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Computational Neuroscience: A Beginner's Guide

A primer in Computational Neuroscience

December 22, 2024

Springer Nature

*To Maura, who never stopped walking with
me, and in memory of Professors Grattarola
and Tagliasco, who showed me the path.*

Foreword

To be written by a person other than the author or editor of the book.

Preface

To be written.

Modena,

Michele GIUGLIANO

Acknowledgements

Special thanks to Maura and Margherita for their unwavering support. I am also in debt to several generations of students I taught while in Antwerp (2008-2019), Trieste (2019-2023), and Modena (2024-), for their precious feedback.

Declarations

Competing Interests The Author has no conflicts of interest to declare that are relevant to the content of this book.

Ethics Approval Experimental traces collected in the Author's lab, included in a few figures of this book for illustrative purposes, were obtained in full compliance with the EU Directive 2010/63, the Belgian Royal Decree of 29/5/2013, the Italian Decree 26 of 4/3/2014, and upon explicit prior authorisation by institutional Ethical Committees and national regulatory authorities.

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Acronyms

Lists of abbreviations, symbols and the like are easily formatted with the help of the Springer-enhanced `description` environment.

ABC	Spelled-out abbreviation and definition
BABI	Spelled-out abbreviation and definition
CABR	Spelled-out abbreviation and definition

Part I
Part Title

Use the template *part.tex* together with the document class SVMono (monograph-type books) or SVMult (edited books) to style your part title page and, if desired, a short introductory text (maximum one page) on its verso page.

Chapter 1

Chapter Heading

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Please note that the first line of text that follows a heading is not indented, whereas the first lines of all subsequent paragraphs are.

Use the standard `equation` environment to typeset your equations, e.g.

$$a \times b = c, \quad (1.1)$$

however, for multiline equations we recommend to use the `eqnarray` environment¹.

$$|\nabla U_\alpha^\mu(y)| \leq \frac{1}{d-\alpha} \int \left| \nabla \frac{1}{|\xi-y|^{d-\alpha}} \right| d\mu(\xi) = \int \frac{1}{|\xi-y|^{d-\alpha+1}} d\mu(\xi) \quad (1.2)$$

$$= (d-\alpha+1) \int_{d(y)}^\infty \frac{\mu(B(y,r))}{r^{d-\alpha+2}} dr \leq (d-\alpha+1) \int_{d(y)}^\infty \frac{r^{d-\alpha}}{r^{d-\alpha+2}} dr \quad (1.3)$$

1.2.1 Subsection Heading

Instead of simply listing headings of different levels we recommend to let every heading be followed by at least a short passage of text. Further on please use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2.

Please do not use quotation marks when quoting texts! Simply use the `quotation` environment – it will automatically be rendered in the preferred layout.

1.2.1.1 Subsubsection Heading

Instead of simply listing headings of different levels we recommend to let every heading be followed by at least a short passage of text. Further on please use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2.1, see also Fig. 1.1²

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Paragraph Heading

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¹ In physics texts please activate the class option `vecphys` to depict your vectors in ***boldface-italic*** type - as is customary for a wide range of physical subjects.

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1. Livelihood and survival mobility are oftentimes coutcomes of uneven socioeconomic development.
 - a. Livelihood and survival mobility are oftentimes coutcomes of uneven socioeconomic development.
 - b. Livelihood and survival mobility are oftentimes coutcomes of uneven socioeconomic development.
2. Livelihood and survival mobility are oftentimes coutcomes of uneven socioeconomic development.

Subparagraph Heading

In order to avoid simply listing headings of different levels we recommend to let every heading be followed by at least a short passage of text. Use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2, see also Fig. 1.2.

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- Livelihood and survival mobility are oftentimes coutcomes of uneven socioeconomic development, cf. Table 1.1.
 - Livelihood and survival mobility are oftentimes coutcomes of uneven socioeconomic development.
 - Livelihood and survival mobility are oftentimes coutcomes of uneven socioeconomic development.

Fig. 1.1 If the width of the figure is less than 7.8 cm use the `sidecaption` command to flush the caption on the left side of the page. If the figure is positioned at the top of the page, align the sidecaption with the top of the figure – to achieve this you simply need to use the optional argument `[t]` with the `sidecaption` command

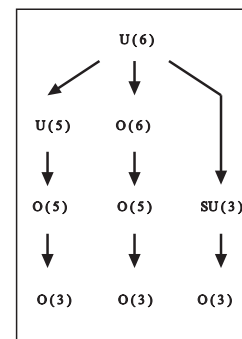


Fig. 1.2 Please write your figure caption here

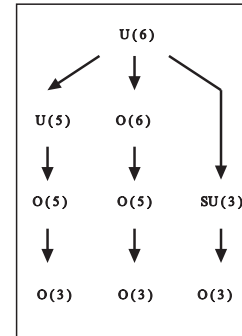


Table 1.1 Please write your table caption here

Classes	Subclass	Length	Action Mechanism
Translation	mRNA ^a	22 (19–25)	Translation repression, mRNA cleavage
Translation	mRNA cleavage	21	mRNA cleavage
Translation	mRNA	21–22	mRNA cleavage
Translation	mRNA	24–26	Histone and DNA Modification

^a Table foot note (with superscript)

- Livelihood and survival mobility are oftentimes outcomes of uneven socioeconomic development.

