Doctoral Thesis

Counting the dead

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*A thesis submitted in fulfillment of the requirements
for the degree of Doctor of Philosophy*

in the

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Department of Epidemiology and Biostatistics

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Declaration of Authorship

I, Theo Rashid, declare that this thesis titled, Counting the deadand the work presented in it are my own. I confirm that:

- This work was done wholly or mainly while in candidature for a research degree at this University.

- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.

- Where I have consulted the published work of others, this is always clearly attributed.

- Where I have quoted from the work of others, the source is always given. With the exception of such quotations, this thesis is entirely my own work.

- I have acknowledged all main sources of help.

- Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself.

Signed:

_____

Date:

_____

"*Nobody is going to read your thesis.*"

Kyle Foreman

Abstract

People died in England and we modelled the death rates. This took longer than expected.

Acknowledgements

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List of Abbreviations

CrI   **Cr**edible **i**nterval
CAR   **C**onditional **a**uto**r**egressive
ICAR   **I**ntrinsic **C**onditional **a**uto**r**egressive
LSOA   **L**ower Layer **S**uper **O**utput **A**rea
MCMC **M**arkov **c**hain **M**onte **C**arlo
MSOA **M**iddle Layer **S**uper **O**utput **A**rea
NUTS   **N**o **U**-**t**urn **S**ampler

Chapter 1

Overview

1.1 Welcome and Thank You

Welcome to this LaTeX Thesis Template, using the LaTeX typesetting system and [Quarto](#) and based on the LaTeX thesis template MastersDoctoralThesis version 2.0 downloaded from [LaTeXTemplates](#). This LaTeX document class was authored by Vel (vel@latextemplates.com) and Johannes Böttcher based on a style file by Steve R. Gunn from the University of Southampton (UK), department of Electronics and Computer Science.

1.2 A Short Math Guide for LaTeX

If you are writing a technical or mathematical thesis, then you may want to read the document by the AMS (American Mathematical Society) called, "A Short Math Guide for LaTeX". It can be found online at [AMS](#) under the "Additional Documentation" section towards the bottom of the page.

1.2.1 Common LaTeX Math Symbols

There are a multitude of mathematical symbols available for LaTeX and it would take a great effort to learn the commands for them all. The most common ones you are likely to use are shown on [this page](#).

You can use this page as a reference or crib sheet, the symbols are rendered as large, high quality images so you can quickly find the LaTeX command for the symbol you need.

1.3 About this Template

This LaTeX Thesis Template is originally based and created around a LaTeX style file created by Steve R. Gunn from the University of Southampton (UK), department of Electronics and Computer Science. You can find his original thesis style file at his site, here: http://www.ecs.soton.ac.uk/~srg/softwaretools/document/templates/.

Steve's `ecsthesis.cls` was then taken by Sunil Patel who modified it by creating a skeleton framework and folder structure to place the thesis files in. The resulting template can be found on Sunil's site here: http://www.sunilpatel.co.uk/thesis-template.

Sunil's template was made available through [LaTeXTemplates](#) where it was modified many times based on user requests and questions. Version 2.0 and onwards of this template represents a major modification to Sunil's template and is, in fact, hardly recognisable. The work to make version 2.0 possible was carried out by Vel (vel@latextemplates.com) and Johannes Böttcher.

1.4   What this Template Includes

1.4.1   Folders

- Appendices – this is the folder where you put the appendices. Each appendix should go into its own separate qmd file. An example and template are included in the directory.

- Chapters – this is the folder where you put the thesis chapters. Each chapter should go in its own separate qmd file.

- Figures – this folder contains static figures for the thesis, i.e. figures that are not generated by code in the chapters.

1.4.2   Files

- example.bib – this is file that contains all the bibliographic information and references that you will be citing in the thesis for use with BibTeX. You can write it manually, but there are reference manager programs available that will create and manage it for you. Zotero is popular and integrates with RStudio IDE if you use that.

- MastersDoctoralThesis.cls – this is the class file that tells LaTeX how to format the thesis.

- pdf in docs folder – this is your typeset thesis.

- Frontmater folder – this has the files for the various front matter elements.

1.5   Filling in Your Information

Most of the personal information is found on in the `_quarto.yml` file.

- author – you; optionally add url
- supervisor – your supervisor; optionally add url.
- university – your university
- department – your department
- faculty – faculty name
- group – research group name (optional)
- abstract

1.6   The `tex\before-body.tex` File Explained

The `tex\before-body.tex` file contains the structure of the thesis and is a mix of Pandoc template and LaTeX code. The bits that look like `$book.university$` say are Pandoc and are referencing variables in the `_quarto.yml` file. Knowing that, you should be able to figure out what is happening.

