申请上海交通大学博士学位论文

上海交通大学论文 Rmd bookdown 模板

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SJTU Bookdown Template

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上海交通大学
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上海交通大学论文 Rmd bookdown 模板

摘　要

上海交通大学是我国历史最悠久的高等学府之一，是教育部直属、教育部与上海市共建的全国重点大学，是国家''七五''、''八五''重点建设和''211 工程''、''985 工程''的首批建设高校。经过 115 年的不懈努力，上海交通大学已经成为一所''综合性、研究型、国际化''的国内一流、国际知名大学，并正在向世界一流大学稳步迈进。

十九世纪末，甲午战败，民族危难。中国近代著名实业家、教育家盛宣怀和一批有识之士秉持''自强首在储才，储才必先兴学''的信念，于 1896 年在上海创办了交通大学的前身——南洋公学。建校伊始，学校即坚持''求实学，务实业''的宗旨，以培养''第一等人才''为教育目标，精勤进取，笃行不倦，在二十世纪二三十年代已成为国内著名的高等学府，被誉为''东方 MIT''。抗战时期，广大师生历尽艰难，移转租界，内迁重庆，坚持办学，不少学生投笔从戎，浴血沙场。解放前夕，广大师生积极投身民主革命，学校被誉为''民主堡垒''。

新中国成立初期，为配合国家经济建设的需要，学校调整出相当一部分优势专业、师资设备，支持国内兄弟院校的发展。五十年代中期，学校又响应国家建设大西北的号召，根据国务院决定，部分迁往西安，分为交通大学上海部分和西安部分。1959 年 3 月两部分同时被列为全国重点大学，7 月经国务院批准分别独立建制，交通大学上海部分启用''上海交通大学''校名。历经西迁、两地办学、独立办学等变迁，为构建新中国的高等教育体系，促进社会主义建设做出了重要贡献。六七十年代，学校先后归属国防科工委和六机部领导，积极投身国防人才培养和国防科研，为''两弹一星''和国防现代化做出了巨大贡献。

改革开放以来，学校以''敢为天下先''的精神，大胆推进改革：率先组成教授代表团访问美国，率先实行校内管理体制改革，率先接受海外友人巨资捐赠等，有力地推动了学校的教学科研改革。1984 年，邓小平同志亲切接见了学校领导和师生代表，对学校的各项改革给予了充分肯定。在国家和上海市的大力支持下，学校以''上水平、创一流''为目标，以学科建设为龙头，先后恢复和兴建了理科、管理学科、生命学科、法学和人文学科等。1999 年，上海农学院并入；2005 年，与上海第二医科大学强强合并。至此，学校完成了综合性大学的学科布局。近年来，通过国家''985 工程''和''211 工程''的建设，学校高层次人才日渐汇聚，科研实力快速提升，实现了向研究型大学的转变。

与此同时，学校通过与美国密西根大学等世界一流大学的合作办学，实施国际化战略取得重要突破。1985 年开始闵行校区建设，历经 20 多年，已基本建设成设施完善，环境优美的现代化大学校园，并已完成了办学重心向闵行校区的转移。学校现有徐汇、闵行、法华、七宝和重庆南路（卢湾）5 个校区，总占地面积 4840 亩。通过一系列的改革和建设，学校的各项办学指标大幅度上升，实现了跨越式发展，整体实力显著增强，为建设世界一流大学奠定了坚实的基础。

交通大学始终把人才培养作为办学的根本任务。一百多年来，学校为国家和社会培养了 20 余万各类优秀人才，包括一批杰出的政治家、科学家、社会活动家、实业家、工程技术专家和医学专家，如江泽民、陆定一、丁关根、汪道涵、钱学森、吴文俊、徐光宪、张光斗、黄炎培、邵力子、李叔同、蔡锷、邹韬奋、陈敏章、王振义、陈竺等。在中国科学院、中国工程院院士中，有 200 余位交大校友；在国家 23 位 ''两弹一星'' 功臣中，有 6 位交大校友；在 18 位国家最高科学技术奖获得者中，有 3 位来自交大。交大创造了中国近现代发展史上的诸多 ''第一''：中国最早的内燃机、最早的电机、最早的中文打字机等；新中国第一艘万吨轮、第一艘核潜艇、第一艘气垫船、第一艘水翼艇、自主设计的第一代战斗机、第一枚运载火箭、第一颗人造卫星、第一例心脏二尖瓣分离术、第一例成功移植同种原位肝手术、第一例成功抢救大面积烧伤病人手术等，都凝聚着交大师生和校友的心血智慧。改革开放以来，一批年轻的校友已在世界各地、各行各业崭露头角。

截至 2011 年 12 月 31 日，学校共有 24 个学院/直属系（另有继续教育学院、技术学院和国际教育学院），19 个直属单位，12 家附属医院，全日制本科生 16802 人、研究生 24495 人（其中博士研究生 5059 人）；有专任教师 2979 名，其中教授 835 名；中国科学院院士 15 名，中国工程院院士 20 名，中组部 ''千人计划''49 名，''长江学者''95 名，国家杰出青年基金获得者 80 名，国家重点基础研究发展计划（973 计划）首席科学家 24 名，国家重大科学研究计划首席科学家 9 名，国家基金委创新研究群体 6 个，教育部创新团队 17 个。

学校现有本科专业 68 个，涵盖经济学、法学、文学、理学、工学、农学、医学、管理学和艺术等九个学科门类；拥有国家级教学及人才培养基地 7 个，国家级校外实践教育基地 5 个，国家级实验教学示范中心 5 个，上海市实验教学示范中心 4 个；有国家级教学团队 8 个，上海市教学团队 15 个；有国家级教学名师 7 人，上海市教学名师 35 人；有国家级精品课程 46 门，上海市精品课程 117 门；有国家级双语示范课程 7 门；2001、2005 和 2009 年，作为第一完成单位，共获得国家级教学成果 37 项、上海市教学成果 157 项。

关键词：上海交大　　饮水思源　　爱国荣校

SJTU BOOKDOWN TEMPLATE

ABSTRACT

An imperial edict issued in 1896 by Emperor Guangxu, established Nanyang Public School in Shanghai. The normal school, school of foreign studies, middle school and a high school were established. Sheng Xuanhuai, the person responsible for proposing the idea to the emperor, became the first president and is regarded as the founder of the university.

During the 1930s, the university gained a reputation of nurturing top engineers. After the foundation of People's Republic, some faculties were transferred to other universities. A significant amount of its faculty were sent in 1956, by the national government, to Xi'an to help build up Xi'an Jiao Tong University in western China. Afterwards, the school was officially renamed Shanghai Jiao Tong University.

Since the reform and opening up policy in China, SJTU has taken the lead in management reform of institutions for higher education, regaining its vigor and vitality with an unprecedented momentum of growth. SJTU includes five beautiful campuses, Xuhui, Minhang, Luwan Qibao, and Fahua, taking up an area of about 3,225,833 m2. A number of disciplines have been advancing towards the top echelon internationally, and a batch of burgeoning branches of learning have taken an important position domestically.

Today SJTU has 31 schools (departments), 63 undergraduate programs, 250 masters-degree programs, 203 Ph.D. programs, 28 post-doctorate programs, and 11 state key laboratories and national engineering research centers.

