MONASH University

MONASH BUSINESS SCHOOL

ETC4500/ETC5450
Advanced R programming

Week 6: Literate programming with Quarto

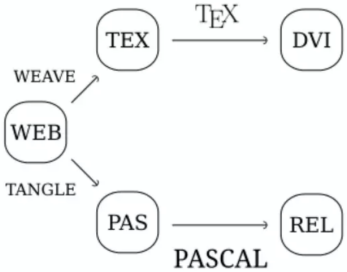
Outline

1. Literate programming
2. roxygen2
3. Rmarkdown
4. Quarto
5. Monash Quarto Templates
6. Assignment 2

Outline

Literate programming

- Due to Donald Knuth (Stanford), 1984
- A script or document that contains an explanation of the program logic in a natural language (e.g. English), interspersed with snippets of source code, which can be compiled and rerun.
- Generates two representations from a source file: formatted documentation and “tangled” code.



Literate programming

- As a programming approach, it never quite caught on.
- But it has become the standard approach for reproducible documents.

Literate programming examples

- WEB (combining Pascal and TeX)
- roxygen2 comments
  - technically documentation generation rather than literate programming
  - documentation embedded in code, rather than code embedded in documentation
- Sweave documents
- Jupyter notebooks
- Rmarkdown documents
- Quarto documents

Outline

roxygen2

- roxygen2 documentation are just comments to R.
- roxygen2::roxygenize():
  - generates documentation from these comments in the form of Rd files
  - adds relevant lines to the NAMESPACE file.
- roxygen2::roxygenize() is called by devtools::document().
- Advantage: keeps documentation with the code. More readable, less chance for errors.

Outline

Markdown syntax

Markdown: a “markup” language for formatting text.

- Headings:

```
# Heading 1
## Heading 2
```

- **Bold**: `**bold**`.
- *Italic*: `*italic*`.
- Blockquotes:

```
> blockquote.
```

Markdown and Rmarkdown

- Markdown (markup language):
  - Extension either `.md` or `.markdown`.
  - Used in many places on the web, in note-taking apps, etc.
- Rmarkdown (markup language):
  - an extension of markdown that allows for embedded R code chunks.
  - Extension `.Rmd`.
- Rmarkdown (package):
  - an R package that allows for the conversion of `.Rmd` files to other formats.

Rmarkdown files

- Structure:
  1. YAML header
  2. Markdown content
  3. R code chunks surrounded by ```` ```{r} ```` and ```` ``` ````
  4. Inline R surrounded by `` `r `` and `` ` ``
- Rmarkdown documents can be compiled to HTML, PDF, Word, and other formats
- Compile with `rmarkdown::render("file.Rmd")`

Rmarkdown, knitr and pandoc

- `rmarkdown::render()`
  - Uses `knitr` to run all code chunks, and "knit" the results into a markdown file (replacing R chunks with output).
  - Uses `pandoc` to convert the markdown file to the desired output format.
  - If PDF output is desired, LaTeX then converts the tex file (from pandoc output) to pdf.

knitr functions

- `knitr::knit()`: knits a single Rmd file — runs all code chunks and replaces them with output in a markdown file.
- `knitr::purl()`: extracts all R code from an Rmd file and saves it to a new file.
- `knitr::spin()`: knits a specially formatted R script file into an Rmd file.

Rmarkdown packages

- rmarkdown (to html, pdf, docx, odt, rtf, md, etc.)
- bookdown (to html, pdf, epub)
- blogdown (to html) – uses hugo rather than pandoc
- xaringan (to html) – uses remark.js rather than pandoc
- beamer (to pdf)
- rticles (to pdf)
- tufte (to html, pdf)
- vitae (to pdf)
- distill (to html)
- flexdashboard (to html)

Outline

Quarto

- Generalization of Rmarkdown (not dependent on R)
- Supports R, Python, Javascript and Julia chunks by using either `knitr`, `jupyter` or `ObservableJS` engines.
- More consistent yaml header and chunk options.
- Many more output formats, and many more options for customizing format.
- Heavier reliance on pandoc Lua filters
- Uses pandoc templates for extensions

Choose your engine

Specify the engine in the yaml header:

```
---
engine: knitr
---
```

```
---
engine: jupyter
jupyter: python3
---
```

Default: If any `{r}` blocks found, use `knitr` engine; otherwise use `jupyter` (with kernel determined by first block).

Code chunks

Chunk options use the hash-pipe `#|`

````
```{r}
#| label: fig-chunklabel
#| fig-caption: My figure
#| fig-width: 6
#| fig-height: 4
mtcars |>
  ggplot(aes(x = mpg, y = wt)) +
  geom_point()
```
````

Reference the figure using `@fig-chunklabel`.

Chunk options

- Quarto consistently uses hyphenated options (`fig-width` rather than `fig.width`)
- The Rmarkdown `knitr` options are recognized for backwards compatibility.
- Options that are R expressions need to be prefaced by `!expr`

````
```{r}
#| fig-cap: !expr paste("My figure", 1+1)
```
````

Execute options

- `execute` option in yaml header can be used instead of a `setup` chunk:

```
execute:
  cache: true
  echo: false
  warning: false
```

Some chunk options

- `label`: name of chunk. Useful for cross-references
- `eval`: whether to evaluate the code chunk
- `echo`: whether to display the code chunk
- `output`: whether to show chunk output
- `results: 'asis'` includes the output without markup
- `message`: whether to display messages
- `warning`: whether to display warnings
- `error: true`: continue even if code returns an error.
- `fig-cap`: caption for the figure
- `fig-width`, `fig-height`: width and height of the figure
- `cache`: whether to cache the code chunk
- `dependson`: cache dependencies

Debugging

- The Quarto document is compiled in a different environment from your R console.
- If you get an error, try running all chunks (Ctrl+Alt+R).
- If you can't reproduce the error, check the working directory (add `getwd()` in a chunk).
- Try setting `error: true` on problem chunk to help you diagnose what happens. (But change it back!)
- Look at the intermediate files (`.md` or `.tex`) to see what is happening.

Caching

```
```{r}
#| cache: true
```
```

- When evaluating code chunks, knitr will save the results of chunks with caching to files to be reloaded in subsequent runs.
- Caching is useful when a chunk takes a long time to run.
- It will re-run if the code in the chunk changes in any way (even comments or spacing).
- Beware of inherited objects from earlier chunks. Without explicit dependencies, a chunk will not re-run if inherited objects change.
- Beware of dependence on external files.

Caching

````
```{r}
#| label: chunk1
#| cache = TRUE
x <- 1
```


```{r}
#| label: chunk2
#| cache: true
#| dependson: "chunk1"
y <- x*3
```
````

Caching

Cache will be rebuilt if:

- Chunk options change except `include`
- Any change in the code, even a space or comment
- An explicit dependency changes

Do not cache if:

- setting R options like `options('width')`
- setting knitr options like `opts_chunk$set()`
- loading packages via `library()` if those packages are used by uncached chunks

Caching with random numbers

````
```{r}
#| label: setup
#| include: false
knitr::opts_chunk$set(cache.extra = knitr::rand_seed)
```
````

- `rand_seed` is an unevaluated expression.
- Each chunk will check if `.Random.seed` has been changed since the last run.
- If it has, the chunk will be re-run.

Some caching options

- `cache-comments` If `false`, changing comments does not invalidate the cache.
- `cache-rebuild` Force rebuild of cache.
- `dependson` A character vector of labels of chunks that this chunk depends on.
- `autodep` If `true`, the dependencies are automatically determined. (May not be reliable.)

Caching

Build automatic dependencies among chunks

```
execute:
  cache: true
  autodep: true
```

Child documents

````
```{r}
#| child: file1.qmd, file2.qmd
```
````

Child documents

```
```{r}
#| child: file1.qmd, file2.qmd
```
```

Conditional inclusion

```
```{r}
#| child: !expr if(condition) 'file1.qmd' else 'file2.qmd'
```
```

Child documents

```
```{r}
#| child: file1.qmd, file2.qmd
```
```

Conditional inclusion

```
```{r}
#| child: !expr if(condition) 'file1.qmd' else 'file2.qmd'
```
```

R Script files

```
```{r}
#| file: "Rscript1.R"
```
```

- Better than `source("Rscript1.R")` because output of script included and dependencies tracked.