There are plenty of written comments that explain what pages, sections and formatting the LATEX code is creating. Each major document element is divided into commented blocks with titles in all capitals to make it obvious what the following bit of code is doing. Initially there seems to be a lot of LATEX code, but this is all formatting, and it has all been taken care of so you don't have to do it.

Many of the sections have `$if(...)$` so that the section is only included if you included information for that in `_quarto.yml`.

In the `_quarto.yml`, `pdf: toc: false` is used so that Quarto/Pandoc doesn't add a table of contents. This template puts the table of contents before the abbreviations and symbols pages and Quarto/Pandoc doesn't let us control where it puts the table of contents. So we have to add the TOC manually for pdf and pass in `toc: false`.

The list of figures and tables are all taken care of for you and do not need to be manually created or edited. The next set of pages are more likely to be optional and can be deleted since they are for a more technical thesis: insert a list of abbreviations you have used in the thesis, then a list of the physical constants and numbers you refer to and finally, a list of mathematical symbols used in any formulae. Making the effort to fill these tables means the reader has a one-stop place to refer to instead of searching the internet and references to try and find out what you meant by certain abbreviations or symbols.

The list of symbols is split into the Roman and Greek alphabets. Whereas the abbreviations and symbols ought to be listed in alphabetical order (and this is **not** done automatically for you) the list of physical constants should be grouped into similar themes.

The next page contains a one line dedication. Who will you dedicate your thesis to?

1.7 Adding Your Chapters and Appendices

Add your chapters and appendices to `_quarto.yml`. Note that the spacing is important as is the leading -.

1.8 Bibliography and Citations

Citations will be added and formatted automatically for you.

Practice reference (Rashid et al. 2021) Lorem ipsum dolor sit amet (Bennett et al. 2015, 2018; Yu et al. 2021)

If you use the RStudio IDE, then you can link Zotero to RStudio and Quarto will find your citations for you when you enter `@`. This is in the visual editor mode. Make sure to search for videos on how to do this as using Zotero libraries will make your citation and bibliography management much much easier.

In the text use `@smith2000` to produce Smith (2000) add use `[@smith2000,` `@jones1999]` to produce (Smith 2000; Jones 1999). See the natbib cheatsheet for how to do other types of formatting for your in text citations. The bibliography style (`classoption: "authoryear"`) is used for the bibliography and is a fully featured style that will even include links to where the referenced paper can be found online.

1.8.0.1   A Note on bibtex

The bibtex backend used in the template by default does not correctly handle uni-code character encoding (i.e. "international" characters). You may see a warning about this in the compilation log and, if your references contain unicode characters, they may not show up correctly or at all. One solution to this is to use the biber backend instead of the outdated bibtex backend. This is done by finding this in `tex/in-header.tex`: `backend=bibtex` and changing it to `backend=biber`. Google a bit to find information on this.

1.9   Thesis Features and Conventions {sec-ThesisConventions}

To get the best out of this template, there are a few conventions that you may want to follow.

1.9.1   Printing Format

This thesis template is designed for double sided printing (i.e. content on the front and back of pages) as most theses are printed and bound this way. Switching to one sided printing is as simple as adding `"oneside"` to `classoptions:` in the `_quarto.yml` file. The headers for the pages contain the page number on the outer side (so it is easy to flick through to the page you want) and the chapter name on the inner side.

The text is set to 11 point by default with single line spacing, again, you can tune the text size and spacing should you want or need to using the class options. The spacing can be changed similarly by replacing the `"singlespacing"` with `"onehalfspacing"` or `"doublespacing"` in the class options.

1.9.2   Using US Letter Paper

The paper size used in the template is A4, which is the standard size in Europe. If you are using this thesis template elsewhere and particularly in the United States, then you may have to change the A4 paper size to the US Letter size. This can be by editting `geometry:` in `_quarto.yml` in the pdf format section.

1.10   Tables

When you render your Quarto thesis to PDF, it will process LaTeX table code just fine. However, if you are doing that, I am guessing you would be writing your thesis in LaTeX not Quarto. So I will not discuss LaTeX tables. Instead here is how you create tables using R. Python and Julia users, you'll have your own table packages but the idea will be similar.

See the Quarto manual for full examples and instructions.

1.11   Figures

Again we write in Quarto (markdown) not LaTeX for our figures. You can write in LaTeX if you really want but it would only be interpreted for the PDF output.
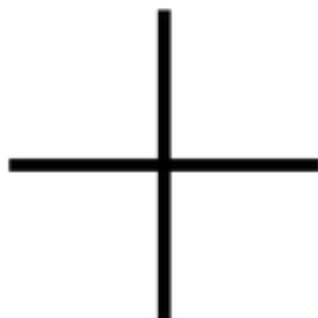
FIGURE 1.1: icon

The `#|` is what sets up our cross-references and you can then reference the table as `@fig-icon`.

