yourself by Visual Thinkery is licensed under CC-BY-ND

4. **Socialising:** prioritise time with friends and family, rather than turning inward or diving deeper into work
5. **Mindfulness:** be mindful of emotions using the R.A.I.N. technique:
 - **Recognise:** negative emotions
 - **Accept:** accept emotions rather than fighting them
 - **Investigate:** notice how the emotion feels inside your body
 - **Nurture:** be kind to yourself

Laurie explains the R.A.I.N. technique in figure ??.

So there are things you can do to help yourself, but you may also need to seek help from others.

Sometimes a desire to be productive by working hard has the opposite effect, because the sacrifices you make can be counter-productive.

pic.twitter.com/D2SP4iJspT
— lizandmollie (@lizandmollie) February 23, 2020

3.4 Help is available if you need it

If you are affected by mental ill health, particularly anxiety or depression, it can be hard:



Figure 3.5: Laurie Santos describes five coping techniques for improving well-being: Exercise, gratitude, sleep, getting social and meditation (?).

- to recognise that you need help in the first place
- to help yourself using self-help resources
- to ask others to help you

Even if you don't need help, it's important to recognise and understand the symptoms of mental ill health. It's quite likely that someone you know will suffer from mental health issues and as their friend or peer, it might be you that can help by encouraging them to get the help they wouldn't otherwise ask for.

You are not alone, help is available if you (or your friends) need it from a wide variety of sources:

3.4.1 Your University

There are lots of people who can help you:

- your personal tutor or other academic members of staff
- non-academic staff in the University, for example in Manchester contact the Student Support Office (SSO) studentsupport.manchester.ac.uk
- counselling services, for example contact counsellingservice.manchester.ac.uk. The counselling service offers help on dealing with anxiety, depression, exam stress, confidence and other issues.
- peers, flat-mates, family, friends etc. People close to you can help, although some people affected by mental health find it easier to discuss

mental health with a trained professional or volunteer because of the social stigmas. There are lots of services outlined below that provide this kind of service.

3.4.2 The National Health Service

As a student studying in the UK you are entitled to access free healthcare provided by the National Health Service (NHS) of the United Kingdom. To do so you'll need to be registered with your general practitioner (GP), see nhs.uk: Getting medical care as a student

Your doctor can advise you on medical treatment if required, see for example nhs.uk/conditions/antidepressants

3.4.3 Nightline

Nightline nightline.ac.uk is a confidential listening and information service run by students for students. Nightline is open 8pm till 8am every night during term time. It offers anonymous, non-judgmental and non-advisory support for students as described in figure ??.

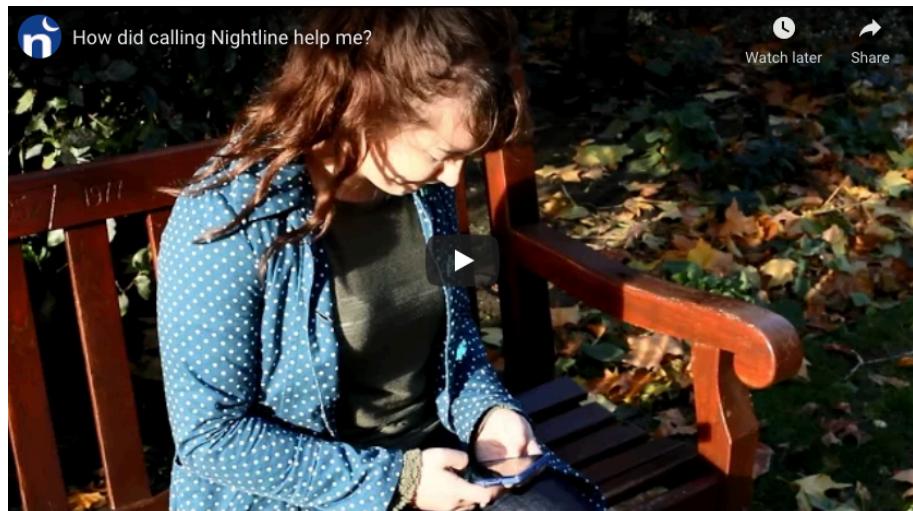


Figure 3.6: Students explain in their own words how calling Nightline helped them whilst at university. [[@youtube-nightline](https://www.youtube.com/@youtube-nightline)]

Manchester students can contact nightline at nightmail@nightline.manchester.ac.uk and expect a reply within 48 hours. See manchester.nightline.ac.uk for details.