SJTU boasts a large number of famous scientists and professors, including 35 academics of the Academy of Sciences and Academy of Engineering, 95 accredited professors and chair professors of the "Cheung Kong Scholars Program" and more than 2,000 professors and associate professors.

Its total enrollment of students amounts to 35,929, of which 1,564 are international students. There are 16,802 undergraduates, and 17,563 masters and Ph.D. candidates. After more than a century of operation, Jiao Tong University has inherited the old tradition of "high starting points, solid foundation, strict requirements and extensive practice." Students from SJTU have won top prizes in various competitions, including ACM International Collegiate Programming

Contest, International Mathematical Contest in Modeling and Electronics Design Contests. Famous alumni include Jiang Zemin, Lu Dingyi, Ding Guangen, Wang Daohan, Qian Xuesen, Wu Wenjun, Zou Taofen, Mao Yisheng, Cai Er, Huang Yanpei, Shao Lizi, Wang An and many more. More than 200 of the academics of the Chinese Academy of Sciences and Chinese Academy of Engineering are alumni of Jiao Tong University.

KEY WORDS: SJTU, Thesis, Rmarkdown/Bookdown template

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作者简介

这将是是一群深度操作系统爱好者的杰作！！！

我一直致力于寻找合作者，但是我感觉现在有点迷茫。这边进度实在是慢，常常一个月写不了多少内容，可能一个月就几百字，都写不到一页内容。经常停下来。我只是想告诉别人，这个事业还在继续中。我却找不到一点点进步的身影。

现在（2017-10-29）写作进行的很困难，主要是零碎的时间很难用于整理大篇大篇的文字。还有其他繁重的任务要做，似乎不太容易写。我觉得可以分析一下困难，研究一下对策。不要再让这本书半途而废了。现在遇到的问题，负责带教，挤占了较多的时间，一时半会，他们也帮不上忙。还有两个网站的内容在整理，不可荒废。包括驾校也要报名。结婚的事情，还有一大堆。也就是有这么几件事，婚前准备，两个网站的维护，驾校考试，带教学习，完成本书第一版草稿，基本就是这么个优先级顺序，当然时刻伴随着要上班这个无法逃脱的事情。鉴于此，我认为接下来可以这样安排。婚前准备虽然优先级高，但是实际占场时间不多，如果可以快速下决定，花不了太长时间的。两个网站的维护，基本上要浪费掉很多晚上的时间。可以每天抽出两个小时的时间，弄一弄。驾校的事情，周末可以去试试，也可以在工作间隙去练练。带教学习，也是很耗费时间的，每次可能要一到两个小时，一周也就两到三次。可以跟网站维护交叉进行。完成本书第一版草稿，更是要耗费几年时间的任务。另外带教学习的就是本书，可以充分利用这个带教的事情，毕竟有徒弟可以帮着写写画画的。制定这么一个时间表，有时间里面把婚前准备的事情给结束掉，避免多次设想，带来的巨大时间浪费。每周抽出两到三天晚上带教，可以做好任务安排，每完成一章课程，作业就是帮我整理本草稿。剩下的两到三天去编写网站代码，做好维护，且不再增加新的网站或者其他任务了。驾校的事情，暂且缓一缓，找个时间去把科目一考了。

终于领结婚证了（2017-11-03），我现在觉得写作特别耗费时间，需要''庙算''一下，好好规划一下，要写哪些内容。github 的一些功能是非常值得充分利用的，比如 issue，这样可以充分利用零碎时间。半夜我坐在一个孤独的房间，又不看书，怎么可能写好这个笔记。必须边学习边做笔记，也就是写到 issue 上。不要手机整天微信、支付宝了。当前贡献者：黄煌、贺鹏飞、董春柏、邱鹏飞，还有参考网页的一些好友，抱歉没来得及写在这里，以后慢慢添加，在此表示感谢。

第一章　这是什么

这是上海交通大学 (非官方) 学位论文 Bookdown 模板。

据最新 [2018-06-08] 的上海交通大学学位论文 LaTeX 模板[1]，参考谢益辉 Bookdown 中文模板[2]改写而成[1]。支持使用 LaTeX 和 R Markdown 混编，最大速度提高论文书写速度，让论文书写更便捷。

1.1　准备工作

本模板使用 bookdown 实现了由 R Markdown （Bookdown）-> LaTeX-> PDF 的一系列转换，其中用到的依赖有：

- bookdown
- pandoc
- Tex

需要安装这些软件，才可以使用。

1.1.1　Linux 下使用

下面以深度操作系统 15.5 版本为例说明。安装过程中，请确保当前 rstudio 的版本高于 1.0.0, texlive 为 2015 年及之后的版本。

```
$ sudo apt-get install r-base r-base-dev \
rstudio texlive-full pandoc make
```

如果不能满足，请参考相关软件官网，下载最新版本。

1.1.2　Windows 下使用

略

1.1.3　苹果操作系统下使用

略

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[1]https://github.com/sjtug/SJTUThesis

[2]https://github.com/yihui/bookdown-chinese

1.2　模板选项

sjtuthesis-rmd 提供了一些常用选项，可以组合使用，在 *./index.Rmd* 文件中配置。具体配置方法，见后文。这些选项包括：

- 学位类型：bachelor(学位)、master(硕士)、doctor(博士)，是必选项。
- 中文字体：fandol(Fandol 开源字体)、windows(Windows 系统下的中文字体)、mac(macOS 系统下的华文字体)、ubuntu(Ubuntu 系统下的文泉驿和文鼎字体)、adobe(Adobe 公司的中文字体)、founder(方正公司的中文字体)，默认根据操作系统自动配置。
- 英文模版：使用 english 选项启用英文模版。
- 盲审选项：使用 review 选项后，论文作者、学号、导师姓名、致谢、发表论文和参与项目将被隐去。

1.3　编译模板

模板默认使用 GNUMake 构建，后续如无特殊说明，默认执行命令的文件夹以及当前文件夹均为本模板的根目录。

```
$ make
```

在已经安装 RStudio 的前提下，也可手动编译。打开 RStudio 软件，在弹出的界面，左上角点击 File->Open Project，选中 *./SJTUThesis-Rmd.Rproj* 文件打开，点击右上角靠下的一栏，有个 `Build` 格，会出现 `Build Book` 等按钮。点击 `Build Book` 就会生成 PDF 书籍了，位于 *./_book/sjtu-thesis-rmd.pdf* 。

如果需要查看字数，先生成文件，然后执行，

```
$ make wordcount
```

1.4　文件布局

使用 `tree` 命令所得。

代码 1–1 模板文件布局

```
├── bib
│   └── thesis.bib
├── _book
│   ├── sjtu-thesis-rmd.pdf
```

```
│       └── sjtu-thesis-rmd.tex
├── _bookdown_files
├── _bookdown.yml
├── figure
│   ├── example
│   │   ├── flow_chart.tex
│   │   ├── sjtulogo.eps
│   │   ├── sjtulogo.jpg
│   │   └── sjtulogo.png
│   ├── sjtubadge.pdf
│   ├── sjtubanner.pdf
│   └── sjtulogo.pdf
├── handed_pdf
│   ├── authorization.pdf
│   └── original.pdf
├── index.Rmd
├── tex
│   ├── ack.tex
│   ├── content.tex
│   ├── end_english_abstract.tex
│   ├── patents.tex
│   ├── projectsreview.tex
│   ├── projects.tex
│   ├── pubreview.tex
│   ├── pub.tex
│   └── template.tex
├── Makefile
├── _output.yml
├── README.md
├── _render.R
├── rmd
│   ├── 000-abstract.Rmd
│   ├── 001-symbol.Rmd
│   ├── 003-author.Rmd
│   ├── 101-intro.Rmd
│   ├── 102-chapters.Rmd
│   ├── 103-latex.Rmd
│   ├── 104-rmarkdown.Rmd
│   ├── 105-example.Rmd
│   ├── 601-appendix-bookdown.Rmd
│   ├── 602-appendix-tale.Rmd
│   ├── 603-appendix-history.Rmd
│   └── 604-appendix-r-diagram.Rmd
├── sjtuthesis.cfg
```

```
├── sjtuthesis.cls
└── SJTUThesis-Rmd.Rproj
```

