



SimpleBook Book Template

L^AT_EX template based on ElegantBook

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Preface

SimpleBook is a note template modified based on **ElegantBook**. ElegantBook is a well-known open-source book template, but the author ceased updating it on January 1, 2023. SimpleBook is based on its final version, which has been organized and simplified: most of the fancy beautification configurations have been removed, and the code retained in ElegantBook for version compatibility has been cleaned up.

The project is hosted on GitHub: <https://github.com/fenglielie/simplebook/>.

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Chapter 1 Configuration

SimpleBook supports two compilation methods: pdf \LaTeX and X \LaTeX . It supports two modes: Chinese and English. In English mode, any compilation method can be used, while in Chinese mode, X \LaTeX must be used. When using the SimpleBook document class, the main options are as follows:

1. Language: Chinese (cn, default) or English (en).
2. Color: Determines the theme color, including blue (default) and black.
3. Chinese fonts: Determines the Chinese fonts, including several default options provided by ctex and open-source fonts such as Fangzheng and Source Han Sans. See below for details.

Remark *The options for the document class can be specified either in full key-value pairs, for example `device=normal`, or directly by using the option name, such as `normal`. Multiple options can be set consecutively, and in any order.*

1.1 Language

This template includes two basic language environments: `lang=cn` (Chinese) and `lang=en` (English), with Chinese being the default. Changing the language environment will affect the captions of figures and tables, structural words (such as table of contents, bibliography, etc.), and the lead words in theorem environments (such as theorem, lemma, etc.). The language mode can be enabled as follows:

```
\documentclass[en]{simplebook}
\documentclass[lang=en]{simplebook}
```

1.2 Color

The default theme color of this template is the blue-green tone `blue`, which can be changed to `black` for an all-black theme. If custom colors are needed, choose the `nocolor` option or use `color=nocolor`, and then define the colors `ecolor`, `main`, `second`, and `third` in the preamble as follows:

```
\definecolor{ecolor}{RGB}{0,0,0}
\definecolor{main}{RGB}{70,70,70}
\definecolor{second}{RGB}{115,45,2}
\definecolor{third}{RGB}{0,80,80}
```

1.3 Chinese Fonts

Please refer to the Chinese documentation for the explanation of this section.

1.4 Cover Information

Currently, the cover supports many elements, and all cover elements, including `\title`, can be left empty.

- Title: `\title`
- Subtitle: `\subtitle`
- Author: `\author`
- Institute: `\institute`
- Date: `\date`
- Bottom Info: `\bottominfo`
- Cover: `\cover`
- Logo: `\logo`

The cover image must be **strictly** replaced with an image of size 1280×1024 :

```
\cover{demo.jpg}
```

The color of the block in the middle of the cover can be modified using the following command:

```
\definecolor{customcolor}{RGB}{32,178,170}
\colorlet{coverlinecolor}{customcolor}
```

A logo can be added to the bottom right corner of the cover. The logo image should have a ratio of 1:1, and it can be omitted:

```
\logo{demo.jpg}
```

1.5 References

The original ElegantBook template includes the section for references: using the Biblatex package and supporting style passing through parameters. However, for personal reasons, this part has been completely removed, and configuration needs to be done manually when referencing is required.

The basic usage of traditional BibTeX is as follows:

1. Specify the style in the preamble, for example, `\bibliographystyle{plain}`.

2. Use `\bibliography{reference}` at the location where the bibliography list is to be displayed. Here, it is assumed that the bibliography file is named `reference.bib`.

An example is as follows:

```
\documentclass{article}
\bibliographystyle{plain}

\begin{document}

According to Einstein's theory of relativity \cite{einstein1905}...

\bibliography{reference} % reference.bib

\end{document}
```

The basic usage of modern Biblatex is as follows:

1. Import the biblatex package in the preamble, where you can specify the style and backend.
2. Load the bibliography file in the preamble, for example, `\addbibresource[location=local]{reference.bib}`. Here, it is assumed that the bibliography file is named `reference.bib`.
3. Use `\printbibliography` at the location where the bibliography list is to be displayed.