3.4.4 The Samaritans

The Samaritans are a charity who provide emotional support to anyone in the United Kingdom and Ireland that:

- is suffering from emotional distress
- is struggling to cope
- is at risk of suicide

The name of the charity comes from the Parable of the Good Samaritan although the organisation itself is not religious. The Samaritans are available 24 hours a day, seven days a week, to talk confidentially about any problem, however big or small. See samaritans.org or telephone 116 123.

3.4.5 Students Against Depression

Students Against Depression (SAD) acknowledge the devastating impact that depression can have on those experiencing it, as well as on their friends, family and supporters. For further help in understanding and coping with suicidal thoughts, and emergency contacts in a crisis, visit studentsagainstdepression.org

Actor Ruby Wax has written about mental health and how the “internal critics” in our minds can send us mad in her book *Sane New World*. (?) She is interviewed by Students Against Depression in the video in figure ?? about using mindfulness to “dodge the bullets” of depression.

3.4.6 Papryus

Suicide is the biggest killer of under 35’s in the UK. Papyrus believe that many young suicides can be prevented, they are a national charity that you can find out more about at papyrus-uk.org or telephone the free number 0800 068 4141.

3.4.7 Self-help services

Self-Help services are a mental health charity which helps people to help themselves, see selfhelpservices.org.uk or phone 0161 226 3871.

3.4.8 MIND

MIND provide advice and support to empower anyone experiencing a mental health problem. They campaign to improve services, raise awareness and promote understanding of mental health issues. Find out more at mind.org.uk and in the video in figure ??



Figure 3.7: Ruby Wax describes being affected by depression in her childhood and how mindfulness and cognitive behavioural therapy (CBT) provided an alternative to medical treatment enabling her to dodge the bullets of mental health. [@youtube-wax]



Figure 3.8: Stephen Fry, President of Mind, describes how MIND tackles misconceptions around mental health and social stigmas. [@youtube-we-are-mind]

3.4.9 Student minds

Student Minds empowers students to look after their own mental health, support others and create change, find out more at studentminds.org.uk and in the video in Figure ?? which describes why its important to talk about student mental health.



Figure 3.9: Talking about mental health is a crucial part of helping those who are suffering from it [@youtube-student-minds]

3.4.10 Togetherall

Togetherall is an online community for people who are stressed, anxious or feeling low. The service has an active forum with round-the-clock support from trained professionals. You can talk anonymously to other members and take part in group or 1-to-1 therapy with therapists. Togetherall is for anyone aged 16 or over who wants to improve their mental health. The service is free for many universities. Find out more at togetherall.com and in the video in figure ?? which describes why its important to talk about student mental health.

3.5 Developing a growth mindset

Learning at University can be hard because you might have gone from being at (or near) the top of the class in high school to no longer being top of the class at University.

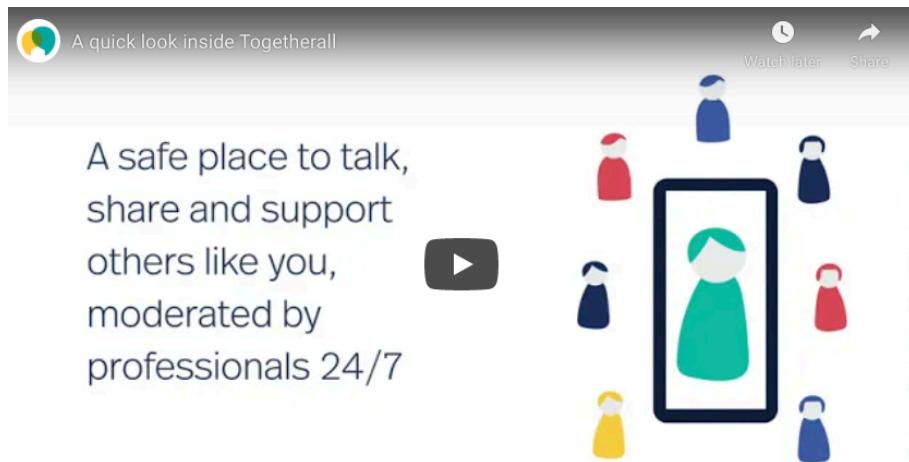


Figure 3.10: A quick look inside togetherall, an online community for people who are stressed, anxious or feeling low. [@youtube-togetherall]

Likewise the job hunting we describe in the chapter on searching can take a heavy toll on your mental health because repeated rejection is an ordinary part of the process. It can be time consuming, stressful and demoralising. You may find your applications disappear into a black hole. They will be ghosted (ignored) by employers. Interviewers will blank you and refuse to give you meaningful feedback because they're too busy. This could happen multiple times. This is all *par for the course*, normal and expected, and is not necessarily a reflection on your abilities or potential.