This is Figure 1.1.

See the Quarto manual for full examples and instructions.

1.11.1 Typesetting mathematics

If your thesis is going to contain heavy mathematical content, LaTeX will make it look beautiful, for HTML or PDF output.

The Not So Short Introduction to LaTeX should tell you everything you need to know for most cases of typesetting mathematics. If you need more information, a much more thorough mathematical guide is available from the AMS called, A Short Math Guide to LaTeX.

1.12 In Closing

Good luck and have lots of fun!

This guide was written originally by

Sunil Patel: http://www.sunilpatel.co.uk}{www.sunilpatel.co.uk

and Vel: http://www.LaTeXTemplates.com

and heavily shortened and adapted for Quarto by Eli Holmes.

Chapter 2

Background

2.1   The Small Area Health Statistics Unit

In 1983, a documentary on the fallout produced from a fire at the Sellafield nuclear site in Cumbria claimed that there was a ten-fold increase in cases of childhood leukaemia in the surrounding community. This anomaly had gone undetected by public health authorities, raising concern that routinely collected data were not able to identify local clusters of disease. The subsequent enquiry confirmed the excess, and recommended that a research unit was set up to monitor small area statistics and respond quickly to *ad hoc* queries on local health hazards. The Small Area Health Statistics Unit (SAHSU) was established in 1987 (P. Elliott et al. 1992).

Beyond producing substantive research studies on environment and health, a core aim of SAHSU was to develop small area statistical methodology. In particular, methods of:

- *Disease mapping*. Summarising the spatial variation in risk.
- *Geographic correlation studies*. Is there a correlation between disease risk and environmental variables?
- *Point source type studies*, Is there an increased risk close to an environmental hazard?
- *Clustering*. Does a disease to produce non-random spatial patterns of incidence? If the aetiology is unknown, this could suggest the disease is infectious.

The focus for many of the studies were rare diseases at small areas, so there was a need for statistical smoothing, in particular Bayesian methods (Best, Richardson, and Thomson 2005; Wakefield and Elliott 1999; Paul Elliott et al. 2001).

Elliot 1992. Pilot study was a point source. Collect deaths at postcode level. Docks near Plymouth. Dockyard workers, mesothelioma and asbestosis related to industrial exposure and asbestos. Circular bands drawn around Plymouth docks. Clear increase in risk within 3km of the docks.

Aylin 1999, building the facility. Point source

Move beyond exposure studying in circles, distance as proxy for exposure, directly model the exposure surface

Kidney risk near plants Hodgson 2004. Exposure to Mercury Hodgson 2006.

Chlorination congenital anomalies Whitaker 2004, Nieuwenhuijsen 2008, stillbirths Toldeano 2009, low birth weight Toledano 2009, Toledano 2011

Between 2001 and 2009 the Small Area Health Statistics Unit - SAHSU (based at Imperial College) published results from the most extensive study ever conducted into health effects of landfill sites. This work was initiated due to public concern over whether humans are exposed to toxic chemicals in landfill (which accounts for over 80% of municipal waste in Britain) and suffer adverse health consequences as a result [1-5]. The rates of birth defects, low birthweight, stillbirths, and of certain cancers in populations living within 2km of landfill sites were studied. Landfill reproductive health effects Elliot 2001, Jarup 2002, Morris 2003, Elliot 2005, Down's Jarup 2006, Jarup 2007, Elliot 2009

Telephone masts childhood cancers 2011

HES aircraft noise Hansell 2013. Road traffic noise London Halonen 2015

Incinerators study and reproductive health https://www.imperial.ac.uk/school-public-health/epidemiology-and-biostatistics/small-area-health-statistics-unit/our-research/incinerators-study/ Ghosh 2018, Parkes 2020

Environment and Health Atlas for England and Wales, fourteen health outcomes, six environmental exposures, spatial variation in long-term (25 years: 1985 -2009), ward level

Health Impacts of Bioaerosols from Large Scale Biocomposting Waste Facilities Douglas 2019

2.1.1   Disease mapping

Best 2005 focuses on disease mapping. Discuss the method of each paper

Aylin 1999, Mapped statistically smoothed diseases Kensington, Chelsea and Westminster. Directly standardised

Disease mapping. Methods in Best 2005. Cancer mapping: brain in west midlands Eaton 1997, testicular Toledano 2001, prostate Jarup 2002. CVD risk Asaria 2012, Asaria 2017. Model for small-area trends in cause-specific and all-cause mortality. Bennett 2015, Bennett 2018.