An example is as follows:

```
\documentclass{article}
\usepackage[style=authoryear]{biblatex}
\addbibresource{reference.bib} % reference.bib

\begin{document}

According to Einstein's theory of relativity \parencite{einstein1905}...

\printbibliography[title={References}]

\end{document}
```

1.6 Mathematical Environments

This template supports common mathematical theorem environments:

- *Theorem-like environments*, which include both title and content. All theorem-like environments are numbered according to chapter numbers. There are two types based on formatting:
 - **definition** environment, with color `main`;

- **theorem, lemma, corollary, proposition** environments, with color **second**.
- *Examples*, including **example**, **problem**, and **exercise** environments (corresponding to example, problem, and exercise). They are automatically numbered, with numbering based on chapters.
- *Notes and Remarks*, including **note**, **remark**, and **solution** environments, without numbering.

Each theorem-like environment has a starred version: **definition***, **theorem***, **lemma***, **corollary***, **proposition***. Starred theorem-like environments are unnumbered. Additionally, there is a **proof** environment.

Usage of theorem-like environments is as follows:

```
\begin{theorem}[theorem name]\label{thm:label}
  This is a named theorem with a label. You can reference this theorem using \ref{thm:label
    }.
\end{theorem}

\begin{theorem}[theorem name]
  This is a named theorem.
\end{theorem}
```

The other three environments do not have options and can be used directly. For example, the usage and effect of the **example** environment are as follows:

```
\begin{example}
  This is the content of the example environment.
\end{example}
```

Remark *The original ElegantBook supported two modes for mathematical theorem environments: fancy and simple. However, I personally felt that the colorful boxes in fancy mode were too fancy, so I chose to remove them directly.*

Chapter 2 Writing Sample

Theorem 2.1 (Fubini's Theorem) *If $f(x, y)$ is a non-negative measurable function on $\mathcal{R}^p \times \mathcal{R}^q$, then for almost every $x \in \mathcal{R}^p$, $f(x, y)$ as a function of y is non-negative and measurable on \mathcal{R}^q , and $g(x) = \int_{\mathcal{R}^q} f(x, y) dy$ is non-negative and measurable on \mathcal{R}^p . Moreover,*

$$\int_{\mathcal{R}^p \times \mathcal{R}^q} f(x, y) dx dy = \int_{\mathcal{R}^p} \left(\int_{\mathcal{R}^q} f(x, y) dy \right) dx. \quad (2.1)$$

Theorem 2.2 *For the Burgers' equation, assuming a smooth initial value $u_0(x)$, and if there exist some points where $u'_0(x) < 0$, then the exact solution first intersects at the characteristic lines at time T_b , and infinite slope (discontinuity, shock) appears at time T_b .*

$$T_b = \frac{-1}{\min u'_0(x)}$$

Proof. The proof is divided into two parts: first, prove that the characteristic lines first intersect at time T_b , and then prove that infinite slope appears at time T_b , details of the proof are omitted. \square

Lemma 2.1 (Harten's Lemma) *If the difference scheme can be formulated as follows*

$$v_j^{n+1} = v_j^n - C_{j-1/2}(v_j^n - v_{j-1}^n) + D_{j+1/2}(v_{j+1}^n - v_j^n)$$

and it holds everywhere

$$C_{j+1/2} \geq 0, D_{j+1/2} \geq 0, C_{j+1/2} + D_{j+1/2} \leq 1, \forall j$$

then it is a TVD scheme.

Proposition 2.1 *The following two conclusions are equivalent:*

1. *There exists a constant $\delta > 0$ such that all eigenvalues of A satisfy $\Re \lambda \geq \delta$; (parabolic definition)*
2. *There exists a constant $\delta > 0$ such that $A + A^* \geq \delta I$.*

Corollary 2.1 *Monotone schemes must be TVD schemes, TVD schemes must be monotonicity-preserving schemes, but the converse is not true. In the context of linear difference schemes, monotone schemes, TVD schemes, and monotonicity-preserving schemes are equivalent concepts.*