Adopting a growth mindset can be a successful strategy for maintaining your wellbeing, see figure ???. If your grades aren't as good as you hoped or your search for employment is being met with repeated rejection, a growth mindset can help. Let's take rejection from potential employers as an example, there are two ways you can react to it:

1. **Fixed mindset:** responding with a fixed mindset will mean you are likely to take rejection personally. You might even assume that this confirms what you've always suspected. You're not good enough or that you made some fatal mistake in your applications or interviews. Ouch.
2. **Growth mindset:** by responding to rejection with a growth mindset, you focus on what happens next. Rejection is not failure but a "not yet" described in figure ???. Maybe you're not yet ready for that employer, but you'll definitely have a good idea of what you learned from the process and how you can do better next time.

According to Stanford psychologist Carol Dweck we can all be placed on a



Figure 3.11: A fixed mindset is monolithic like the Easter island statues, known as Mo ai. If you're not already, you should be wary of a fixed mindset. Fixed mindsets by Visual Thinkery is licensed under CC-BY-ND

spectrum according to where we think our abilities come from. At one end, the fixed mindset assumes all kinds of abilities are fixed traits while at the other end, a growth mindset assumes these abilities can be developed over time. (?) There is good evidence to suggest that adopting a growth mindset will make you a better learner who can cope with the inevitable failures and rejections in life better. This approach can be used in a range of different disciplines such as learning programming languages (?), music (?) and job hunting.

3.6 Wellbeing signposts

This chapter has looked at your wellbeing and especially the role that both your mental health and physical health play in your future. Matt Haig's first-hand accounts of poor mental health will be comforting to anyone who is affected by mental ill health. Even if you're not affected, there is a 25% chance you will do at some point in your life. There's also a high probability someone close to you will suffer from mental health issues. It might be a colleague, friend, family member, fellow student or partner, so it is worth educating yourself on the issues by reading his two short books:

1. *Notes on a Nervous Planet* is a personal account of anxiety (?)
2. *Reasons to Stay Alive* is a personal account of depression (?)

What's good about Matt Haig's books is they are quick and easy to read, but give plenty of first-hand insight into what mental ill-health can do to people



Figure 3.12: Psychologist Carol Dweck explains the power of “not yet” and the growth mindset (?)

(including you). Matt describes his top five tips for good mental health in figure ??

There’s plenty of evidence to suggest that social media can have a detrimental effect on health. Jaron Lanier’s skeptical polemic *Ten Arguments for Deleting Your Social Media Accounts Right Now* (?) is a thought-provoking romp through some of the pitfalls of social media that may have you reaching for the delete or un-install button fairly quickly.

If all these books are making you sleepy, neuroscientist Matthew Walker’s *Why We Sleep: The New Science of Sleep and Dreams* may change your view on the importance of a good nights sleep. (?)

Finally, it’s well worth taking a look at Laurie Santos course on *The Science of Wellbeing* (TSOWB) at coursera.org/learn/the-science-of-well-being. (?) TSOWB course provides an alternative to medication as it follows the principles of cognitive behavioural therapy (CBT).

TSOWB is the most popular course at Yale University and looks at some simple techniques you can use to improve your happiness. (?) The course will help you increase your happiness and build more productive habits. Using the latest research, Santos describes the misconceptions about happiness and “annoying features” of your mind that can impair your well-being. The course takes about 19 hours to complete but you can spread this over a whole semester (or longer) if you choose. The short clip in figure ?? gives you a brief taster of Laurie’s style and work.