My studies

Over space and time. Ability to reliably detect excess risk depends on size of risk and expected numbers (small areas). Li et al Biostatistics 2012, Boulieri et al Spatial Spatio-temp Epidemiol 2016

Methodology developed generally in 1990s-2000s spatial epidemiology book. Point sources, exposure. Elliot 2008. Best etc book on spatial epi, particularly bayesian methods

2.2   (Bayesian) and disease mapping (finer scales)

Correlation matrix MVN, using centroids, function of distance (Spatial epi book application to disease mapping). Gaussian Markov Random Field (CAR). BYM model. Gaussian processes. Hierarchcial model, Foreman 2012. Exploit hierarchical structure

Statistics of spatial modelling. Gaussian processes etc Kyle's thesis.

2.2.1   Small area analysis of mortality (over space, but also time age)

Population issue, measuring between census, migration. Look at sahsu spatial epi book, Wakefield 1999. Births, deaths and migration for population between census years

Poeple who have calculated SMR. **Indirect** model vs direct model (calculate age specific and use life tables) of mortality

United States LDL King county 2015, LDL 2016

United Kingdom Bennett 2015

Australia, Stephens 2013 NSW

Canada, Yu 2022

South Korea

SALURBAL. Santiago Chile Bilal 2019

Rotterdam Jonker 2012

Rasulo, D., Bajekal, M., Yar, M., 2007. Inequalities in health expectancies in England and Wales–small area analysis from the 2001 Census. Health Stat Q 34 (35), 35.

London wards DALY Congdon 2014

Practice reference (Rashid et al. 2021) Lorem ipsum dolor sit amet (Bennett et al. 2015, 2018; Yu et al. 2021), consectetur adipiscing elit. Aliquam ultricies lacinia euismod. Nam tempus risus in dolor rhoncus in interdum enim tincidunt. Donec vel nunc neque. In condimentum ullamcorper quam non consequat. Fusce sagittis tempor feugiat. Fusce magna erat, molestie eu convallis ut, tempus sed arcu. Quisque molestie, ante a tincidunt ullamcorper, sapien enim dignissim lacus, in semper nibh erat lobortis purus. Integer dapibus ligula ac risus convallis pellentesque.

2.3   Cause-specific analyses

See Kyle's thesis

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2.4   Inqualities in the UK

People modelling over space Bennett 2015 Deprivation Bennett 2018 Marmot Class Wilkinson and Whitehead

Chapter 3

The model

3.1 Model

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3.1.1 Contributions to open source

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3.1.2 NumPyro quicker than nimble

Chapter 4

Small: Life expectancy trends in England, LPH

4.1 Introduction

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4.1.1 Methods

Nunc posuere quam at lectus tristique eu ultrices augue venenatis. Vestibulum ante ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Aliquam erat volutpat. Vivamus sodales tortor eget quam adipiscing in vulputate ante ullamcorper. Sed eros ante, lacinia et sollicitudin et, aliquam sit amet augue. In hac habitasse platea dictumst.

4.1.2 Results

4.1.3 Discussion

4.1.4 Conclusion

Chapter 5

Smaller: Life expectancy inequality in London

5.1 Introduction

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5.1.1 Methods

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5.1.2 Results

5.1.3 Discussion

5.1.4 Conclusion

Chapter 6

Cancers

6.1 Introduction

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6.1.1 Methods

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6.1.2 Results

6.1.3 Discussion

6.1.4 Conclusion

Chapter 7

Cause-specific

7.1 Introduction

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ismod. Nam tempus risus in dolor rhoncus in interdum enim tincidunt. Donec vel
nunc neque. In condimentum ullamcorper quam non consequat. Fusce sagittis tem-
por feugiat. Fusce magna erat, molestie eu convallis ut, tempus sed arcu. Quisque
molestie, ante a tincidunt ullamcorper, sapien enim dignissim lacus, in semper nibh
erat lobortis purus. Integer dapibus ligula ac risus convallis pellentesque.

7.1.1 Methods

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ipsum primis in faucibus orci luctus et ultrices posuere cubilia Curae; Aliquam erat
volutpat. Vivamus sodales tortor eget quam adipiscing in vulputate ante ullamcor-
per. Sed eros ante, lacinia et sollicitudin et, aliquam sit amet augue. In hac habitasse
platea dictumst.

7.1.2 Results

7.1.3 Discussion

7.1.4 Conclusion

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Appendix A

Frequently Asked Questions

A.1   How do I change the colors of links?

Pass in `urlcolor:` in yaml. Or set these in the include-in-header file.

If you want to completely hide the links, you can use:

{\hypersetup{allcolors=.}}, or even better:

{\hypersetup{hidelinks}}.

If you want to have obvious links in the PDF but not the printed text, use:

{\hypersetup{colorlinks=false}}.