1.5 主要文件介绍

1.5.1 LATEX 模板文件

格式控制文件控制着论文的表现形式，包括 *./sjtuthesis.cfg* 和 *./sjtuthesis.cls*。其中，"cls" 控制论文主体格式，"cfg" 为配置文件。上述文件全部来自上海交通大学学位论文 LATEX 模板[1]

1.5.2 各章源文件

主要位于 *./rmd/* 文件夹。由于现阶段部分功能实现不全，暂且把部分内容以 LATEX 形式存放在 *./tex/* 文件夹下。

- 中英文摘要 (*./rmd/000-abstract.Rmd*)，符号表 (*./rmd/001-symbol.Rmd*) 等。前言 (frontmatter) 的其他部分，中英文封面、原创性声明、授权信息在 sjtuthesis.cls 中定义，不单独分离为 Rmd 文件。
- 目录文件 (*./tex/content.tex*)，设置目录内容。如果不需要图片、算法等的目录，可以修改该文件。
- 模板文件 (*./tex/template.tex*)，统筹最终生成的 *_book/sjtu-thesis-rmd.tex* 内容。
- 正文 (mainmatter)，是文章的主体，位于 *./rmd/* 文件夹下，基本用 Rmarkdown 实现，部分不容易实现的，照搬 LATEX 原文，均在 *xxx.Rmd* 文件内。
- 附录 (*./rmd/xxx-appendix-name.Rmd*)，类似正文，使用 Rmarkdown 实现，部分内容用 LATEX 实现，均在 *xxx.Rmd* 文件内。
- 致谢 (*./tex/ack.tex*)、攻读学位论文期间发表的学术论文目录 (*./tex/pub.tex*)、个人简历 (*./tex/resume.tex*) 组成附录后的部分 (backmatter)。这部分能力所限，未能实现从 LATEX 到 Rmarkdown 的转换，仍旧保留为 LATEX 格式。参考文献列表由 bibtex 插入，不作为一个单独的文件。

1.5.3 配置文件

主要为 *./index.Rmd* 文件，另外两个配置文件 (*./_bookdown.yml*、*./_output.yml*) 没有特殊需求不需要更改。

---

[1] https://github.com/sjtug/SJTUThesis

对于 *./index.Rmd* 文件，论文题目、作者等信息直接更改为自己的即可。对第1.2节提到的论文选项，比如学位类型、英文模板、盲审选项、最终提交等可以放在 classoption 的 [] 内。比如 classoption: [doctor, openright, twoside, submit]，就表示博士论文的提交版本。

1.5.4 图片文件夹 figure

figure 文件夹放置了需要插入文档中的图片文件 (支持 PNG/JPG/PDF/EPS 格式的图片)，可以在按照章节划分子目录。模板文件中使用\graphicspath命令定义了图片存储的顶层目录，在插入图片时，顶层目录名 "figure" 可省略。

1.5.5 参考文献数据库 bib

目前参考文件数据库目录只存放一个参考文件数据库 *./bib/thesis.bib*。关于参考文献引用，可参考第三章中的例子。

1.5.6 辅助文件

- *./SJTUThesis-Rmd.Rproj* 项目文件，方便使用 rstudio 打开，如果仅使用 make，可以不要。
- *./_render.R* 渲染文件，复制自谢益辉 Bookdown 中文模板[1]，致谢。
- *./Makefile* make 的文件，综合上海交通大学学位论文 LaTeX 模板[2]和谢益辉 Bookdown 中文模板[3]。
- *./handed_pdf/* 复制自上海交通大学学位论文 LaTeX 模板[4]手写授权。
- *./_book/* 最终生成文件所在文件夹。
- *./_bookdown_files/* 过程中生成的文件所在文件夹。

---

[1]https://github.com/yihui/bookdown-chinese

[2]https://github.com/sjtug/SJTUThesis

[3]https://github.com/yihui/bookdown-chinese

[4]https://github.com/sjtug/SJTUThesis

第二章   各章格式说明

Bookdown 编译各 Rmd 文件时，是按照文件名的字母排序拼接在一起的，故而我们不需要专门写一个文件，类似 LATEX 模板的 thesis.tex 文件，但是也要求文件名需要特殊处理才可以做到有序。本模板的文件名采用如下命名方式，*xxx-name.Rmd*。其中 xxx 表示从 000 到 999，用于排序。name 是对应章节的名字。一章一个文件。

由于自身水平所限，部分格式实现起来费劲，就采用直接书写 LATEX 代码的形式实现了。

2.1   摘要

摘要文件需要放在除了扉页的最开头位置。由于扉页等已经在模板中处理生成，故摘要需要放在最开头，命名为 *./rmd/000-abstract.Rmd*。

代码 2–1 摘要代码框架示例

```latex
1  \frontmatter
2  \pagestyle{main}
3
4  \abstract
5
6  上海交通大学是我国历史最悠久的高等学府之一。
7
8  \keywords{\large 上海交大 \quad 饮水思源 \quad 爱国荣校}
9
10 \englishabstract
11
12 An imperial edict issued in 1896 by Emperor Guangxu, established
        Nanyang Public School in Shanghai.
13
14 \englishkeywords{\large SJTU, Thesis, Rmarkdown/Bookdown template}
15
16 \include{tex/content}
```

解释

1. 第 1、2 行，表示下面属于论文前言部分，采用**罗马数字对前言编号**，页面格式属于正文格式。
2. 第 4、10 行，表示下面是中英文的摘要部分。

3. 第 16 行，表示接下来为目录部分。
4. 摘要全文属于 LATEX 原文复制，局部改动的方法实现。为了减少文件个数，把文件格式以及目录也放在该文件了，但也造成了文件不专用的问题。请根据爱好，自行斟酌。

2.2　摘要后的部分章节

摘要后的部分章节，属于标准的 Markdown 文件，代码框架示例如代码2–2所示。

代码 2–2 前言后文代码框架示例

```
1  # 主要符号对照表
2
3  \begin{longtable}{rl}
4  $\epsilon$      & 介电常数 \\
5   $\mu$          & 磁导率 \\
6  \end{longtable}
```

解释

1. 第 1 行，标准 Markdown 语句，表示这是一章。
2. 第 3-6 行，该章的具体内容，本章直接复制的 LATEX 源码，也可用使用 Markdown 书写。

2.3　正文第一章

代码 2–3 正文第一章代码框架示例

```
1  \mainmatter
2  \pagestyle{main}
3
4  # 这是什么 {#chap:intro}
5
6  这是上海交通大学(非官方)学位论文 Bookdown 模板。
```