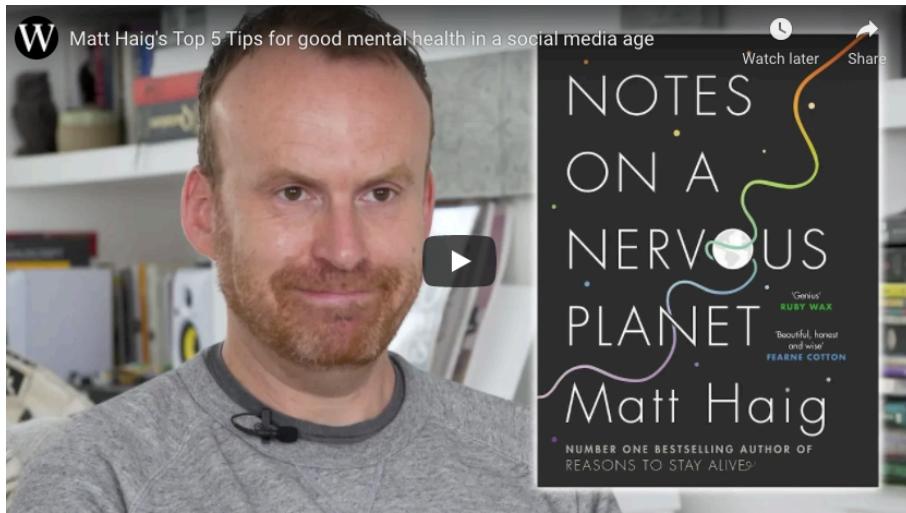


Figure 3.13: Two of Matt Haig's top five tips for good mental health (?) include 1. Being more careful (and mindful) of social media and 2. Reading more books because books are good for your soul. Not just his book. Any book. Books are good for you. Trust me on this. (?)

3.7 Summarising well-being

Too long, didn't read (TL;DR)? Here's a summary:

Anxiety and depression are serious conditions that are very likely to affect you or somebody close to you while you are at University. There's a one in four chance that you will be affected by mental health issues at some point in your life.

We've only talked about two particular mental health issues, anxiety and depression, but there are many other conditions such as phobias, obsessive-compulsive disorder (OCD), eating disorders, self-harm and more that are beyond the scope of this chapter. They do have one thing in common, and that is that talking about them is an important part of starting to develop better mental health.

If you are affected by mental ill health, talking about it is the first place to start, but often the hardest. In this chapter, I've outlined some ways you can help yourself alongside some of the services and people you can talk to if you need to.

Despite how you might feel, you are not alone.

Take my thoughts with you and when you look behind, you will surely see, a face that you recognise, you're not alone. (?)

Chapter 4

Writing your future

Let's get straight to the point of this chapter: your soft skills will take a **life time** to develop and are **really hard** use. Why? Because soft skills are about *communicating* with and *understanding* other people so that you can work *together* as a team toward a shared goal. Your soft skills are hard. There are very few jobs where you work on your own, and most software and hardware is designed, built, tested and used by teams of people. Many of these teams are large and have very diverse membership. This means that sooner or later you're going to have to master the dark arts of *working with other people* by deploying your softer skills.



Figure 4.1: Unless you want to be a lighthouse keeper on a remote island, there are very few jobs where you don't have to work as part of a team with other people. Sorry to break the bad news! This means you need to constantly improve your softer skills and provide evidence of them to potential employers. Other people sketch by Visual Thinkery is licensed under CC-BY-ND

Communicating with other people and working in teams is inherently difficult because we're all human. There is good news and bad news...

- **THE GOOD NEWS** is, people can be diligent, humble, competent, honest, caring and reliable. They can be co-operative, generous, supportive, kind, thoughtful, intelligent, sensitive, understanding, punctual and professional too!
- **THE BAD NEWS** is, unfortunately people can also be lazy, stupid, ignorant, vain, incompetent, dishonest, unreliable, greedy, egomaniacal, unpredictable and moody. They can be proud, selfish, competitive, lustful, angry, envious, mean, busy, insensitive and thoughtless too. Some will disagree with you, boss you around, betray, exploit, misunderstand and mislead you, deliberately or otherwise. (?)

So communicating with and understanding other people can be hard work, but don't worry, **everyone** finds this challenging, it's not just you! It doesn't matter if you're an extrovert or an introvert, we *all* find communication difficult, and everyone can get better at it. This chapter takes a look at the softer skills and techniques you can use to improve your communication with other people, whatever mood they are in and whosever team they are on.

