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# Computational Neuroscience: A Beginner's Guide

A primer in Computational Neuroscience

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*To Maura, who has kept 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** Thos experimental traces, collected in the Author's lab and included here for illustrative purposes, were obtained in 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 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**

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# Chapter 1

## Chapter Heading

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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` environment<sup>1</sup>.

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

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

### 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.

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#### 1.2.1.1 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.

#### 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. 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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<sup>1</sup> 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.

<sup>2</sup> If you copy text passages, figures, or tables from other works, you must obtain *permission* from the copyright holder (usually the original publisher). Please enclose the signed permission with the manuscript. The sources must be acknowledged either in the captions, as footnotes or in a separate section of the book.

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For typesetting numbered lists we recommend to use the `enumerate` environment – it will automatically render Springer’s preferred layout.

1. Livelihood and survival mobility are oftentimes coutcomes of uneven socioeco-  
nomic development.
  - a. Livelihood and survival mobility are oftentimes coutcomes of uneven socioe-  
conomic development.
  - b. Livelihood and survival mobility are oftentimes coutcomes of uneven socioe-  
conomic development.
2. Livelihood and survival mobility are oftentimes coutcomes of uneven socioeco-  
nomic development.

### *Subparagraph Heading*

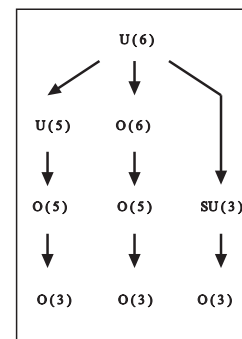
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Please note that the first line of text that follows a heading is not indented, whereas the first lines of all subsequent paragraphs are.

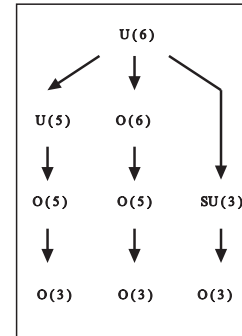
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- Livelihood and survival mobility are oftentimes coutcomes of uneven socioeco-  
nomic development, cf. Table 1.1.
  - Livelihood and survival mobility are oftentimes coutcomes of uneven socioe-  
conomic development.
  - Livelihood and survival mobility are oftentimes coutcomes of uneven socioe-  
conomic 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 <sup>a</sup>	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

<sup>a</sup> Table foot note (with superscript)

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

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If you want to list definitions or the like we recommend to use the Springer-enhanced `description` environment – it will automatically render Springer’s preferred layout.

- 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}
```

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### ? Questions

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```
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...
\end{questype}
```

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### > Important

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```

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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.

## 1.4 Styling of References

In view of the parallel print and (chapter-wise) online publication of your book at [www.springerlink.com](http://www.springerlink.com) it has been decided that – as a general rule – references should be sorted chapter-wise and placed at the end of the individual chapters. However, upon agreement with your contact at Springer you may list your references in a single separate chapter at the end of your book. Deactivate the class option `sectrefs` and the `thebibliography` environment will be put out as a chapter of its own.

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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.

The *styling* of references<sup>4</sup> depends on the subject of your book:

- The *two* recommended styles for references in books on *mathematical, physical, statistical and computer sciences* are depicted in [1, 2, 3, 4, 5] and [6, 7, 8, 9, 10].
- Examples of the most commonly used reference style in books on *Psychology, Social Sciences* are [11, 12, 13, 14, 15].
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- Examples of the basic Springer style used in publications on a wide range of subjects such as *Computer Science, Economics, Engineering, Geosciences, Life Sciences, Medicine, Biomedicine* are [21, 22, 24, 23, 25].

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<sup>4</sup> 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 Section Heading

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##### A.1.1 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. Furtheron please use the  $\LaTeX$  automatism for all your cross-references and citations as has already been described in Sect. A.1.

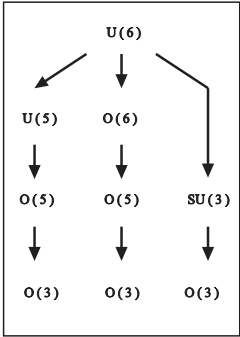
For multiline equations we recommend to use the `eqnarray` environment.

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

##### 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 <sup>a</sup>	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

<sup>a</sup> 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.