Definition 2.1 (Conservative Scheme) *A difference scheme is called a conservative scheme if it can be formulated as follows*

$$v_j^{n+1} = v_j^n - \frac{\Delta t}{\Delta x} \left(\hat{f}_{j+1/2}^n - \hat{f}_{j-1/2}^n \right) \quad (*)$$

where $\hat{f}_{j+\frac{1}{2}}$ is called the numerical flux, with the expression $\hat{f}_{j+\frac{1}{2}} = \hat{f}(v_{j-r}, \dots, v_{j+s})$, and satisfies

1. *Continuity: \hat{f} is locally Lipschitz continuous with respect to each variable*

2. *Compatibility:* $\hat{f}(v, \dots, v) = f(v)$

Example 2.1 The characteristic lines of the Burgers' equation $u_t + uu_x = 0$ satisfy

$$\frac{dx}{dt} = f'(u_0(x_0)) = u_0(x_0) \quad (2.2)$$

The characteristic lines are straight lines in the $x-t$ plane

$$x = x_0 + u_0(x_0)t \quad (2.3)$$

Below are examples of images and tables. Figure 2.1 presents a typical exact solution of the Burgers' equation, obtained by solving the nonlinear equation (2.3); Table 2.1 presents a comparison of a set of numerical algorithms, including errors and orders.

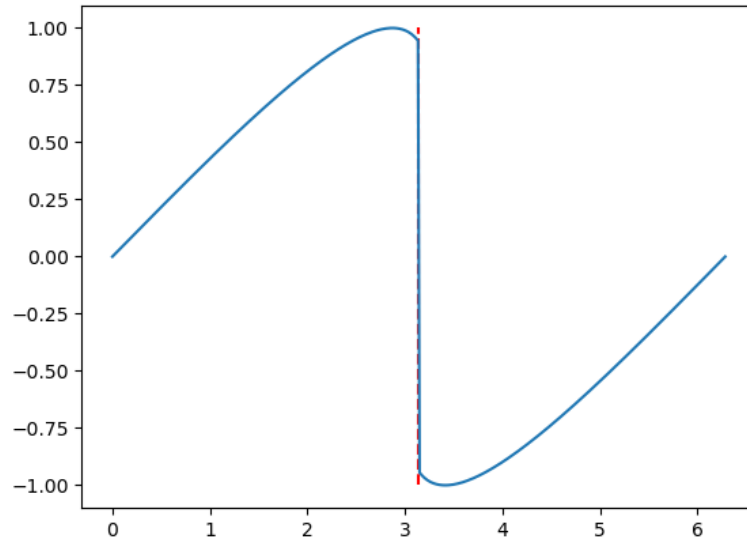


Figure 2.1: Solution of Burgers' equation

Table 2.1: Computational Results

		N=25	N=50	N=100	N=200	N=400
FTCS	Error	2.8e-03	7.1121e-04	1.7821e-04	4.4559e-05	1.1139e-05
	Order of Error	-	1.97	1.99	2.00	2.00
	Time/s	0.009449	0.009827	0.087355	0.840438	33.303874
SVD	Error	2.8e-03	7.1121e-04	1.7847e-04	4.4615e-05	1.1153e-05
	Order of Error	-	1.97	1.99	2.00	2.00
	Time/s	0.016365	0.010492	0.034441	0.205993	1.431576

Problem 2.1 Determine the order of accuracy of the following difference equations to the partial differential equation

$$u_t + au_x = 0$$

$$v_k^{n+1} = v_k^{n-1} - R\delta_0 u_k^n + \frac{R}{6}\delta^2 \delta_0 u_k^n$$

Solution The truncation error is

$$\begin{aligned} T_k^n &= \frac{u_k^{n+1} - u_k^{n-1}}{2\Delta t} + \frac{a}{2\Delta x}(u_{k+1}^n - u_{k-1}^n) - \frac{a}{12\Delta x}(u_{k+2}^n - 2u_{k+1}^n + 2u_{k-1}^n - u_{k-2}^n) \\ &= (u_t + \frac{\Delta t^2}{6}u_{ttt} + O(\Delta t^4))|_k^n + a(u_x + \frac{\Delta x^2}{6}u_{xxx} + \frac{\Delta x^4}{120}u_{xxxxx} + O(\Delta x^6))|_k^n \\ &\quad - \frac{a}{12}(2\Delta x^2u_{xxx} + \frac{\Delta x^4}{2}u_{xxxxx} + O(\Delta x^6))|_k^n \\ &= O(\Delta t^2 + \Delta x^4) \end{aligned}$$

2nd order in time, 4th order in space.