4.1 What you will learn

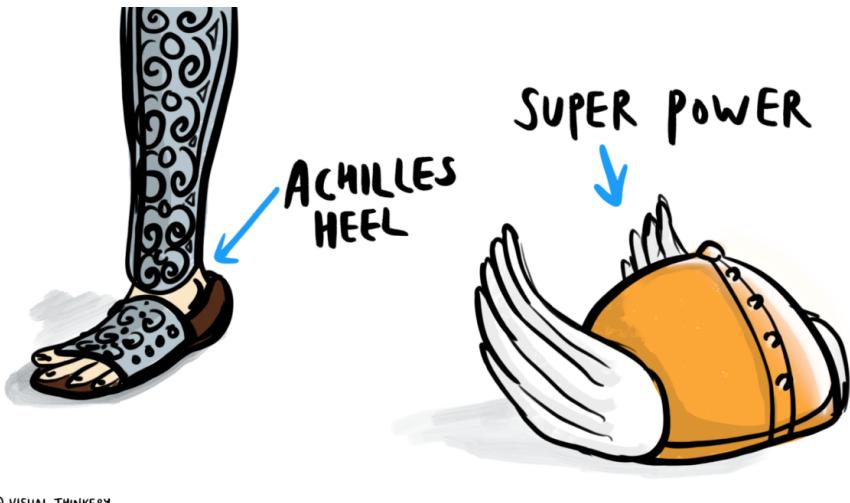
- Recognise the importance of written communication, both as a reader and a writer
- Identify examples of where written communication is crucial in science and engineering
- Improve your written communication skills using some simple writing and reading exercises
- Identify the importance of teamwork

4.2 Computing is your superpower!

Studying computer science gives you an awesome superpower. We will look at some of the reasons why in the chapter on Computing your Future. But for now, let us just acknowledge that hard technical skills like computing are highly sought after and valuable, both commercially and otherwise.

Your computational superpower is less powerful if it isn't complemented by a broad range of softer skills. Typically, these skills are not emphasised (by repeated assessment) in most computer science degrees. This not because soft skills aren't important but because they are hard to measure accurately.

For example, if I want to know how good you are at understanding the syntax and semantics of a programming language like Python, there are tried and tested techniques for doing this. However, if I want to know how good you are at using



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Figure 4.2: Computing is a superpower that gods like Hermes and heroes like Achilles would probably have envied. (?) As a technical or “hard skill”, computing a crucial weapon in your armoury but what are your weaker skills? What is your Achilles’ heel? For some scientists and engineers, their weakness is their soft skills, such as communication and team work. This chapter looks at what you can do to improve them and convince employers that you are rounded individual with a healthy balance of soft and hard skills. Achilles heel to superpower by Visual Thinkery is licensed under CC-BY-ND

your communication skills to work in a team, negotiate, lead, resolve conflicts, persuade others, show empathy etc that's **much** harder to measure accurately.

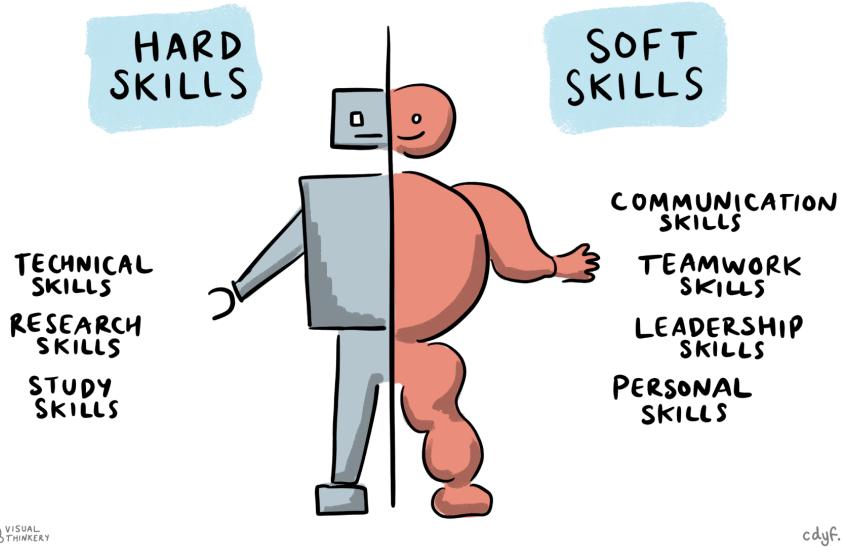


Figure 4.3: Hard skills and soft skills aren't much use without each other. You will need both to survive and thrive but your most science and engineering education focuses on your hard skills, not your soft skills. Why? Because hard skills are often much easier to measure. Hard and soft skills sketch by Visual Thinkery is licensed under CC-BY-ND

Let's look at some of low-level communication skills (I/O) that they are built on.