Other language engines

````
```{python}
print("Hello Python!")
```
````

````
```{stata}
sysuse auto
summarize
```
````

- Python and Stata need to be installed with executables on PATH

Other language engines

```
names(knitr::knit_engines$get())
```

```
 [1] "awk"       "bash"      "coffee"    "gawk"      "groovy"
 [6] "haskell"   "lein"      "mysql"     "node"      "octave"
[11] "perl"      "php"       "psql"      "Rscript"   "ruby"
[16] "sas"       "scala"     "sed"       "sh"        "stata"
[21] "zsh"       "asis"      "asy"       "block"     "block2"
[26] "bslib"     "c"         "cat"       "cc"        "comment"
[31] "css"       "ditaa"     "dot"       "embed"     "eviews"
[36] "exec"      "fortran"   "fortran95" "go"        "highlight"
[41] "js"        "julia"     "python"    "R"         "Rcpp"
[46] "sass"      "scss"      "sql"       "stan"      "targets"
[51] "tikz"      "verbatim"  "ojs"       "mermaid"   "glue"
[56] "glue_sql"  "gluesql"
```

Extensions and templates

- Quarto extensions modify and extend functionality.
- They are stored locally, in the `_extensions` folder alongside the qmd document.
- See https://quarto.org/docs/extensions/ for a list.
- Templates are extensions used to define new output formats.
- Journal templates at https://quarto.org/docs/extensions/listing-journals.html
- Monash templates at https://github.com/quarto-monash

quarto on the command line

- `quarto render` to render a quarto or Rmarkdown document.
- `quarto preview` to preview a quarto or Rmarkdown document.
- `quarto add <gh-org>/<gh-repo>` to add an extension from a github repository.
- `quarto update <gh-org>/<gh-repo>` to update an extension
- `quarto remove <gh-org>/<gh-repo>` to remove an extension
- `quarto list extensions installed`
- `quarto use template <gh-org>/<gh-repo>` to use existing repo as starter template.

Add a custom format

From the CLI: `quarto add quarto-monash/memo`

Add a custom format

From the CLI: `quarto add quarto-monash/memo`

New folder/files added

```
├── _extensions
│   └── quarto-monash
│       └── memo
│           └── ...
```

Add a custom format

From the CLI: `quarto add quarto-monash/memo`

New folder/files added

```
├── _extensions
│   └── quarto-monash
│       └── memo
│           └── ...
```

Update YAML

```
---
title: "My new file using the Monash memo format"
format: memo-pdf
---
```

Activity 1

- Set up a new project.
- Create a quarto document using an html format.
- Add a code chunk to generate a figure with a caption.
- Reference the figure in the text using `@fig-chunklabel`.
- Add the monash memo extension and generate a pdf output.

Activity 2

- Create a thesis using the `quarto-monash/thesis` template, and add your name and details to the front page.

Outline

Letter template

MONASH University

MONASH BUSINESS SCHOOL

9 October 2024

Hypatia
University of Alexandria
Egypt

Dear Hypatia

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Proin mollis dolor vitae tristique eleifend. Quisque non ipsum sit amet velit malesuada consectetur. Praesent vel facilisis leo. Sed facilisis varius orci, ut aliquam lorem malesuada in. Morbi nec purus at nisi fringilla varius non ut dui. Pellentesque bibendum sapien velit. Nulla purus justo, congue eget enim a, elementum sollicitudin eros. Cras porta augue ligula, vel adipiscing odio ullamcorper eu. In tincidunt nisi sit amet tincidunt tincidunt. Maecenas elementum neque eget dolor egestas fringilla:

> Nullam eget dapibus quam, sit amet sagittis magna. Nam tincidunt, orci ac imperdiet ultricies, neque metus ultrices quam, id gravida augue lacus ac leo.

Vestibulum id sodales lectus, sed scelerisque quam. Nullam auctor mi et feugiat commodo. Duis interdum imperdiet nulla, vitae bibendum eros placerat non. Cras ornare, risus in faucibus malesuada, libero sem fringilla quam, ut luctus enim sapien eget dolor.

Sincerely

PS: Lorem ipsum dolor sit amet, *consectetur* adipiscing elit.

Pierre Curie, Nobel Prize, PhD
Professor
Department of Econometrics & Business Statistics
Monash University, Victoria 3800, Australia.
Pierre.Curie@monash.edu +61 3 9905 5555 curie.com
ABN: 12 377 614 012 CRICOS Provider Number: 00008C

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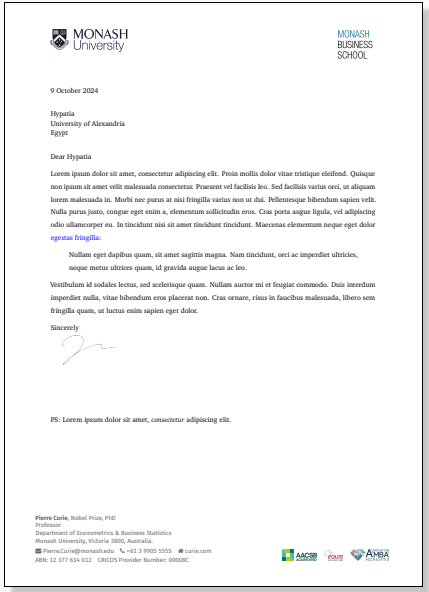
Letter template



MONASH University

MONASH BUSINESS SCHOOL

9 October 2024

Hypatia
University of Alexandria
Egypt

Dear Hypatia

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Proin mollis dolor vitae tristique eleifend. Quisque non ipsum sit amet velit malesuada consectetur. Praesent vel facilisis leo. Sed facilisis varius orci, ut aliquam lorem malesuada in. Morbi nec purus at nisi fringilla varius non ut dui. Pellentesque bibendum sapien velit. Nulla purus justo, congue eget enim a, elementum sollicitudin eros. Cras porta augue ligula, vel adipiscing odio ullamcorper eu. In tincidunt nisi sit amet tincidunt tincidunt. Maecenas elementum neque eget dolor egestas fringilla:

> Nullam eget dapibus quam, sit amet sagittis magna. Nam tincidunt, orci ac imperdiet ultricies, neque metus ultrices quam, id gravida augue lacus ac leo.

Vestibulum id sodales lectus, sed scelerisque quam. Nullam auctor mi et feugiat commodo. Duis interdum imperdiet nulla, vitae bibendum eros placerat non. Cras ornare, risus in faucibus malesuada, libero sem fringilla quam, ut luctus enim sapien eget dolor.

Sincerely

PS: Lorem ipsum dolor sit amet, *consectetur* adipiscing elit.

Pierre Curie, Nobel Prize, PhD
Professor
Department of Econometrics & Business Statistics
Monash University, Victoria 3800, Australia.
Pierre.Curie@monash.edu +61 3 9905 5555 curie.com
ABN: 12 377 614 012 CRICOS Provider Number: 00008C

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```
---
author: Pierre Curie
qualifications: Nobel Prize, PhD
position: Professor
www: curie.com
email: Pierre.Curie@monash.edu
phone: +61 3 9905 5555
signature: sigfile.png
address:
  - Hypatia
  - University of Alexandria
  - Egypt
opening: "Dear Hypatia"
closing: "Sincerely"
linestretch: 1.4
ps: "PS. Lorem ipsum dolor sit amet, *consectetur*
     adipiscing elit."
format: letter-pdf
---
```

Memo template

MONASH University

MONASH BUSINESS SCHOOL

Note to self

Marie Curie 14 October 2024

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> Nullam eget dapibus quam, sit amet sagittis magna. Nam tincidunt, orci ac imperdiet ultricies, neque metus ultrices quam, id gravida augue lacus ac leo.

Vestibulum id sodales lectus, sed scelerisque quam. Nullam auctor mi et feugiat commodo. Duis interdum imperdiet nulla, vitae bibendum eros placerat non. Cras ornare, risus in faucibus malesuada, libero sem fringilla quam, ut luctus enim sapien eget dolor.

1

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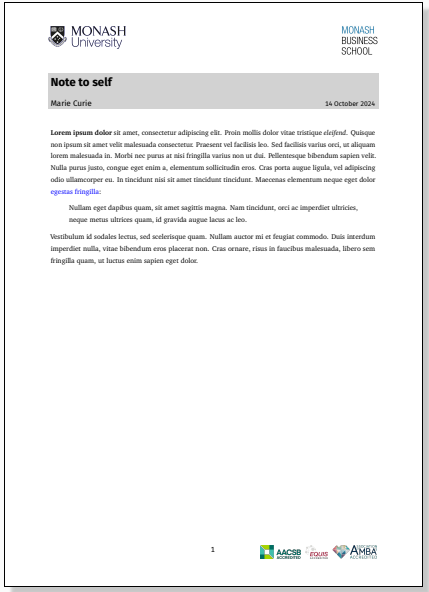
Memo template



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MONASH BUSINESS SCHOOL

Note to self

Marie Curie 14 October 2024

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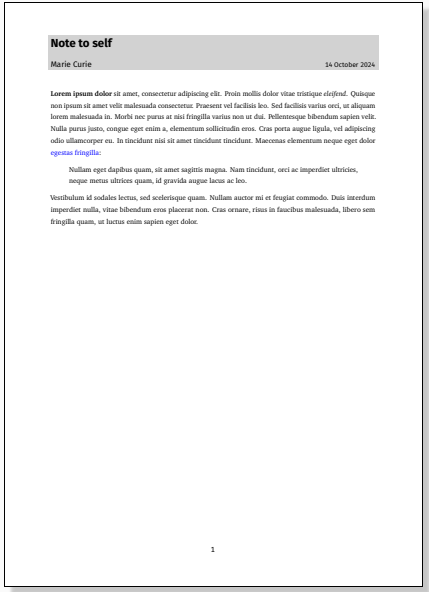
Vestibulum id sodales lectus, sed scelerisque quam. Nullam auctor mi et feugiat commodo. Duis interdum imperdiet nulla, vitae bibendum eros placerat non. Cras ornare, risus in faucibus malesuada, libero sem fringilla quam, ut luctus enim sapien eget dolor.

1

AACSB ACCREDITED EQUIS ACCREDITED AMBA ACCREDITED