解释

1. 第 1、2 行，表示下面属于论文正文部分，采用**阿拉伯数字对正文编号**，页面格式属于正文格式。
2. 第 4 行及以后，属于标准的 Markdown 内容。

2.4 正文后续章节

框架格式类似摘要后的文件，如代码2–2所示，略。

2.5 全文总结

全文总结比较特殊，没有编入章节序号，采用如下方式。

代码 2–4 全文总结代码框架示例

```
1  \summary
2
3  这里是全文总结内容。
```

解释

1. 第 1 行，表示下面为全文总结部分。
2. 第 3 行及以后，书写全文总结内容，可以使用 LaTeX 或 Markdown 书写。

2.6 附录第一章

代码 2–5 附录代码框架示例

```
1  \appendix
2
3  # bookdown 入门简介 {#bookdown-intro}
```

解释

1. 第 1 行，表示下面属于论文附录部分，采用**英文字母对附录编号**。
2. 第 3 行及以后，属于标准的 Markdown 内容。

2.7 附录后续章节

框架格式类似摘要后的文件，如代码2–2所示，略。

2.8 后缀部分

相关代码为 LaTeX 形式，位于 *./tex/* 文件夹下，请参考上海交通大学学位论文 LaTeX 模板[1]。

---

[1]https://github.com/sjtug/SJTUThesis

第三章 兼容 LATEX 排版

本章完全照抄交大论文模板的 LATEX 排版例子，除了动了标题和多了这行话，运行良好，但是部分地方会多出括号来，请对照原文删除。

3.1 列表环境

3.1.1 无序列表

以下是一个无序列表的例子，列表的每个条目单独分段。

- 这是一个无序列表。
- 这是一个无序列表。
- 这是一个无序列表。

使用`itemize*` 环境可以创建行内无序列表。

• 这是一个无序列表。• 这是一个无序列表。• 这是一个无序列表。

行内无序列表条目不单独分段，所有内容直接插入在原文的段落中。

3.1.2 有序列表

使用环境`enumerate` 和`enumerate*` 创建有序列表, 使用方法无序列表类似。

1. 这是一个有序列表。
2. 这是一个有序列表。
3. 这是一个有序列表。

使用`enumerate*` 环境可以创建行内有序列表。

1. 这是一个默认有序列表。2. 这是一个默认有序列表。3. 这是一个默认有序列表。

行内有序列表条目不单独分段，所有内容直接插入在原文的段落中。

3.1.3 描述型列表

使用环境`description` 可创建带有主题词的列表，条目语法是`\item[`主题`]` 内容。

主题一 详细内容
主题二 详细内容
主题三 详细内容 . . .

3.1.4 自定义列表样式

可以使用 `label` 参数控制列表的样式，详细可以参考 WikiBooks[1]。比如一个自定义样式的行内有序列表

a) 这是一个自定义样式有序列表。*b)* 这是一个自定义样式有序列表。*c)* 这是一个自定义样式有序列表。

3.2 数学排版

3.2.1 公式排版

这里有举一个长公式排版的例子，来自《Math mode》[2]：

$$\frac{1}{2}\Delta(f_{ij}f^{ij}) = 2\left(\sum_{i<j}\chi_{ij}(\sigma_i - \sigma_j)^2 + f^{ij}\nabla_j\nabla_i(\Delta f) + \right.$$
$$\left. +\nabla_k f_{ij}\nabla^k f^{ij} + f^{ij}f^k\left[2\nabla_i R_{jk} - \nabla_k R_{ij}\right]\right) \quad (3\text{--}1)$$

3.2.2 SI 单位

使用 `siunitx` 宏包可以方便地输入 SI 单位制单位，例如 `\SI{5}{\um}` 可以得到 5 μm。

3.2.2.1 一个四级标题

这是全文唯一的一个四级标题。在这部分中将演示了 mathtools 宏包中可伸长符号（箭头、等号的例子）的例子。

$$A \xleftarrow{n=0} B \xrightarrow[LongLongLongLong]{n>0} C$$

$$f(x) \quad \xleftrightarrow{A=B} \quad B \quad\quad (3\text{--}2)$$
$$\xleftarrow[below]{above} B$$
$$\xLeftrightarrow[below]{above} B \quad\quad (3\text{--}3)$$

---

[1] https://en.wikibooks.org/wiki/LaTeX/List_Structures#Customizing_lists

[2] http://www.tex.ac.uk/tex-archive/info/math/voss/mathmode/Mathmode.pdf

又如:

$$I(X_3; X_4) - I(X_3; X_4 \mid X_1) - I(X_3; X_4 \mid X_2)$$

$$= [I(X_3; X_4) - I(X_3; X_4 \mid X_1)] - I(X_3; X_4 \mid \tilde{X}_2) \tag{3-4}$$

$$= I(X_1; X_3; X_4) - I(X_3; X_4 \mid \tilde{X}_2) \tag{3-5}$$

3.2.3 定理环境

模板中定义了丰富的定理环境 algo(算法), thm(定理), lem(引理), prop(命题), cor(推论), defn(定义), conj(猜想), exmp(例), rem(注), case(情形), bthm(断言定理), blem(断言引理), bprop(断言命题), bcor(断言推论)。amsmath 还提供了一个 proof(证明) 的环境。这里举一个 "定理" 和 "证明" 的例子。

定理 3.1 (留数定理). 假设 U 是复平面上的一个单连通开子集, $a_1, \ldots, a_n$ 是复平面上有限个点, f 是定义在 $U \backslash \{a_1, \ldots, a_n\}$ 上的全纯函数, 如果 γ 是一条把 $a_1, \ldots, a_n$ 包围起来的可求长曲线, 但不经过任何一个 a_k, 并且其起点与终点重合, 那么:

$$\oint_\gamma f(z)\, \mathrm{d}z = 2\pi \mathbf{i} \sum_{k=1}^n \mathrm{I}(\gamma, a_k) \mathrm{Res}(f, a_k) \tag{3-6}$$

如果 γ 是若尔当曲线, 那么 $\mathrm{I}(\gamma, a_k) = 1$, 因此:

$$\oint_\gamma f(z)\, \mathrm{d}z = 2\pi \mathbf{i} \sum_{k=1}^n \mathrm{Res}(f, a_k) \tag{3-7}$$

在这里, $\mathrm{Res}(f, a_k)$ 表示 f 在点 a_k 的留数, $\mathrm{I}(\gamma, a_k)$ 表示 γ 关于点 a_k 的卷绕数。卷绕数是一个整数, 它描述了曲线 γ 绕过点 a_k 的次数。如果 γ 依逆时针方向绕着 a_k 移动, 卷绕数就是一个正数, 如果 γ 根本不绕过 a_k, 卷绕数就是零。

定理3.1的证明。

证明. 首先, 由……
其次, ……
所以…… □

上面的公式例子中, 有一些细节希望大家注意。微分号 d 应该使用 "直立体" 也就是用 mathrm 包围起来。并且, 微分号和被积函数之间应该有一段小间隔, 可以插入\, 得到。斜体的 d 通常只作为一般变量。i,j 作为虚数单位时, 也应该使用 "直立体" 为了