Remark *This is a remark content test.*¹

Note *This is a note content test.*[3]

Nested unordered lists look like this:

- xxx
- xxx
 - yyy
 - yyy
 - ◆ zzz
 - ◆ zzz
 - www
 - www

Nested ordered lists look like this:

1. xxx
2. xxx
 - (a) yyy
 - (b) yyy
 - i. zzz
 - ii. zzz
 - A. www
 - B. www

¹Christian Lubich and Ivan V. Oseledets. “A Projector-Splitting Integrator for Dynamical Low-Rank Approximation”. In: *BIT Numerical Mathematics* 54.1 (Mar. 2014), pp. 171–188. issn: 0006-3835, 1572-9125. doi: [10.1007/s10543-013-0454-0](https://doi.org/10.1007/s10543-013-0454-0). URL: <http://link.springer.com/10.1007/s10543-013-0454-0>.

References

- [1] Gianluca Ceruti, Jonas Kusch, and Christian Lubich. “A Rank-Adaptive Robust Integrator for Dynamical Low-Rank Approximation”. In: *BIT Numerical Mathematics* 62.4 (Dec. 2022), pp. 1149–1174. ISSN: 0006-3835, 1572-9125. DOI: [10.1007/s10543-021-00907-7](https://doi.org/10.1007/s10543-021-00907-7). URL: <https://link.springer.com/10.1007/s10543-021-00907-7>.
- [2] Gianluca Ceruti and Christian Lubich. “An Unconventional Robust Integrator for Dynamical Low-Rank Approximation”. In: *BIT Numerical Mathematics* 62.1 (Mar. 2022), pp. 23–44. ISSN: 0006-3835, 1572-9125. DOI: [10.1007/s10543-021-00873-0](https://doi.org/10.1007/s10543-021-00873-0). URL: <https://link.springer.com/10.1007/s10543-021-00873-0>.
- [3] Othmar Koch and Christian Lubich. “Dynamical Low-Rank Approximation”. In: *SIAM Journal on Matrix Analysis and Applications* 29.2 (Jan. 2007), pp. 434–454. ISSN: 0895-4798, 1095-7162. DOI: [10.1137/050639703](https://doi.org/10.1137/050639703). URL: <http://epubs.siam.org/doi/10.1137/050639703>.
- [4] Christian Lubich and Ivan V. Oseledets. “A Projector-Splitting Integrator for Dynamical Low-Rank Approximation”. In: *BIT Numerical Mathematics* 54.1 (Mar. 2014), pp. 171–188. ISSN: 0006-3835, 1572-9125. DOI: [10.1007/s10543-013-0454-0](https://doi.org/10.1007/s10543-013-0454-0). URL: <http://link.springer.com/10.1007/s10543-013-0454-0>.

Appendix A Mathematical Tools

This appendix covers some of the basic mathematics used in econometrics. We briefly discuss the properties of summation operators, study the properties of linear and some nonlinear equations, and review the ratios and percentages. We also introduce some special functions that are common in econometrics applications, including quadratic functions and natural logarithms. The first four sections require only basic algebraic techniques. The fifth section briefly reviews differential Calculus. Although Calculus is not necessary to understand much of this book, it is used in some of the end-of-chapter appendices and in some of the more advanced topics in part 3.

A.1 Summation Operator and Description Statistics

Summation Operator is an abbreviation used to express the summation of numbers, it plays an important role in statistics and econometrics analysis. If $\{x_i : i = 1, 2, \dots, n\}$ is a sequence of n numbers, the summation of the n numbers is:

$$\sum_{i=1}^n x_i \equiv x_1 + x_2 + \dots + x_n \tag{A.1}$$