```
---
title: Note to self
author: Marie Curie
branding: true
linestretch: 1.3
format: memo-pdf
---
```

Memo template



Note to self

Marie Curie 14 October 2024

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Proin mollis dolor vitae tristique *eleifend*. Quisque non ipsum sit amet velit malesuada consectetur. Praesent vel facilisis leo. Sed facilisis varius orci, ut aliquam lorem malesuada in. Morbi nec purus at nisi fringilla varius non ut dui. Pellentesque bibendum sapien velit. Nulla purus justo, congue eget enim a, elementum sollicitudin eros. Cras porta augue ligula, vel adipiscing odio ullamcorper eu. In tincidunt nisi sit amet tincidunt tincidunt. Maecenas elementum neque eget dolor egestas fringilla:

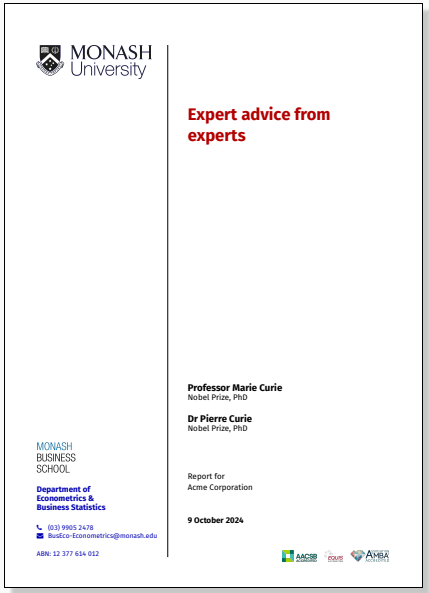
> Nullam eget dapibus quam, sit amet sagittis magna. Nam tincidunt, orci ac imperdiet ultricies, neque metus ultrices quam, id gravida augue lacus ac leo.

Vestibulum id sodales lectus, sed scelerisque quam. Nullam auctor mi et feugiat commodo. Duis interdum imperdiet nulla, vitae bibendum eros placerat non. Cras ornare, risus in faucibus malesuada, libero sem fringilla quam, ut luctus enim sapien eget dolor.

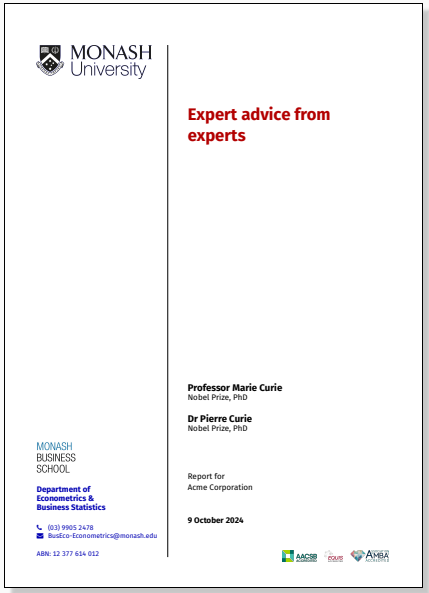
1

```
---
title: Note to self
author: Marie Curie
branding: false
linestretch: 1.3
format: memo-pdf
---
```

Report template



Report template




```yaml
---
title: "Expert advice from experts"
author:
- name: Professor Marie Curie
  degrees: Nobel Prize, PhD
  email: mcurie.notreal@gmail.com
- name: Dr Pierre Curie
  degrees: Nobel Prize, PhD
phone: (03) 9905 2478
email: BusEco-Econometrics@monash.edu
organization: Acme Corporation
bibliography: references.bib
format: report-pdf
---
```

Report template

1 Introduction

In a famous paper, Box & Cox (1964) introduced a family of transformations …

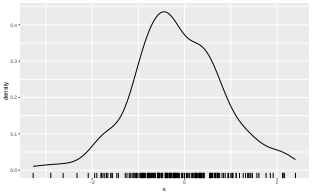


Figure 1: *Simulated data from a N(0,1) distribution.*

Figure 1 shows a kernel density estimate of simulated data from a N(0,1) distribution. The sample variance is given by

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2 = 0.98. \tag{1}$$

Note that Equation 1 is an unbiased estimate of the variance, but it is not the maximum likelihood estimate (Rice 2007, p. 269).

References

Box, GEP & DR Cox (1964). An analysis of transformations. *Journal of the Royal Statistical Society, Series B* **26**(2), 211–252.

Rice, JA (2007). *Mathematical Statistics and Data Analysis*. 3rd edition. Duxbury.