明显，还加上了粗体，例如\mathbf{i}。斜体 i, j 通常用作表示"序号"。其他字母在表示常量时，也推荐使用"直立体"譬如，圆周率 π（需要 upgreek 宏包），自然对数的底 e。不过，我个人觉得斜体的 e 和 π 很潇洒，在不至于引起混淆的情况下，我也用这两个字母的斜体表示对应的常量。

3.3　向文档中插入图像

3.3.1　支持的图片格式

X⅁TEX 可以很方便地插入 PDF、PNG、JPG 格式的图片。

插入 PNG/JPG 的例子如3–1所示。这两个水平并列放置的图共享一个"图标题"(table caption)，没有各自的小标题。
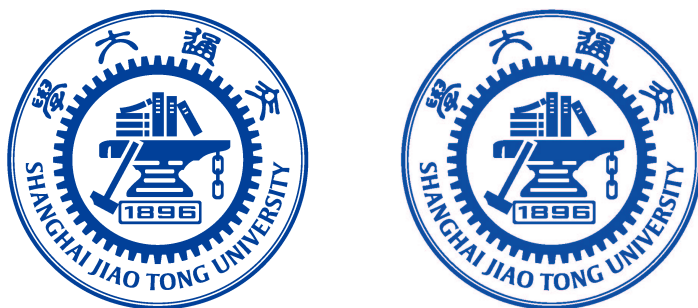
图 3–1 中文题图

Figure 3–1 English caption

这里还有插入 EPS 图像和 PDF 图像的例子，如图3–2a和图3–2b。这里将 EPS 和 PDF 图片作为子图插入，每个子图有自己的小标题。子图标题使用 subcaption 宏包添加。

(a) EPS 图像　　　　　　　　　(b) PDF 图像，注意这个图略矮些。如果标
　　　　　　　　　　　　　　　　　　题很长的话，它会自动换行

图 3–2 插入 eps 和 pdf 的例子（使用 subcaptionbox 方式）

Figure 3–2 An EPS and PDF demo with subcaptionbox

更多关于 LaTeX 插图的例子可以参考《LaTeX 插图指南》[1]。

---

[1] `http://www.cs.duke.edu/junhu/Graphics3.pdf`

(a) EPS 图像

(b) PDF 图像，注意这个图略矮些。subfigure 中同一行的子图在顶端对齐。

图 3–3 插入 eps 和 pdf 的例子（使用 subfigure 方式）

Figure 3–3 An EPS and PDF demo with subfigure

3.3.2　长标题的换行

图3–4和图3–5都有比较长图标题，通过对比发现，图3–5的换行效果更好一些。其中使用了 minipage 环境来限制整个浮动体的宽度。

图 3–4 上海交通大学是我国历史最悠久的高等学府之一，是教育部直属、教育部与上海市共建的全国重点大学.

Figure 3–4 Where there is a will, there is a way.

图 3–5 上海交通大学是我国历史最悠久的高等学府之一，是教育部直属、教育部与上海市共建的全国重点大学.

Figure 3–5 Where there is a will, there is a way.

3.3.3　添加图注

当插图中组成部件由数字或字母等编号表示时，可在插图下方添加图注进行说明，如图3–6所示。
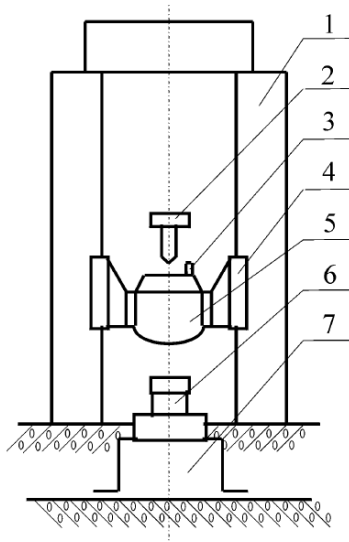
1. 立柱 2. 提升释放机构 3. 标准冲击加速度计
4. 导轨 5. 重锤 6. 被校力传感器 7. 底座

图 3–6 示例图片来源于 [**he1999**]

Figure 3–6 Stay hungry, stay foolish.

3.3.4　绘制流程图

图3–7是一张流程图示意。使用 tikz 环境，搭配四种预定义节点（startstop、process、decision 和io），可以容易地绘制出流程图。
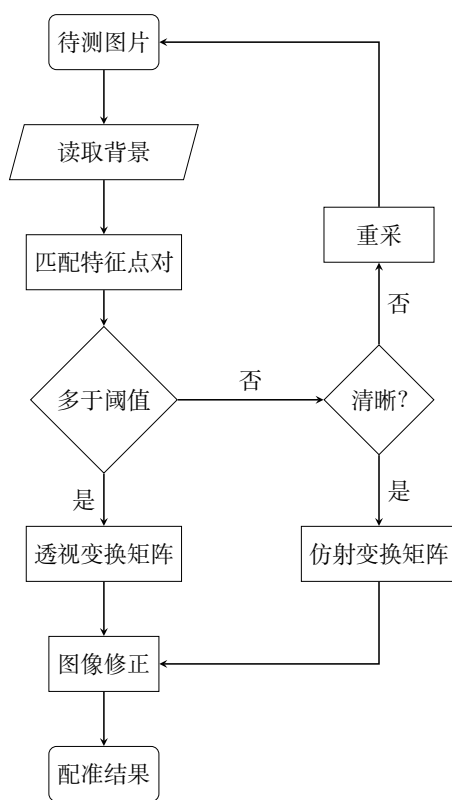
图 3–7 绘制流程图效果

Figure 3–7 Flow chart

3.4　表格

这一节给出的是一些表格的例子，如表3–1所示。

表 3–1 一个颇为标准的三线表格[1]

Table 3–1 A Table

Animal	Description	Price ($)
	Item	
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.50
Emu	stuffed	33.33
Armadillo	frozen	8.99

下面一个是一个更复杂的表格，用 threeparttable 实现带有脚注的表格，如表3–2。

表 3–2 一个带有脚注的表格的例子

Table 3–2 A Table with footnotes

total	20[1]		40		60	
	www	k	www	k	www	k
4.22 (2.12)	120.0140[2]	333.15	0.0411	444.99	0.1387
168.6123	10.86	255.37	0.0353	376.14	0.1058
6.761	0.007	235.37	0.0267	348.66	0.1010

[1]　the first note.

[2]　the second note.

3.5　参考文献管理

LATEX 具有将参考文献内容和表现形式分开管理的能力，涉及三个要素：参考文献数据库、参考文献引用格式、在正文中引用参考文献。这样的流程需要多次编译：

---

[1]这个例子来自《Publication quality tables in LATEX》[1](booktabs 宏包的文档)。这也是一个在表格中使用脚注的例子，请留意与 threeparttable 实现的效果有何不同。

1. 用户将论文中需要引用的参考文献条目，录入纯文本数据库文件 (bib 文件)。

2. 调用 xelatex 对论文模板做第一次编译，扫描文中引用的参考文献，生成参考文献入口文件 (aux) 文件。

3. 调用 bibtex，以参考文献格式和入口文件为输入，生成格式化以后的参考文献条目文件 (bib)。

4. 再次调用 xelatex 编译模板，将格式化以后的参考文献条目插入正文。

参考文献数据库 (thesis.bib) 的条目，可以从 Google Scholar 搜索引擎[1]、CiteSeerX 搜索引擎[2]中查找，文献管理软件 Papers[3]、Mendeley[4]、JabRef[5]也能够输出条目信息。