Run-in Heading Boldface Version Use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2.

Run-in Heading Boldface and Italic Version Use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2.

Run-in Heading Displayed Version

Use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2.

1.3 Section Heading

Instead of simply listing headings of different levels we recommend to let every heading be followed by at least a short passage of text. Further on please use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2.

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- Type 1 That addresses central themes pertaining to migration, health, and disease. In Sect. 1.1, Wilson discusses the role of human migration in infectious disease distributions and patterns.
- Type 2 That addresses central themes pertaining to migration, health, and disease. In Sect. 1.2.1, Wilson discusses the role of human migration in infectious disease distributions and patterns.

1.3.1 Subsection Heading

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If you want to emphasize complete paragraphs of texts we recommend to use the newly defined Springer class option and environment `svgraybox`. This will produce a 15 percent screened box ‘behind’ your text.

1.3.1.1 Subsubsection Heading

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Please note that the first line of text that follows a heading is not indented, whereas the first lines of all subsequent paragraphs are.

Theorem 1.1 *Theorem text goes here.*

Definition 1.1 Definition text goes here.

Proof. Proof text goes here.

□

Paragraph Heading

Instead of simply listing headings of different levels we recommend to let every heading be followed by at least a short passage of text. Furtheron please use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. 1.2.

Note that the first line of text that follows a heading is not indented, whereas the first lines of all subsequent paragraphs are.

Theorem 1.2 *Theorem text goes here.*

Definition 1.2 Definition text goes here.

Proof. Proof text goes here. □

Trailer Head

If you want to emphasize complete paragraphs of texts in a **Trailer Head** we recommend to use

```
\begin{trailer}{Trailer Head}
...
\end{trailer}
```

? Questions

If you want to emphasize complete paragraphs of texts in an **Questions** we recommend to use

```
\begin{questype}{Questions}
...
\end{questype}
```

> Important

If you want to emphasize complete paragraphs of texts in an **Important** we recommend to use

```
\begin{important}{Important}
...
\end{important}
```

! Attention

If you want to emphasize complete paragraphs of texts in an **Attention** we recommend to use

```
\begin{warning}{Attention}  
...  
\end{warning}
```

Program Code

If you want to emphasize complete paragraphs of texts in a **Program Code** we recommend to use

```
\begin{programcode}{Program Code}  
\begin{verbatim}...\end{verbatim}  
\end{programcode}
```

Tips

If you want to emphasize complete paragraphs of texts in a **Tips** we recommend to use

```
\begin{tips}{Tips}  
...  
\end{tips}
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```
\begin{overview}{Overview}  
...  
\end{overview}
```

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\end{backgroundinformation}
```

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...
\end{legalttext}
```

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$$a \times b = c \tag{1.4}$$

Problems

1.1 A given problem or Exercise is described here. The problem is described here. The problem is described here.

1.2 Problem Heading

- (a) The first part of the problem is described here.
- (b) The second part of the problem is described here.

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1. all works by the author alone, ordered chronologically by year of publication
2. all works by the author with a coauthor, ordered alphabetically by coauthor
3. all works by the author with several coauthors, ordered chronologically by year of publication.

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- Examples of the most commonly used reference style in books on *Psychology, Social Sciences* are [11, 12, 13, 14, 15].
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⁴ Always use the standard abbreviation of a journal's name according to the *ISSN List of Title Word Abbreviations*, see <http://www.issn.org/en/node/344>

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Appendix A

Chapter Heading

All's well that ends well

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A.1.1 Subsection Heading

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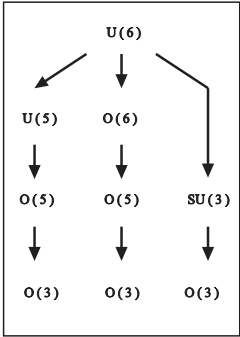
For multiline equations we recommend to use the `eqnarray` environment.

$$\begin{array}{l} \mathbf{a} \times \mathbf{b} = \mathbf{c} \\ \mathbf{a} \times \mathbf{b} = \mathbf{c} \end{array} \quad (\text{A.1})$$

A.1.1.1 Subsubsection Heading

Instead of simply listing headings of different levels we recommend to let every heading be followed by at least a short passage of text. Furtheron please use the \LaTeX automatism for all your cross-references and citations as has already been described in Sect. A.1.1.

Fig. A.1 Please write your figure caption here



Please note that the first line of text that follows a heading is not indented, whereas the first lines of all subsequent paragraphs are.

Table A.1 Please write your table caption here

Classes	Subclass	Length	Action Mechanism
Translation	mRNA ^a	22 (19–25)	Translation repression, mRNA cleavage
Translation	mRNA cleavage	21	mRNA cleavage
Translation	mRNA	21–22	mRNA cleavage
Translation	mRNA	24–26	Histone and DNA Modification

^a Table foot note (with superscript)

Glossary

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Solutions

Problems of Chapter 1

1.1 The solution is revealed here.

1.2 Problem Heading

- (a) The solution of first part is revealed here.
- (b) The solution of second part is revealed here.

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