```
---
title: "Expert advice from experts"
author:
- name: Professor Marie Curie
  degrees: Nobel Prize, PhD
  email: mcurie.notreal@gmail.com
- name: Dr Pierre Curie
  degrees: Nobel Prize, PhD
phone: (03) 9905 2478
email: BusEco-Econometrics@monash.edu
organization: Acme Corporation
bibliography: references.bib
format: report-pdf
---
```

Exam template

MONASH University

Semester One 2024
Examination Period

Faculty of Business & Economics

UNIT CODES:	**ETC0000**
TITLE OF PAPER:	**Advanced Bean Counting**
EXAM DURATION:	2 hours 10 minutes

AUTHORISED MATERIALS

This is a closed book exam, with the following permitted items.

- A physical calculator of any type or Virtual Calculator:
  - Inbuilt Mac/Windows calculator
  - Website https://www.educalc.net/2336211.page
  - 10bii Financial Calculator for Mac by K2 Cashflow, https://apps.apple.com/au/app/10bii-financial-calculator/id473144920
- 5 blank pages for use as working sheets
- 2 pre-printed answer sheets

RULES

During your eExam, you must not have in your possession any item/material that has not been authorised for your exam. This includes books, notes, paper, electronic device/s, smart watch/device, or writing on any part of your body. Authorised items are listed above. Items/materials on your device, desk, chair, in your clothing or otherwise on your person will be deemed to be in your possession. Mobile phones must be switched off and placed face-down on your desk during your exam attempt.

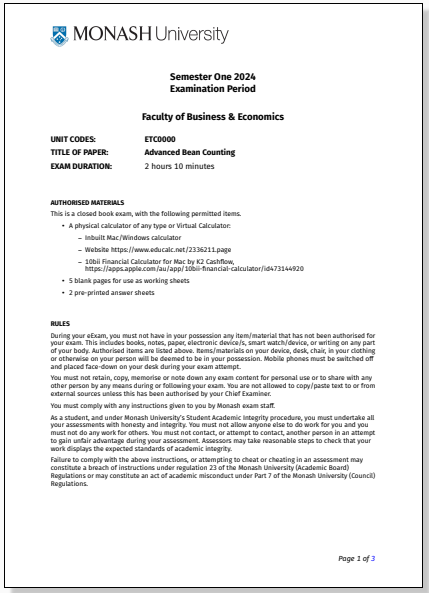
You must not retain, copy, memorise or note down any exam content for personal use or to share with any other person by any means during or following your exam. You are not allowed to copy/paste text to or from external sources unless this has been authorised by your Chief Examiner.

You must comply with any instructions given to you by Monash exam staff.

As a student, and under Monash University's Student Academic Integrity procedure, you must undertake all your assessments with honesty and integrity. You must not allow anyone else to do work for you and you must not do any work for others. You must not contact, or attempt to contact, another person in an attempt to gain unfair advantage during your assessment. Assessors may take reasonable steps to check that your work displays the expected standards of academic integrity.

Failure to comply with the above instructions, or attempting to cheat or cheating in an assessment may constitute a breach of instructions under regulation 23 of the Monash University (Academic Board) Regulations or may constitute an act of academic misconduct under Part 7 of the Monash University (Council) Regulations.

Exam template



MONASH University

Semester One 2024
Examination Period

Faculty of Business & Economics

UNIT CODES:	**ETC0000**
TITLE OF PAPER:	**Advanced Bean Counting**
EXAM DURATION:	2 hours 10 minutes

AUTHORISED MATERIALS

This is a closed book exam, with the following permitted items.

- A physical calculator of any type or Virtual Calculator:
  - Inbuilt Mac/Windows calculator
  - Website https://www.educalc.net/2336211.page
  - 10bii Financial Calculator for Mac by K2 Cashflow, https://apps.apple.com/au/app/10bii-financial-calculator/id473144920
- 5 blank pages for use as working sheets
- 2 pre-printed answer sheets

RULES

During your eExam, you must not have in your possession any item/material that has not been authorised for your exam. This includes books, notes, paper, electronic device/s, smart watch/device, or writing on any part of your body. Authorised items are listed above. Items/materials on your device, desk, chair, in your clothing or otherwise on your person will be deemed to be in your possession. Mobile phones must be switched off and placed face-down on your desk during your exam attempt.

You must not retain, copy, memorise or note down any exam content for personal use or to share with any other person by any means during or following your exam. You are not allowed to copy/paste text to or from external sources unless this has been authorised by your Chief Examiner.

You must comply with any instructions given to you by Monash exam staff.

As a student, and under Monash University's Student Academic Integrity procedure, you must undertake all your assessments with honesty and integrity. You must not allow anyone else to do work for you and you must not do any work for others. You must not contact, or attempt to contact, another person in an attempt to gain unfair advantage during your assessment. Assessors may take reasonable steps to check that your work displays the expected standards of academic integrity.

Failure to comply with the above instructions, or attempting to cheat or cheating in an assessment may constitute a breach of instructions under regulation 23 of the Monash University (Academic Board) Regulations or may constitute an act of academic misconduct under Part 7 of the Monash University (Council) Regulations.

Page 1 of 3

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unitcode: ETC0000