下面是在 Google Scholar 上搜索到的一条文献信息，格式是纯文本：

代码 3–1 从 Google Scholar 找到的参考文献条目

```
@phdthesis{白 2008 信用风险传染模型和信用衍生品的定价,
    title={信用风险传染模型和信用衍生品的定价},
    author={白云芬},
    year={2008},
    school={上海交通大学}
}
```

推荐修改后在 bib 文件中的内容为：

代码 3–2 修改后的参考文献条目

```
@phdthesis{bai2008,
    title={信用风险传染模型和信用衍生品的定价},
    author={白云芬},
    date={2008},
    address={上海},
    school={上海交通大学}
}
```

按照教务处的要求，参考文献外观应符合国标 GBT7714 的要求[6]。在模板中，表现形式的控制逻辑通过 biblatex-gb7714-2015 包实现[7]，基于 {BibLaTeX} 管理文献。在目前的多数 TeX 发行版中，可能都没有默认包含 biblatex-gb7714-2015，需要手动安装。

---

[1]https://scholar.google.com

[2]http://citeseerx.ist.psu.edu

[3]http://papersapp.com

[4]http://www.mendeley.com

[5]http://jabref.sourceforge.net

[6]http://www.cces.net.cn/guild/sites/tmxb/Files/19798_2.pdf

[7]https://www.ctan.org/pkg/biblatex-gb7714-2015

正文中引用参考文献时，用\cite{key1,key2,key3...} 可以产生 '' 上标引用的参考文献''，如[2–4]。使用\parencite{key1,key2,key3...} 则可以产生水平引用的参考文献，例如 [5–7]。请看下面的例子，将会穿插使用水平的和上标的参考文献：关于书的 [2, 5, 7]，关于期刊的[3, 8]，会议论文 [4, 9, 10]，硕士学位论文 [6, 11]，博士学位论文[12–14]，标准文件 [7]，技术报告[15]，电子文献 [16, 17]，用户手册 [18]。

总结一些注意事项：

- 参考文献只有在正文中被引用了，才会在最后的参考文献列表中出现；
- 参考文献 "数据库文件" bib 是纯文本文件，请使用 UTF-8 编码，不要使用 GBK 编码；
- 参考文献条目中默认通过 date 域输入时间。兼容使用 year 域时会产生编译 warning，可忽略。

3.6　用 listings 插入源代码

原先 ctexbook 文档类和 listings 宏包配合使用时，代码在换页时会出现莫名其妙的错误，后来经高人指点，顺利解决了。感兴趣的话，可以看看这里[1]。这里给使用 listings 宏包插入源代码的例子，这里是一段 C 代码。另外，listings 宏包真可谓博大精深，可以实现各种复杂、漂亮的效果，想要进一步学习的同学，可以参考 listings 宏包手册[2]。

代码 3–3 一段 C 源代码

```c
#include <stdio.h>
#include <unistd.h>
#include <sys/types.h>
#include <sys/wait.h>

int main() {
  pid_t pid;

  switch ((pid = fork())) {
  case -1:
    printf("fork failed\n");
    break;
  case 0:
    /* child calls exec */
    execl("/bin/ls", "ls", "-l", (char*)0);
    printf("execl failed\n");
```

---

[1]http://bbs.ctex.org/viewthread.php?tid=53451

[2]http://mirror.ctan.org/macros/latex/contrib/listings/listings.pdf

```
17      break;
18    default:
19      /* parent uses wait to suspend execution until child finishes */
20      wait((int*)0);
21      printf("is completed\n");
22      break;
23    }
24
25    return 0;
26  }
```

3.7　用 algorithm 和 algorithmicx 宏包插入算法描述

algorithmicx 比 algorithmic 增加了一些命令。示例如算法3–1和算法3–2，后者的代码来自 xhSong 的博客[1]。algorithmicx 的详细使用方法见官方 README[2]。使用算法宏包时，算法出现的位置很多时候不按照 tex 文件里的书写顺序，需要强制定位时可以使用\begin{algorithm}[H] [3]

这是写在算法3–1前面的一段话，在生成的文件里它会出现在算法3–1前面。

算法 3–1 求 100 以内的整数和

输出： 100 以内的整数和
  1: $sum \leftarrow 0$
  2: **for** $i = 0 \rightarrow 100$ **do**
  3:     $sum \leftarrow sum + i$
  4: **end for**

这是写在两个算法中间的一段话，当算法3–1不使用\begin{algorithm}[H] 时它也会出现在算法3–1前面。

对于很长的算法，单一的算法块\begin{algorithm}...\end{algorithm} 是不能自动跨页的[4]，会出现的情况有：

- 该页放不下当前的算法，留下大片空白，算法在下一页显示
- 单一页面放不下当前的算法，显示时超过页码的位置直到超出整个页面范围

---

[1]http://hustsxh.is-programmer.com/posts/38801.html

[2]http://mirror.hust.edu.cn/CTAN/macros/latex/contrib/algorithmicx/algorithmicx.pdf

[3]http://tex.stackexchange.com/questions/165021/fixing-the-location-of-the-appearance-in-algorithmicx-environment

[4]http://tex.stackexchange.com/questions/70733/latex-algorithm-not-display-under-correct-section

解决方法有：

- (推荐) 使用algstore{algname}和algrestore{algname}来讲算法分为两个部分[1]，如算法3–2。
- 人工拆分算法为多个小的部分。

算法 3–2 用归并排序求逆序数

输入: *Array* 数组，*n* 数组大小

输出: 逆序数

1: **function** MERGERSORT(*Array*, *left*, *right*)
2: 　　*result* ← 0
3: 　　**if** *left* < *right* **then**
4: 　　　　*middle* ← (*left* + *right*)/2
5: 　　　　*result* ← *result*+ MERGERSORT(*Array*, *left*, *middle*)
6: 　　　　*result* ← *result*+ MERGERSORT(*Array*, *middle*, *right*)
7: 　　　　*result* ← *result*+ MERGER(*Array*, *left*, *middle*, *right*)
8: 　　**end if**
9: 　　**return** *result*
10: **end function**
11:
12: **function** MERGER(*Array*, *left*, *middle*, *right*)
13: 　　*i* ← *left*
14: 　　*j* ← *middle*
15: 　　*k* ← 0
16: 　　*result* ← 0
17: 　　**while** *i* < *middle* **and** *j* < *right* **do**
18: 　　　　**if** *Array*[*i*] < *Array*[*j*] **then**
19: 　　　　　　*B*[*k* + +] ← *Array*[*i* + +]
20: 　　　　**else**
21: 　　　　　　*B*[*k* + +] ← *Array*[*j* + +]
22: 　　　　　　*result* ← *result* + (*middle* − *i*)
23: 　　　　**end if**
24: 　　**end while**

---

[1]http://tex.stackexchange.com/questions/29816/algorithm-over-2-pages

25:	**while** $i < middle$ **do**
26:	$\quad B[k++] \leftarrow Array[i++]$
27:	**end while**
28:	**while** $j < right$ **do**
29:	$\quad B[k++] \leftarrow Array[j++]$
30:	**end while**
31:	**for** $i = 0 \rightarrow k-1$ **do**
32:	$\quad Array[left + i] \leftarrow B[i]$
33:	**end for**
34:	**return** $result$
35:	**end function**