4.3 Communication I/O

In terms of input and output, your fundamental communication skills are listening, speaking, reading and writing words in natural languages shown in table ???. These are the “assembly languages” of human communication. This might sound blindingly obvious, but these skills are often under-estimated or under-valued by engineers and scientists, especially undergraduates. Alongside verbal and written communication, there's also nonverbal language, or body language such as eye contact, gestures and facial expressions.

Engineers and scientists sometimes lack communication skills outlined in table ???. Think of your stereotypical scientist, clad in a white coat, unable to explain the complexities of their subject to people inside their lab, let alone outside

Table 4.1: The inputs and outputs of the fundamental assembly languages of human communication

	Input	Output
Written natural language	Reading	Writing
Spoken natural language	Listening	Speaking
Nonverbal language	Observing other people	Being observed by others

of it. Then there is the nerdy software engineer stereotype who prefers the company of computers to people. Yes, these are lazy and sometimes unhelpful stereotypes, but they express public perception of scientists and engineers as poor communicators.

4.3.1 The pen is mightier than the sword

The art of communication is a huge subject which extends far beyond the scope of this guidebook. So for the rest of this chapter, we'll focus on written communication skills because:

1. **Good writing and reading are crucial in applications** for employment and further study. From writing CV's, covering letters, completing application forms and reading job specifications, and employer or course information, your ability to read and write natural languages is crucial to coding your future.
2. **Writing often gets neglected:** Written communication skills (both reading and writing) are sometimes sidelined in science and engineering degrees. This is particularly true in the “hard sciences”. For example, communicating and solving problems using code or mathematics are usually the dominant forms of assessment in computer science courses. That's understandable given the subject, but tends to push natural languages like english to the sidelines.
3. **Good engineers are also good writers** Many engineers (and scientists) could significantly improve their written communication skills. Software engineers are notoriously bad at writing good documentation, see for example Why Computer Science Students Need Language, (?) *Scientists Must Write* (?) and The Real Reason Silicon Valley Coders Write Bad Software, (?) just three examples amongst many others making exactly the same point. Employers like Google provide training (and a whole career path) for technical writers, see developers.google.com/tech-writing. However, I'm arguing that these careers wouldn't be needed if software engineers were better at documenting, explaining and communicating with other human beings their code in the first place!

4. **Writing good english is like writing good code.** Some of the skills you already have in coding can be transferred to written communication. Just like a good function or method in code should be well-defined with a clear purpose, your writing should also be clear and coherent. Well structured writing is a lot like well architected software too, with a clear separation of concerns (SoC)
5. **It is relatively easy to improve** your written communication skills, simply by reading and writing more. Reading and writing deliberately every day, will significantly improve these skills.

4.3.2 Natural language engineering

If you stop to think about it, engineers and scientists spend a *lot* time communicating in writing. As well as engineering code, they also spend a significant amount of time engineering messages in natural languages like english. Consider the following:

- email and instant messaging, Slack, Microsoft Teams, Discord, Zoom etc
- Posting on social media: LinkenIn, Facebook, WhatsApp, Twitter, blogs, Medium.com etc
- bug reports and messages in issue trackers like Jira, BugZilla and Trello
- ‘How to’ and cookbook style articles and books
- API reference material
- in-code documentation `# comments in code`
- Self-documenting code
- Executable specifications in test suites like cucumber.io
- Laboratory manuals and laboratory notebooks
- The one page summary for management
- User documentation, release notes
- Case studies of software use
- Frequently Asked Questions (FAQ)
- YourPersonalDomain.com (if you have one)
- Questions and answers on forums like stackoverflow.com
- Commit messages in version control systems like git and mercurial etc
- Architecture documentation and design specifications
- Literate programming natural language descriptions of computational logic (?)
- Jupyter.org notebooks, code and natural language mixed together
- bookdown.org mixes code and natural language

What do they all have in common? They’re all written in natural languages like the English language, but without them, the software or hardware they describe and discuss would be useless.

4.4 Writing your future

Hopefully I've convinced you that written communication skills (both as a writer and reader) are important soft skills that engineers often neglect. So how can you improve?

4.4.1 Try Google's Tech Writing course

Google have developed some excellent technical writing courses including:

1. Technical Writing One: Technical Writing Fundamentals for Engineers
developers.google.com/tech-writing/one
2. Technical Writing Two: Intermediate Technical Writing for Engineers
developers.google.com/tech-writing/two

These courses run as part of the second year course COMP2CARS at the University of Manchester, see the course schedule for details

Google occasionally delivers these technical writing courses as free sessions open to the general public. For details, see developers.google.com/tech-writing/announcements for details.