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duration: 2 hours 10 minutes
semester: Semester One 2024
examperiod: Examination Period
format: exam-pdf
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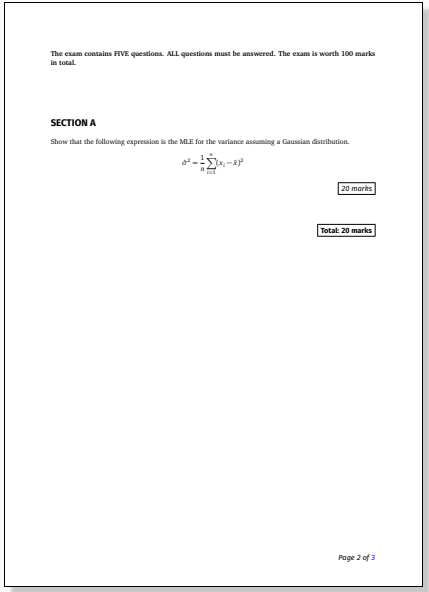

The exam contains FIVE questions. ALL questions must be answered. The exam is worth 100 marks in total.

SECTION A

Show that the following expression is the MLE for the variance assuming a Gaussian distribution.

$$\sigma^2 = \frac{1}{n}\sum_{i=1}^{n}(x_i - \bar{x})^2$$

20 marks

Total: 20 marks

Page 2 of 3

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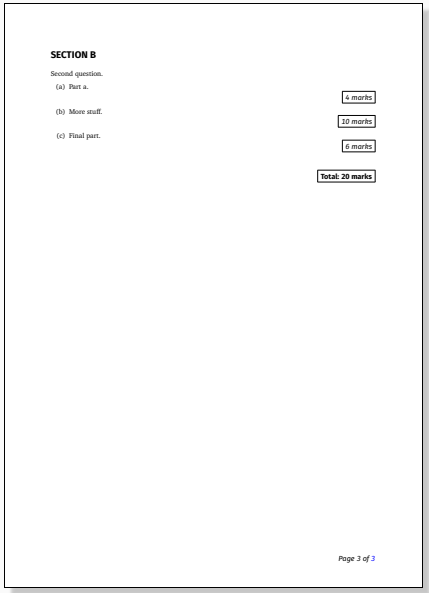

SECTION B

Second question.

(a) Part a.

4 marks

(b) More stuff.

10 marks

(c) Final part.

6 marks

Total: 20 marks

Page 3 of 3

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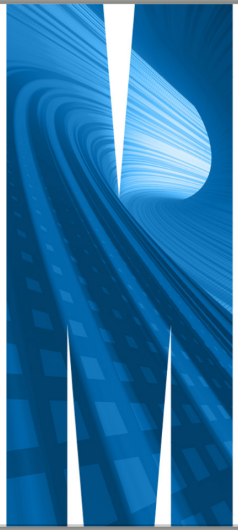

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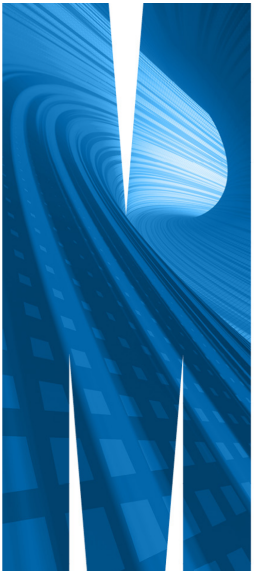

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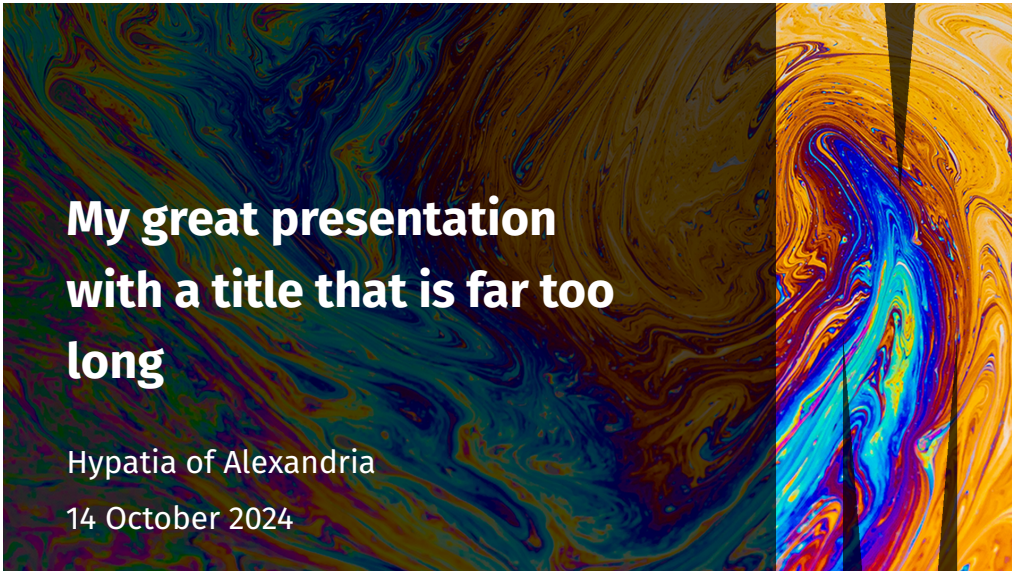
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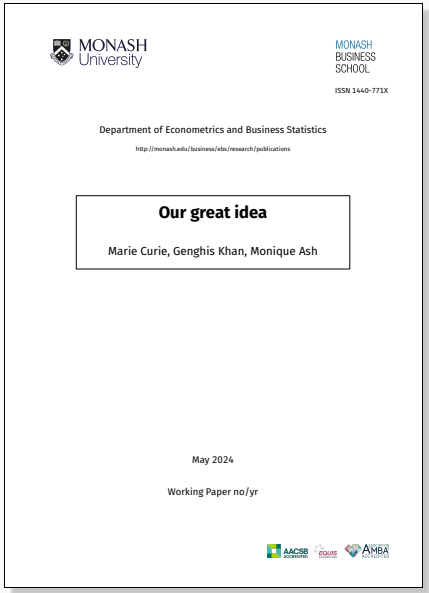

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Marie Curie, Genghis Khan, Monique Ash

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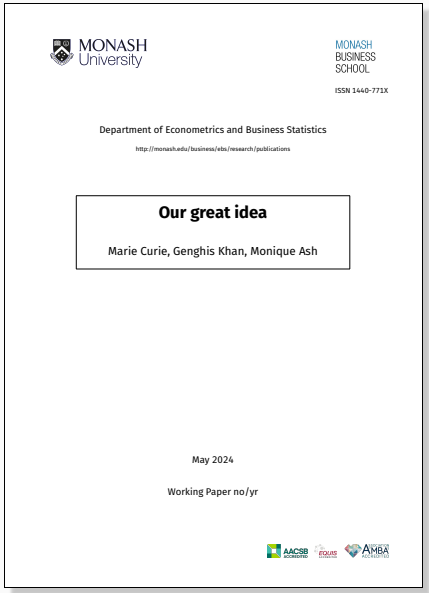
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  affiliations:
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      department: Department of Radiation
      city: Paris
      country: France
      postal-code: PX2039
  email: mcurie.notreal@gmail.com
  corresponding: true
- name: Genghis Khan
  affiliations:
    - name: Monash University
      department: Department of Econometrics & Busine
      city: Clayton VIC
      country: Australia
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  email: Monique.Ash@monash.edu
abstract: |
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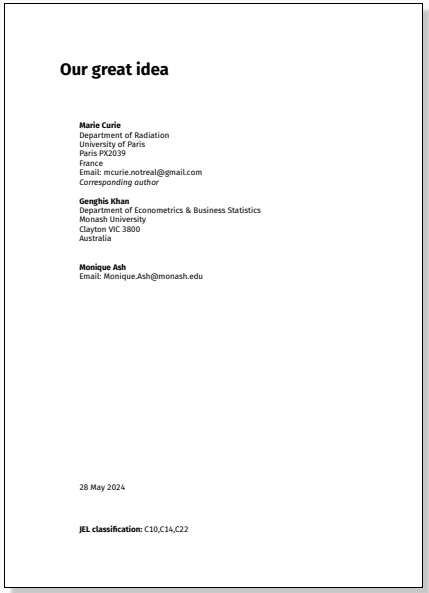

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Corresponding author

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28 May 2024

JEL classification: C10,C14,C22

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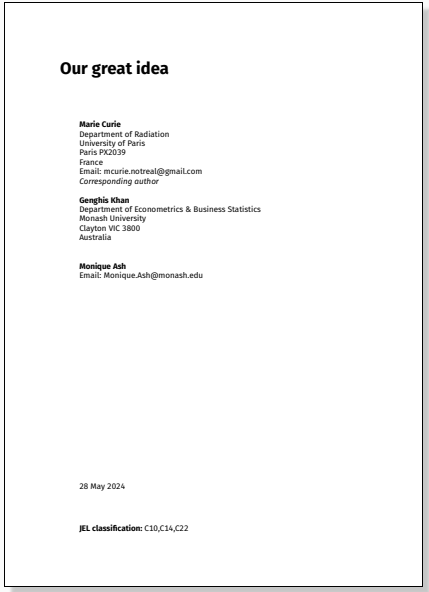

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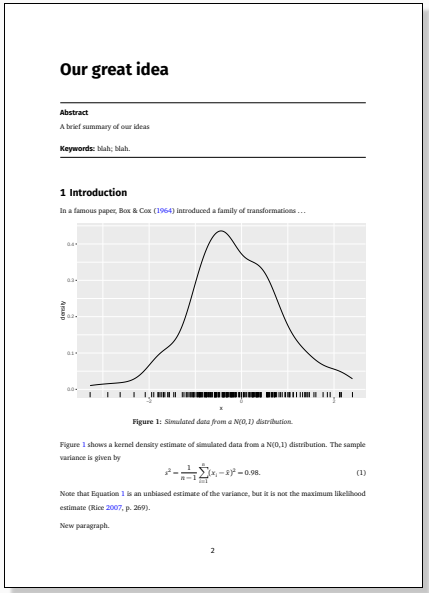

Our great idea

Abstract

A brief summary of our ideas

Keywords: blah; blah.

1 Introduction

In a famous paper, Box & Cox (1964) introduced a family of transformations ...

Figure 1: *Simulated data from a N(0,1) distribution.*

Figure 1 shows a kernel density estimate of simulated data from a N(0,1) distribution. The sample variance is given by

$$s^2 = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2 = 0.98. \quad (1)$$

Note that Equation 1 is an unbiased estimate of the variance, but it is not the maximum likelihood estimate (Rice 2007, p. 269).

New paragraph.


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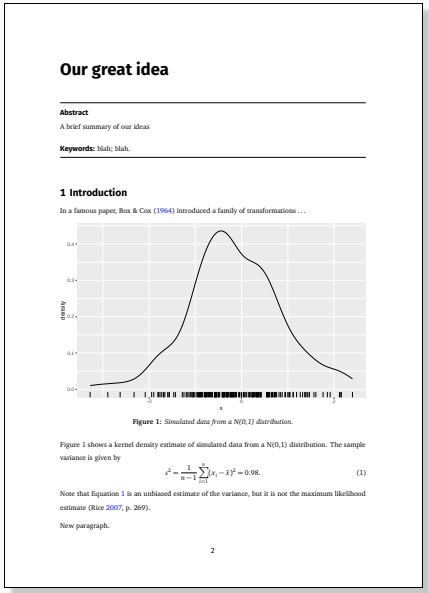

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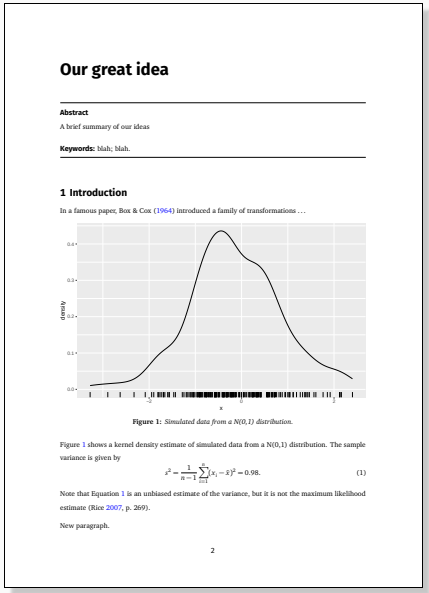

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2

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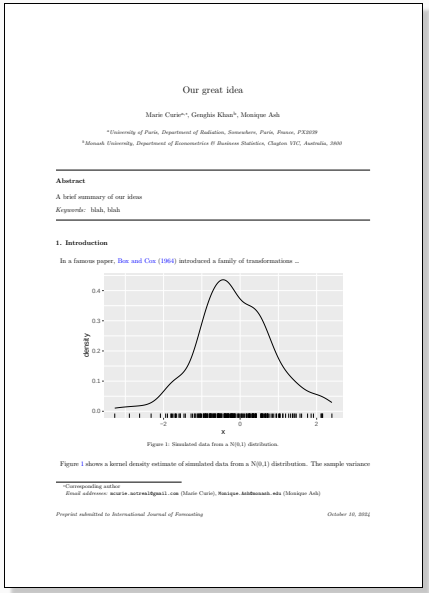
Journal articles



Our great idea

Marie Curie[a,*], Genghis Khan[b], Monique Ash

[a]University of Paris, Department of Radiation, Somewhere, Paris, France, PX1019

[b]Monash University, Department of Econometrics & Business Statistics, Clayton VIC, Australia, 3800

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*Corresponding author

Email addresses: scurie.nutrel@gmail.com (Marie Curie), Monique.Ash@monash.edu (Monique Ash)


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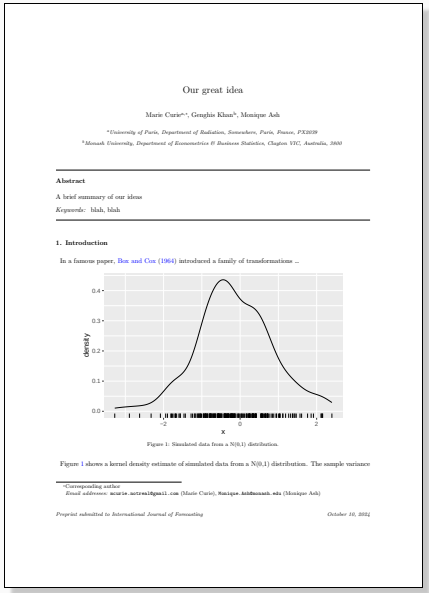

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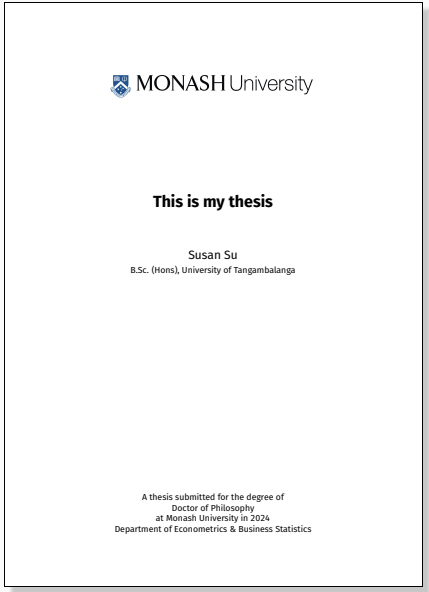

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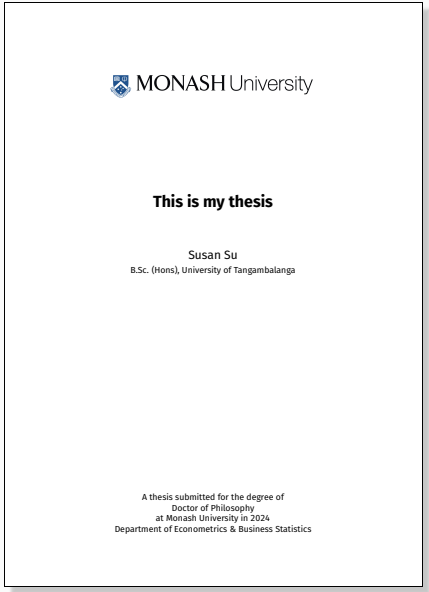


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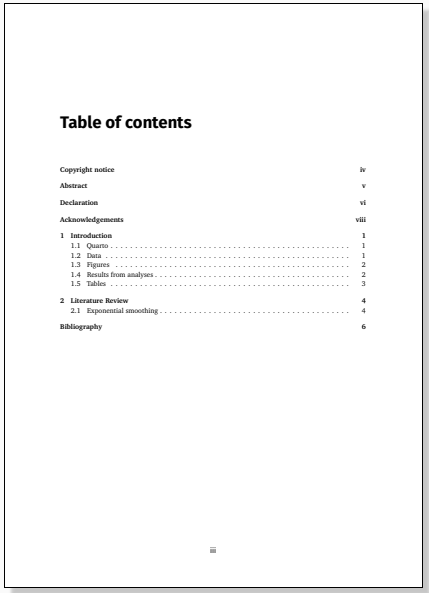

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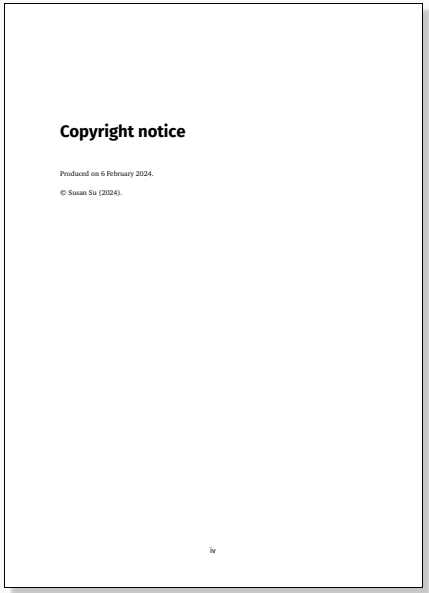

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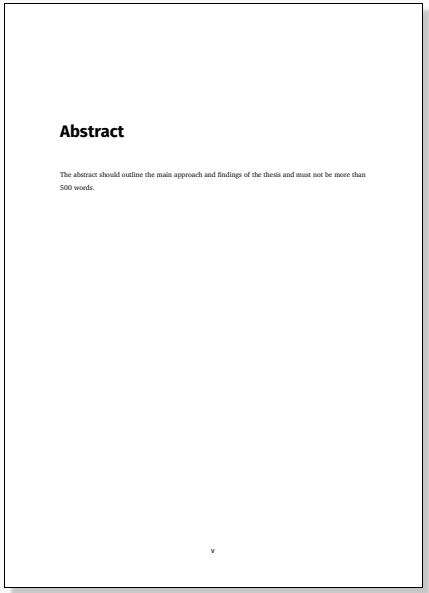

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v

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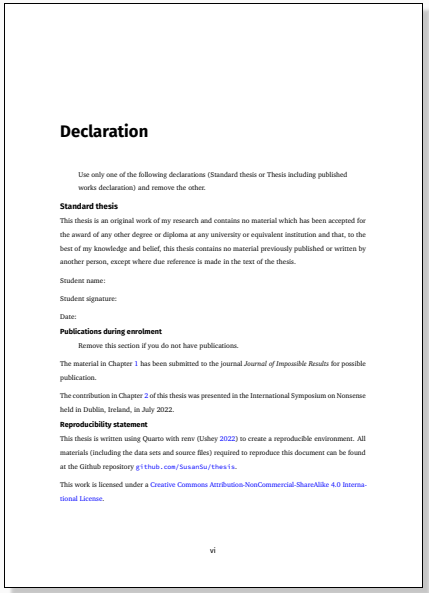

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Date:

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Thesis template

Thesis including published works declaration

I hereby declare that this thesis contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

This thesis includes ?? original papers published in peer reviewed journals and ?? submitted publications. The core theme of the thesis is ??. The ideas, development and writing up of all the papers in the thesis were the principal responsibility of myself, the student, working within the Department of Econometrics & Business Statistics under the supervision of ??