这是写在算法3–2后面的一段话，但是当算法3–2不使用\begin{algorithm}[H]时它会出现在算法3–2 甚至算法3–1前面。

对于算法的索引要注意\caption 和\label 的位置，必须是先\caption 再\label[1]，否则会出现\ref{algo:sum_100} 生成的编号跟对应算法上显示不一致的问题。

根据 Werner 的回答[2] 增加了Switch 和Case 的支持，见算法3–3。

算法 3–3 Switch 示例

1:	**switch** (s)
2:	$\quad$ **case** a:
3:	$\quad\quad$ assert(0)
4:	$\quad$ **case** b:
5:	$\quad\quad$ assert(1)
6:	$\quad$ **default** :
7:	$\quad\quad$ assert(2)
8:	**end switch**

---

[1]http://tex.stackexchange.com/questions/65993/algorithm-numbering

[2]http://tex.stackexchange.com/questions/53357/switch-cases-in-algorithmic

第四章 RMarkdown/Bookdown 排版示例

本文无意全文翻译 RMarkdown/Bookdown 的使用方法，只是简单的复制，详细内容请参考页面：

- `https://rmarkdown.rstudio.com/lesson-1.html`
- `https://bookdown.org/yihui/bookdown/`
- `https://bookdown.org/yihui/bookdown/components.html`
- `http://pandoc.org/`

以下为全文复制 `https://bookdown.org/yihui/bookdown/components.html` ，有改动。

This chapter demonstrates the syntax of common components of a book written in **bookdown**, including code chunks, figures, tables, citations, math theorems, and equations. The approach is based on Pandoc, so we start with the syntax of Pandoc's flavor of Markdown.

4.1 Markdown syntax

In this section, we give a very brief introduction to Pandoc's Markdown. Readers who are familiar with Markdown can skip this section. The comprehensive syntax of Pandoc's Markdown can be found on the Pandoc website `http://pandoc.org`.

4.1.1 Inline formatting

You can make text *italic* by surrounding it with underscores or asterisks, e.g., `_text_` or `*text*`. For **bold** text, use two underscores (`__text__`) or asterisks (`**text**`). Text surrounded by ~ will be converted to a subscript (e.g., `H~2~SO~4~` renders H_2SO_4), and similarly, two carets (^) produce a superscript (e.g., `Fe^2+^` renders Fe^{2+}). To mark text as `inline code`, use a pair of backticks, e.g., `` `code` ``.[1] Small caps can be produced by the HTML tag span, e.g., `<span style="font-variant:small-caps;">Small Caps</span>` renders SMALL CAPS. Links are created using `[text](link)`, e.g., `[RStudio](https://www.rstudio.com)`, and the syntax for images is similar: just add an exclamation mark, e.g., `![alt text or image title](path/to/image)`. Footnotes

---

[1] To include literal backticks, use more backticks outside, e.g., you can use two backticks to preserve one backtick inside: `` `` `code` `` ``.

are put inside the square brackets after a caret `^[]`, e.g., `^[This is a footnote.]`. We will talk about citations in Section 4.8.

4.1.2　Block-level elements

Section headers can be written after a number of pound signs, e.g.,

```
1  # First-level header
2
3  ## Second-level header
4
5  ### Third-level header
```

If you do not want a certain heading to be numbered, you can add `{-}` after the heading, e.g.,

```
1  # Preface {-}
```

Unordered list items start with `*`, `-`, or `+`, and you can nest one list within another list by indenting the sub-list by four spaces, e.g.,

```
1  - one item
2  - one item
3  - one item
4      - one item
5      - one item
```

The output is:

- one item
- one item
- one item
  - one item
  - one item

Ordered list items start with numbers (the rule for nested lists is the same as above), e.g.,

```
1  1. the first item
2  2. the second item
3  3. the third item
```

The output does not look too much different with the Markdown source:

1. the first item

2. the second item

3. the third item

Blockquotes are written after >, e.g.,

```
> "I thoroughly disapprove of duels. If a man should challenge me,
   I would take him kindly and forgivingly by the hand and lead him
   to a quiet place and kill him."
>
> --- Mark Twain
```

The actual output (we customized the style for blockquotes in this book):

> "I thoroughly disapprove of duels. If a man should challenge me, I would take him kindly and forgivingly by the hand and lead him to a quiet place and kill him."
>
> — Mark Twain

Plain code blocks can be written after three or more backticks, and you can also indent the blocks by four spaces, e.g.,

```
```
This text is displayed verbatim / preformatted
```

Or indent by four spaces:

    This text is displayed verbatim / preformatted
```

4.1.3 Math expressions

Inline LaTeX equations can be written in a pair of dollar signs using the LaTeX syntax, e.g., `$f(k) = {n \choose k} p^{k} (1-p)^{n-k}$` (actual output: $f(k) = \binom{n}{k}p^k(1-p)^{n-k}$); math expressions of the display style can be written in a pair of double dollar signs, e.g., `$$f(k) = {n \choose k} p^{k} (1-p)^{n-k}$$`, and the output looks like this:

$$f(k) = \binom{n}{k}p^k(1-p)^{n-k}$$

You can also use math environments inside `$ $` or `$$ $$`, e.g.,

```
1  \begin{array}{ccc}
2  x_{11} & x_{12} & x_{13}\\
3  x_{21} & x_{22} & x_{23}
4  \end{array}
```

$$
\begin{array}{ccc}
x_{11} & x_{12} & x_{13} \\
x_{21} & x_{22} & x_{23}
\end{array}
$$

```
1  X = \begin{bmatrix}1 & x_{1}\\
2  1 & x_{2}\\
3  1 & x_{3}
4  \end{bmatrix}
```

$$
X = \begin{bmatrix} 1 & x_1 \\ 1 & x_2 \\ 1 & x_3 \end{bmatrix}
$$

```
1  \Theta = \begin{pmatrix}\alpha & \beta\\
2  \gamma & \delta
3  \end{pmatrix}
```

$$
\Theta = \begin{pmatrix} \alpha & \beta \\ \gamma & \delta \end{pmatrix}
$$

```
1  \begin{vmatrix}a & b\\
2  c & d
3  \end{vmatrix}=ad-bc
```

$$
\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc
$$

4.2 Markdown extensions by bookdown

Although Pandoc's Markdown is much richer than the original Markdown syntax, it still lacks a number of things that we may need for academic writing. For example, it supports

math equations, but you cannot number and reference equations in multi-page HTML or EPUB output. We have provided a few Markdown extensions in **bookdown** to fill the gaps.

4.2.1 Number and reference equations

To number and refer to equations, put them in the equation environments and assign labels to them using the syntax (\##eq:label), e.g.,

```
1  \begin{equation}
2    f\left(k\right) = \binom{n}{k} p^k\left(1-p\right)^{n-k}
3    \label{eq:binom}
4  \end{equation}
```

It renders the equation below:

$$f(k) = \binom{n}{k} p^k (1-p)^{n-k} \tag{4-1}$$

You may refer to it using \eqref {eq:binom}, e.g., see Equation (4–1).

> Equation labels must start with the prefix eq: in **bookdown**. All labels in **bookdown** must only contain alphanumeric characters, :, -, and/or /. Equation references work best for LaTeX/PDF output, and they are not well supported in Word output or e-books. For HTML output, **bookdown** can only number the equations with labels. Please make sure equations without labels are not numbered by either using the equation* environment or adding \nonumber or \notag to your equations. The same rules apply to other math environments, such as eqnarray, gather, align, and so on (e.g., you can use the align* environment).