4.4.2 Deliberate daily writing

Another technique for improving your written communication is to write something every day, that might be a personal diary that only you read, or it could be something more public like blog. Schedule a time every day, say 15 to 30 minutes when you will do this without fail. That writing could take several forms:

- private diary
- gratitude journal
- public web log or blog
- personal notes gathered somewhere (e.g. private github repository)
- bullet journal. Some people swear by it, see bulletjournal.com

The technique of *30 minutes per day* can be a very effective way of getting things done, incrementally over time. In my experience it works for lots of things besides writing including getting exercise (discussed in the wellbeing chapter) to gardening. (?)

4.4.3 Deliberate daily reading

Reading other people's code will improve your software engineering skills. Likewise, reading other peoples writing will improve your natural language engineering skills. Read anything, it might be novels, magazines, newspapers, stuff online or any of the books cited in the references. Find a time and place to do this every day and stick to it.

4.4.4 Dogfooding

Some companies test their products by trialling them on their own employees, this is sometimes known as eating your own dogfood. Tasty, tasty dogfood.

You can use a similar approach to testing your own writing, known simply as **Dogfooding**. Let's say you've just written a covering letter. It's natural to read it over in your head to check for errors, before you send it. However, **reading it aloud** will pick up errors you may not have spotted by reading silently. There's something about articulating words out loud that flushes out errors you don't pick up when you read them. This is a tried and tested technique. It also means you're ready to vocalise those answers in an interview.

You might want to choose carefully where you do this as it might look a bit strange, but it works well. If you talk into a mobile phone while looking at a piece of paper, people won't notice you're talking to yourself. But you'll probably need some privacy as the stuff you're talking about is likely to be personal.

4.4.5 Reading the friendly manual

You don't get good at communicating with computers (coding) by just *writing* lots of code. You also need to *read* other people's code too and be able to understand and modify it. Likewise, you don't get good at communicating with people by just *writing* stuff in natural languages like english. You need to *read* stuff too. Books, manuals, software documentation, articles, use cases, novels, poetry, plays, magazines, newspapers etc. Reading this stuff will help you learn and you'll improve your written communication skills too. This sentiment is commonly expressed in Computer Science as read the friendly manual (RTFM), as shown in figure ??

4.5 Coding challenges

- Write an article or blog post about something you care about, find a suitable venue for publication



Figure 4.4: As well as learning from other people's hard won experience, reading the friendly manual (RTFM) will also improve you written communication skills. Just like you improve your coding skills by writing and reading code, improve your written communication skills by reading and writing in natural languages like English. RTFM poster by Jeremy Keith, modified by Atlaslowa is licensed under CC-BY on Wikimedia Commons w.wiki/vBX

- Take a course from outside computer science, where the main form of assessment is written essays or dissertations. Humanities departments are a good place to start. This will improve your written communication skills
- Not been reading many books lately? Pick a book to read just because its interesting, rather than because you have to.

4.6 Summarising your soft skills

Too long, didn't read (TL;DR)? Here's a summary:

You'll need both soft and hard skills to compete in the workplace. Don't underestimate the importance of softer skills, we've looked briefly at written communication skills in this chapter but that's only the tip of the soft skills iceberg.

Teamwork, negotiation, conflict resolution, motivation and leadership are other soft skills that are important too. How can you develop these skills while at University? How can you demonstrate to potential employers that you have these skills?

This chapter is under construction because I'm using agile space station development methods, see figure ??.

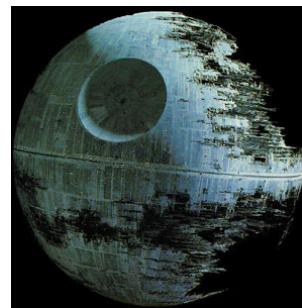


Figure 4.5: This chapter is under construction. Image of the Death Star via Wikimedia Commons w.wiki/32PB

Chapter 5

Experiencing your future

So, tell me, are you experienced? Why is experience valuable and what kind of experience are employers looking for anyway? How can you get some more experience?