(The inclusion of co-authors reflects the fact that the work came from active collaboration between researchers and acknowledges input into team-based research.)

In the case of (??insert chapter numbers) my contribution to the work involved the following:

Thesis chapter	Publication title	Status	Nature and % of student contribution	Nature and % of coauthors' contribution	Coauthors are Monash students
2	The life cycle of Mongolian cricketa	Submitted	Concept and data analysis, writing first draft: 60%	Shu Xu, input into manuscript: 25%; Eddie Bstu, input into manuscript: 15%	Shu Xu: No; Eddie Bstu: Yes

I have / have not renumbered sections of submitted or published papers in order to generate a consistent presentation within the thesis.

Student name:

Student signature:

Date:

I hereby certify that the above declaration correctly reflects the nature and extent of the student's and co-authors' contributions to this work. In instances where I am not the responsible author I have consulted with the responsible author to agree on the respective contributions of the authors.

Main Supervisor name:

Main Supervisor signature:

Date:


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  author: "Susan Su"
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degreetype: Doctor of Philosophy
submitted: 2024
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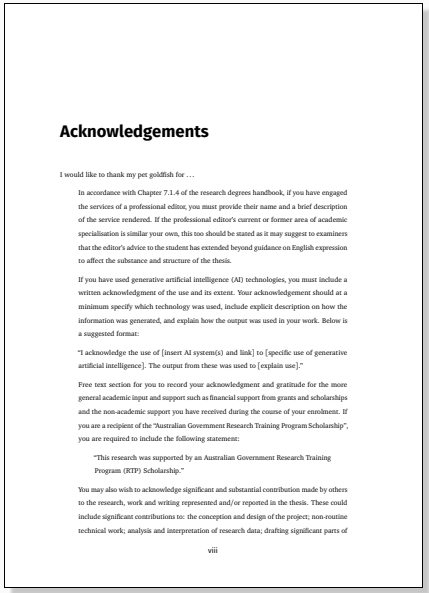

Acknowledgements

I would like to thank my pet goldfish for …

In accordance with Chapter 7.1.4 of the research degrees handbook, if you have engaged the services of a professional editor, you must provide their name and a brief description of the service rendered. If the professional editor's current or former area of academic specialisation is similar your own, this too should be stated as it may suggest to examiners that the editor's advice to the student has extended beyond guidance on English expression to affect the substance and structure of the thesis.

If you have used generative artificial intelligence (AI) technologies, you must include a written acknowledgment of the use and its extent. Your acknowledgement should at a minimum specify which technology was used, include explicit description on how the information was generated, and explain how the output was used in your work. Below is a suggested format:

"I acknowledge the use of [insert AI system(s) and link] to [specific use of generative artificial intelligence]. The output from these was used to [explain use]."

Free text section for you to record your acknowledgment and gratitude for the more general academic input and support such as financial support from grants and scholarships and the non-academic support you have received during the course of your enrolment. If you are a recipient of the "Australian Government Research Training Program Scholarship", you are required to include the following statement:

> "This research was supported by an Australian Government Research Training Program (RTP) Scholarship."

You may also wish to acknowledge significant and substantial contribution made by others to the research, work and writing represented and/or reported in the thesis. These could include significant contributions to: the conception and design of the project; non-routine technical work; analysis and interpretation of research data; drafting significant parts of

viii

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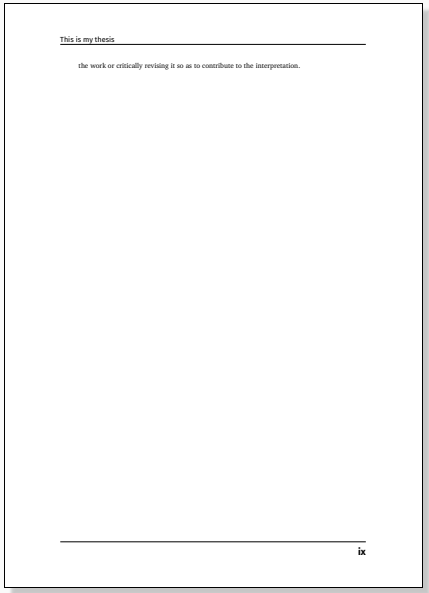
Thesis template

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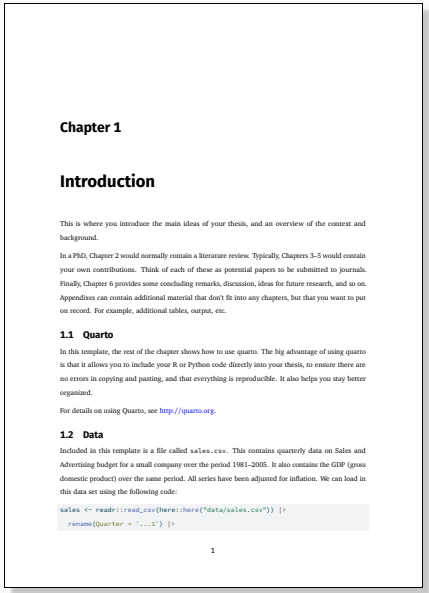
Thesis template



Chapter 1

Introduction

This is where you introduce the main ideas of your thesis, and an overview of the context and background.

In a PhD, Chapter 2 would normally contain a literature review. Typically, Chapters 3–5 would contain your own contributions. Think of each of these as potential papers to be submitted to journals. Finally, Chapter 6 provides some concluding remarks, discussion, ideas for future research, and so on. Appendixes can contain additional material that don't fit into any chapters, but that you want to put on record. For example, additional tables, output, etc.

1.1 Quarto

In this template, the rest of the chapter shows how to use quarto. The big advantage of using quarto is that it allows you to include your R or Python code directly into your thesis, to ensure there are no errors in copying and pasting, and that everything is reproducible. It also helps you stay better organized.

For details on using Quarto, see http://quarto.org.

1.2 Data

Included in this template is a file called `sales.csv`. This contains quarterly data on Sales and Advertising budget for a small company over the period 1981–2005. It also contains the GDP (gross domestic product) over the same period. All series have been adjusted for inflation. We can load in this data set using the following code:

```
sales <- readr::read_csv(here::here("data/sales.csv")) |>
  rename(Quarter = `...1`) |>
```

1

```yaml
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format:
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```

Thesis template


```
mutate(
  Quarter = as.Date(paste0("01-", Quarter), "%d-%b-%y"),
  Quarter = yearquarter(Quarter)
) |>
as_tsibble(index = Quarter)
```

Any data you use in your thesis can go into the `data` directory. The data should be in exactly the format you obtained it. Do no editing or manipulation of the data prior to including it in the `data` directory. Any data munging should be scripted and form part of your thesis files (possibly hidden in the output).

1.3 Figures

Figure 1.1 shows time plots of the data we just loaded. Notice how figure captions and references work. Chunk names can be used as figure labels with `fig-` prefixed. Never manually type figure numbers, as they can change when you add or delete figures. This way, the figure numbering is always correct.

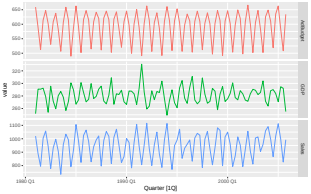

Figure 1.1: *Quarterly sales, advertising and GDP data.*

1.4 Results from analyses

We can fit a regression model to the sales data.


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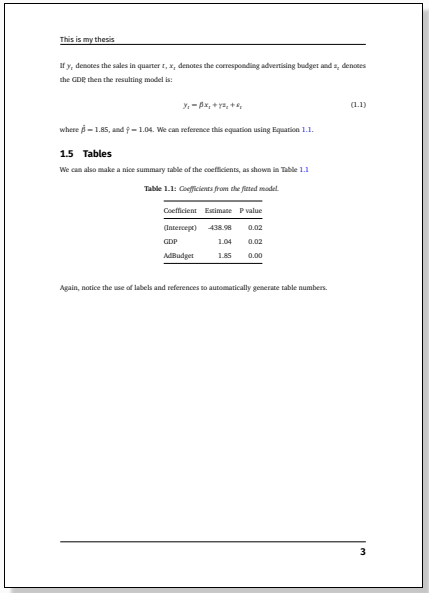

This is my thesis

If y_t denotes the sales in quarter t, x_t denotes the corresponding advertising budget and z_t denotes the GDP, then the resulting model is:

$$y_t = \beta x_t + \gamma z_t + \epsilon_t \tag{1.1}$$

where $\hat{\beta} = 1.85$, and $\hat{\gamma} = 1.04$. We can reference this equation using Equation 1.1.

1.5 Tables

We can also make a nice summary table of the coefficients, as shown in Table 1.1

Table 1.1: *Coefficients from the fitted model.*

Coefficient	Estimate	P value
(Intercept)	-438.98	0.02
GDP	1.04	0.02
AdBudget	1.85	0.00

Again, notice the use of labels and references to automatically generate table numbers.

3

```
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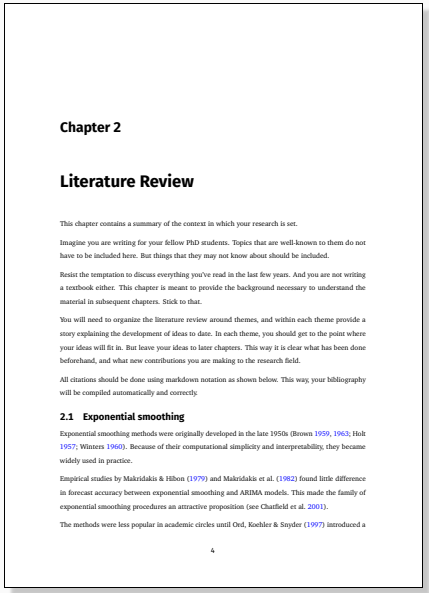

Chapter 2

Literature Review

This chapter contains a summary of the context in which your research is set.

Imagine you are writing for your fellow PhD students. Topics that are well-known to them do not have to be included here. But things that they may not know about should be included.

Resist the temptation to discuss everything you've read in the last few years. And you are not writing a textbook either. This chapter is meant to provide the background necessary to understand the material in subsequent chapters. Stick to that.

You will need to organize the literature review around themes, and within each theme provide a story explaining the development of ideas to date. In each theme, you should get to the point where your ideas will fit in. But leave your ideas to later chapters. This way it is clear what has been done beforehand, and what new contributions you are making to the research field.

All citations should be done using markdown notation as shown below. This way, your bibliography will be compiled automatically and correctly.

2.1 Exponential smoothing

Exponential smoothing methods were originally developed in the late 1950s (Brown 1959, 1963; Holt 1957; Winters 1960). Because of their computational simplicity and interpretability, they became widely used in practice.

Empirical studies by Makridakis & Hibon (1979) and Makridakis et al. (1982) found little difference in forecast accuracy between exponential smoothing and ARIMA models. This made the family of exponential smoothing procedures an attractive proposition (see Chatfield et al. 2001).

The methods were less popular in academic circles until Ord, Koehler & Snyder (1997) introduced a

4

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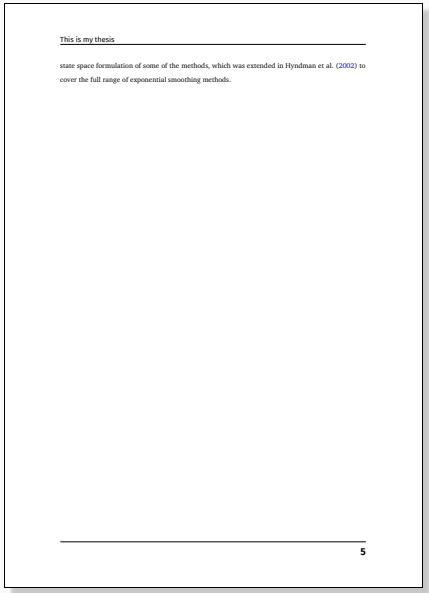


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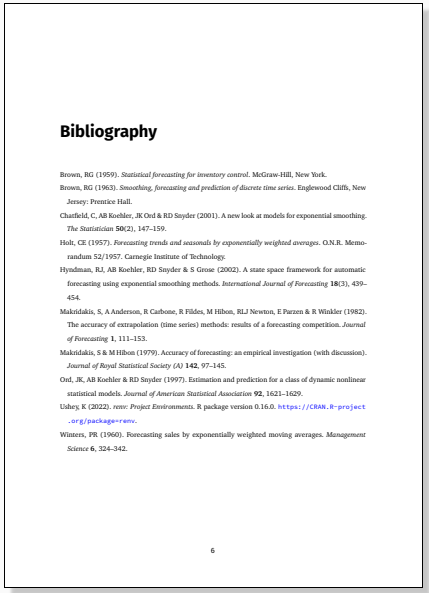

Bibliography

Brown, RG (1959). *Statistical forecasting for inventory control*. McGraw-Hill, New York.

Brown, RG (1963). *Smoothing, forecasting and prediction of discrete time series*. Englewood Cliffs, New Jersey: Prentice Hall.

Chatfield, C, AB Koehler, JK Ord & RD Snyder (2001). A new look at models for exponential smoothing. *The Statistician* **50**(2), 147–159.

Holt, CE (1957). *Forecasting trends and seasonals by exponentially weighted averages*. O.N.R. Memorandum 52/1957. Carnegie Institute of Technology.

Hyndman, RJ, AB Koehler, RD Snyder & S Grose (2002). A state space framework for automatic forecasting using exponential smoothing methods. *International Journal of Forecasting* **18**(3), 439–454.

Makridakis, S, A Anderson, R Carbone, R Fildes, M Hibon, RLJ Newton, E Parzen & R Winkler (1982). The accuracy of extrapolation (time series) methods: results of a forecasting competition. *Journal of Forecasting* **1**, 111–153.

Makridakis, S & M Hibon (1979). Accuracy of forecasting: an empirical investigation (with discussion). *Journal of Royal Statistical Society (A)* **142**, 97–145.

Ord, JK, AB Koehler & RD Snyder (1997). Estimation and prediction for a class of dynamic nonlinear statistical models. *Journal of American Statistical Association* **92**, 1621–1629.

Ushey, K (2022). *renv: Project Environments*. R package version 0.16.0. https://CRAN.R-project.org/package=renv.

Winters, PR (1960). Forecasting sales by exponentially weighted moving averages. *Management Science* **6**, 324–342.


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Thesis template

This is my thesis

AUTHOR
Susan Su

A thesis submitted for the degree of Doctor of Philosophy at Monash University, Department of Econometrics & Business Statistics.

Copyright notice

Produced on 14 October 2024.

Abstract

The abstract should outline the main approach and findings of the thesis and must not be more than 500 words.

Declaration

Use only one of the following declarations (Standard thesis or Thesis including published works declaration) and remove the other.

Standard thesis

This thesis is an original work of my research and contains no material which has been accepted for the award of any other degree or diploma at any university or equivalent institution and that, to the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text of the thesis.

Student name:

Student signature:

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Design choices: Fonts

- All templates use Fira Sans for headings.
- All templates use `Source Code Pro` for code which has good disambiguation: `LIli1!| oO0 4AH 5S 7T`
- All but presentation use Bitstream Vera for the body with a matching mathematical font:

The standard deviation s of the sample $y_1, \ldots, y_n$ is given by

$$s = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(y_i - \bar{y})^2}.$$

Design choices: Citations

All templates use biblatex with an author-year style consistent with most statistical journals.

Brown, RG (1959). *Statistical forecasting for inventory control*. McGraw-Hill, New York.

Brown, RG (1963). *Smoothing, forecasting and prediction of discrete time series*. Englewood Cliffs, New Jersey: Prentice Hall.

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Github repos: github.com/quarto-monash

quarto-monash

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Monash Quarto Templates

The `quarto-monash` organization collects a curated set of templates for using Quarto at Monash University. Some templates are specific to the Department of Econometrics & Business Statistics.

Use a template with the command:

```
quarto use template quarto-monash/<template-name>
```

Template	Name	Install
Monash Business School letterhead	letter	`quarto use template quarto-monash/letter`
Monash Business School memo	memo	`quarto use template quarto-monash/memo`
Monash University themed Beamer and RevealJS presentations	presentation	`quarto use template quarto-monash/presentation`
Monash Business School consulting report	report	`quarto use template quarto-monash/report`
Monash University thesis	thesis	`quarto use template quarto-monash/thesis`
Monash University Department of Econometrics & Business Statistics working paper	workingpaper	`quarto use template quarto-monash/workingpaper`

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Monash Business School consulting report	report	`quarto use template quarto-monash/report`
Monash University thesis	thesis	`quarto use template quarto-monash/thesis`
Monash University Department of Econometrics & Business Statistics working paper	workingpaper	`quarto use template quarto-monash/workingpaper`

From a terminal

```
quarto use template quarto-monash/<name>
```

- letter
- memo
- presentation
- report
- thesis
- workingpaper
- exam

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Overview | Repositories 8 | Projects | Packages | People

README.md

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Monash University thesis	thesis	`quarto use template quarto-monash/thesis`
Monash University Department of Econometrics & Business Statistics working paper	workingpaper	`quarto use template quarto-monash/workingpaper`

From a terminal

```
quarto use template quarto-monash/<name>
```

- letter
- memo
- presentation
- report
- thesis
- workingpaper
- exam

From the R console

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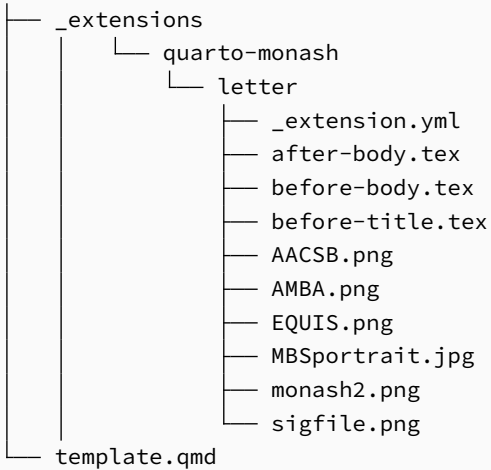
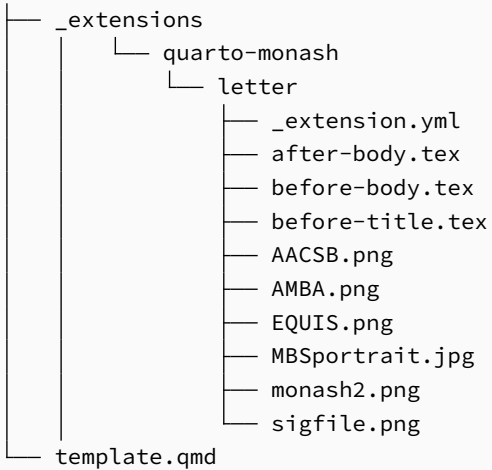
Structure of a template

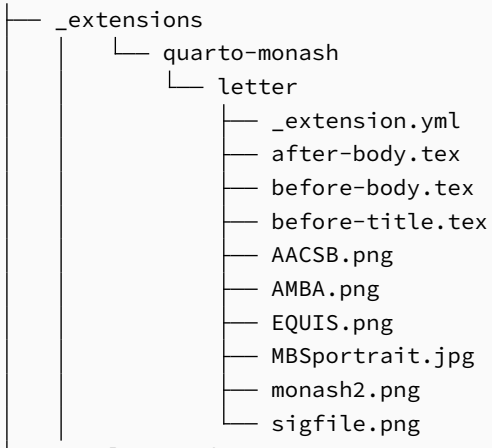


Structure of a template



- `template.qmd`: template for user to edit.
- `extension.yml`: default yaml
- `*.tex`: pandoc partials
- Everything else: graphical files needed for the template

Structure of a template



template.qmd

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author: Pierre Curie
qualifications: Nobel Prize, PhD
position: Professor
www: curie.com
email: Pierre.Curie@monash.edu
phone: +61 3 9905 5555
signature: sigfile.png
address:
  - Hypatia
  - University of Alexandria
  - Egypt
opening: "Dear Hypatia"
closing: "Sincerely"
linestretch: 1.4
ps: "PS. Lorem ipsum dolor sit amet, *consectetur*
     adipiscing elit."
format: letter-pdf
---

I am writing about the paper you recently published in
```

Structure of a template

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│       └── letter
│           ├── _extension.yml
│           ├── after-body.tex
│           ├── before-body.tex
│           ├── before-title.tex
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│           ├── AMBA.png
│           ├── EQUIS.png
│           ├── MBSportrait.jpg
│           ├── monash2.png
│           └── sigfile.png
└── template.qmd
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extension.yml

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author: Rob J Hyndman
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quarto-required: ">=1.4.0"
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      pdf-engine: pdflatex
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        - monash2.png
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Structure of a template

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│       └── letter
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│           ├── MBSportrait.jpg
│           ├── monash2.png
│           └── sigfile.png
└── template.qmd
```

before-body.tex

```
\begin{letter}{$for(address)$$address$$sep$\\$endfor$}
$if(opening)$
\opening{$opening$}
$endif$
```

Structure of a template

```
├── _extensions
│   └── quarto-monash
│       └── letter
│           ├── _extension.yml
│           ├── after-body.tex
│           ├── before-body.tex
│           ├── before-title.tex
│           ├── AACSB.png
│           ├── AMBA.png
│           ├── EQUIS.png
│           ├── MBSportrait.jpg
│           ├── monash2.png
│           └── sigfile.png
└── template.qmd
```

after-body.tex

```
$if(closing)$
\closing{$closing$\\[0.2cm]\hspace*{0.5cm}
$if(signature)$
\includegraphics[height=1.5cm]{$signature$}
$endif$
}
$endif$
\vfill
$if(encl)$
\encl{$for(encl)$$encl$$sep$\\$endfor$}
$endif$
$if(cc)$
\cc{$for(cc)$$cc$$sep$\\$endfor$}
$endif$
$if(ps)$
\ps{$ps$}
$endif$
\end{letter}
```

Structure of a template

```
├── _extensions
│   └── quarto-monash
│       └── letter
│           ├── _extension.yml
│           ├── after-body.tex
│           ├── before-body.tex
│           ├── before-title.tex
│           ├── AACSB.png
│           ├── AMBA.png
│           ├── EQUIS.png
│           ├── MBSportrait.jpg
│           ├── monash2.png
│           └── sigfile.png
└── template.qmd
```

before-title.tex

```
% Fonts
\usepackage{bera,fontawesome}
\usepackage[charter]{mathdesign}
\usepackage[lf,t]{FiraSans}
\usepackage[scale=0.9]{sourcecodepro}

% Letterhead
\usepackage[absolute,overlay]{textpos}
\setlength{\TPHorizModule}{1cm}
\setlength{\TPVertModule}{1cm}

\makeatletter
\def\ps@monash{%
\begin{textblock}{4}(2,1)
\includegraphics[height=1.5cm]{monash2}
\end{textblock}%
\begin{textblock}{4}(17,1)
\includegraphics[height=1.5cm]{MBSportrait}
\end{textblock}%
\begin{textblock}{10}(1.2,26.4)
{\fontsize{9}{8}\selectfont\sffamily\color[gray]{0.4}%
\begin{tabular}{@{}l@{}}
  \textbf{$for(authors)$$it.name.literal$$endfor$},
  $if(qualifications)$$qualifications$$endif$\\
  $if(position)$$position$\\$endif$
```

Pandoc partial templates

- **doc-class.tex**: document class and options
- **before-title.tex**: preamble before title block.
- **title.tex**: create title block.
- **before-body.tex**: frontmatter, title page, abstract.
- **after-body.tex**: content at the end of the body.
- **toc.tex**: table of contents, lists of figures and tables.
- **before-bib.tex**: after content but before bibliography.
- **biblio.tex**: creates bibliography

- **Details:** https://quarto.org/docs/journals/templates.html
- **Defaults:** https://github.com/quarto-dev/quarto-cli/tree/main/src/resources/formats/pdf/pandoc

Outline

Activity 3

- Work on your Assignment 2.
- Ask for help if you need it.