5.1 What you will learn

By the end of this chapter you will be able to

- Describe why having experience can improve your chances of getting interviews
- Identify what counts as experience and why it's valuable
- Recognise opportunities to get more experience before you graduate

5.2 Why is experience so valuable?

It's common for students to be focused on their grades, whether those grades are low, middling or high. At the extremes, if you have got lower grades than you'd like, you might be anxious or unhappy about them. If you've got higher grades, you're probably focussed on keeping them high. Either way, you are *much more* than your grades, because your education is only a part of who you are, shown in figure ???. You are the sum total of your experiences, this is one of the reasons that experience is so valuable.



cdyf.me

cdyf.me

Figure 5.1: Do you respond with a sheepish *experience not found* error message when people ask about your experience? Is your experience like the classic HTTP 404 page not found? The client sent you a valid request for your experience, but your server couldn't find it. Awkward. Embarrassing silence? Don't worry, there are some simple and easy ways to build your experience so that instead of negative 404's, you can respond with a cheerfully positive 200 (OK), as described in this list of HTTP status codes. We'll look at some of them in this chapter. Experience not found sketch by Visual Thinkery is licensed under CC-BY-ND

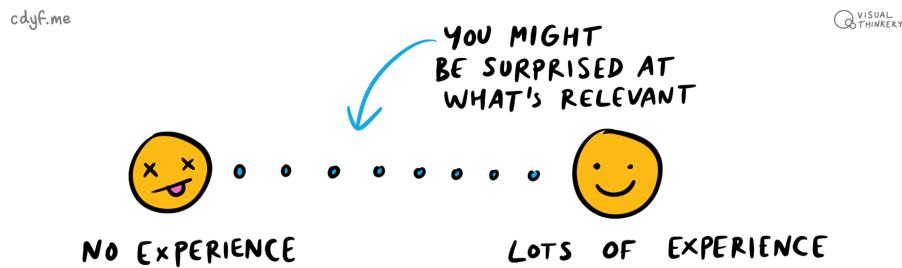


Figure 5.2: You might be surprised by which of your experiences are relevant, and what kinds of experience are relevant on your CV. What's relevant sketch by Visual Thinkery is licensed under CC-BY-ND



Figure 5.3: You are not your grades. Your experience tells people much more about your character, not just paid work, but any voluntary work and projects you've been involved in too. I am more than just my grades sketch by Visual Thinkery is licensed under CC-BY-ND

5.3 Are you experienced?

So what counts as experience?

- Freelance work: being self-employed
- Insight programmes and spring weeks: work shadowing
- Part-time jobs: casual or part-time work

5.3.1 Big name experience

It's easier than you might think to get a big name on your CV. For example, many large employers run insight days, vacation schemes and spring weeks. These are often aimed at first years, and are sometimes less competitive to get into than a longer term commitment such as a summer internship, year-long placement or even graduate job. A big name on your CV early in your degree can help it stand out later, as fluff bucket the grinning cheshire cat demonstrates on their CV shown in ??.

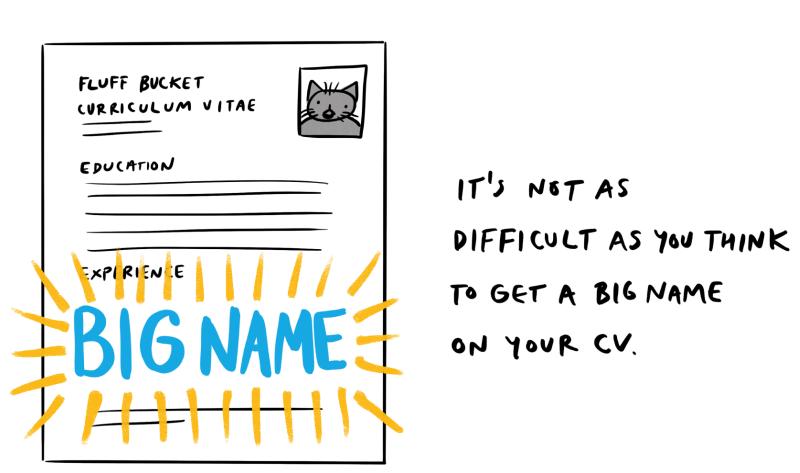


Figure 5.4: It's easier than you might think to get a big name on your CV, sometimes these can help your application stand out from the competition. Big name sketch by Visual Thinkery is licensed under CC-BY-ND

Other ways to get a big name on your CV include joining a big name competition or event, for example:

- Google has Code Jam, HashCode and Kick Start codingcompetitions.withgoogle.com and Summer of Code summerofcode.withgoogle.com