We demonstrate a few more math equation environments below. Here is an unnumbered equation using the equation* environment:

```
1  \begin{equation*}
2  \frac{d}{dx}\left( \int_{a}^{x} f(u)\,du\right)=f(x)
3  \end{equation*}
```

$$\frac{d}{dx} \left(\int_a^x f(u)\,du \right) = f(x)$$

Below is an `align` environment (4–2):

```
\begin{align}
g(X_{n}) &= g(\theta)+g'({\tilde{\theta}})(X_{n}-\theta) \notag \\
\sqrt{n}[g(X_{n})-g(\theta)] &= g'\left({\tilde{\theta}}\right)
  \sqrt{n}[X_{n}-\theta ] \label{eq:align}
\end{align}
```

$$g(X_n) = g(\theta) + g'(\tilde{\theta})(X_n - \theta)$$

$$\sqrt{n}[g(X_n) - g(\theta)] = g'\left(\tilde{\theta}\right)\sqrt{n}[X_n - \theta] \tag{4–2}$$

You can use the `split` environment inside `equation` so that all lines share the same number (4–3). By default, each line in the `align` environment will be assigned an equation number. We suppressed the number of the first line in the previous example using `\notag`. In this example, the whole `split` environment was assigned a single number.

```
\begin{equation}
\begin{split}
\mathrm{Var}(\hat{\beta}) & =\mathrm{Var}((X'X)^{-1}X'y)\\
 & =(X'X)^{-1}X'\mathrm{Var}(y)((X'X)^{-1}X')'\\
 & =(X'X)^{-1}X'\mathrm{Var}(y)X(X'X)^{-1}\\
 & =(X'X)^{-1}X'\sigma^{2}IX(X'X)^{-1}\\
 & =(X'X)^{-1}\sigma^{2}
\end{split}
\label{eq:var-beta}
\end{equation}
```

$$
\begin{aligned}
\mathrm{Var}(\hat{\beta}) &= \mathrm{Var}((X'X)^{-1}X'y)\\
&= (X'X)^{-1}X'\mathrm{Var}(y)((X'X)^{-1}X')'\\
&= (X'X)^{-1}X'\mathrm{Var}(y)X(X'X)^{-1}\\
&= (X'X)^{-1}X'\sigma^2 IX(X'X)^{-1}\\
&= (X'X)^{-1}\sigma^2
\end{aligned}
\tag{4–3}
$$

4.2.2　Theorems and proofs

Theorems and proofs are commonly used in articles and books in mathematics. However, please do not be misled by the names: a "theorem" is just a numbered/labeled environment,

表 4–1 Theorem environments in **bookdown**.

Environment	Printed Name	Label Prefix
theorem	Theorem	thm
lemma	Lemma	lem
corollary	Corollary	cor
proposition	Proposition	prp
conjecture	Conjecture	cnj
definition	Definition	def
example	Example	exm
exercise	Exercise	exr

and it does not have to be a mathematical theorem (e.g., it can be an example irrelevant to mathematics). Similarly, a "proof" is an unnumbered environment. In this section, we always use the *general* meanings of a "theorem" and "proof" unless explicitly stated.

In **bookdown**, the types of theorem environments supported are in Table 4–1. To write a theorem, you can use the syntax below:

```
```{theorem}
Here is my theorem.
```
```

To write other theorem environments, replace ```` ```{theorem} ```` with other environment names in Table 4–1, e.g., ```` ```{lemma} ````.

A theorem can have a `name` option so its name will be printed, e.g.,

```
```{theorem, name="Pythagorean theorem"}
For a right triangle, if c denotes the length of the hypotenuse
and a and b denote the lengths of the other two sides, we have
a^2 + b^2 = c^2
```
```

If you want to refer to a theorem, you should label it. The label can be written after ```` ```{theorem ````, e.g.,

```
```{theorem, label="foo"}
A labeled theorem here.
```

```
3  ```
```

The `label` option can be implicit, e.g., the following theorem has the label `bar`:

```
1  ```{theorem, bar}
2  A labeled theorem here.
3  ```
```

After you label a theorem, you can refer to it using the syntax `\ref {prefix:label}`. See the column `Label Prefix` in Table 4–1 for the value of `prefix` for each environment. For example, we have a labeled and named theorem below, and `\ref {thm:pyth}` gives us its theorem number 4.1:

```
1  ```{theorem, pyth, name="Pythagorean theorem"}
2  For a right triangle, if c denotes the length of the hypotenuse
3  and a and b denote the lengths of the other two sides, we have
4
5  a^2 + b^2 = c^2
6  ```
```

定理 4.1 (Pythagorean theorem)**.** *For a right triangle, if c denotes the length of the hypotenuse and a and b denote the lengths of the other two sides, we have*

$$a^2 + b^2 = c^2$$

The proof environments currently supported are `proof`, `remark`, and `solution`. The syntax is similar to theorem environments, and proof environments can also be named. The only difference is that since they are unnumbered, you cannot reference them.

We have tried to make all these theorem and proof environments work out of the box, no matter if your output is PDF, HTML, or EPUB. If you are a LaTeX or HTML expert, you may want to customize the style of these environments anyway (see Chapter **??**). Customization in HTML is easy with CSS, and each environment is enclosed in `<div></div>` with the CSS class being the environment name, e.g., `<div class="lemma"></div>`. For LaTeX output, we have predefined the style to be `definition` for environments `definition`, `example`, and `exercise`, and `remark` for environments `proof` and `remark`. All other environments use the `plain` style. The style definition is done through the `\theoremstyle{}` command of the **amsthm** package.

Theorems are numbered by chapters by default. If there are no chapters in your document, they are numbered by sections instead. If the whole document is unnumbered (the output format

option `number_sections = FALSE`), all theorems are numbered sequentially from 1, 2, ..., N. LaTeX supports numbering one theorem environment after another, e.g., let theorems and lemmas share the same counter. This is not supported for HTML/EPUB output in **bookdown**. You can change the numbering scheme in the LaTeX preamble by defining your own theorem environments, e.g.,

```
1  \newtheorem{theorem}{Theorem}
2  \newtheorem{lemma}[theorem]{Lemma}
```

When **bookdown** detects `\newtheorem{theorem}` in your LaTeX preamble, it will not write out its default theorem definitions, which means you have to define all theorem environments by yourself. For the sake of simplicity and consistency, we do not recommend that you do this. It can be confusing when your Theorem 18 in PDF becomes Theorem 2.4 in HTML.

Theorem and proof environments will be hidden if the chunk option `echo` is set to `FALSE`. To make sure they are always shown, you may add the chunk option `echo=TRUE`, e.g.,

```
1  ```{theorem, echo=TRUE}
2  Here is my theorem.
3  ```
```

Below we show more examples[1] of the theorem and proof environments, so you can see the default styles in **bookdown**.

定义 4.1. The characteristic function of a random variable X is defined by

$$\varphi_X(t) = \mathrm{E}\left[e^{itX}\right], \ t \in \mathcal{R}$$

例 4.1. We derive the characteristic function of $X \sim U(0, 1)$ with the probability density function $f(x) = \mathbf{1}_{x \in [0,1]}$.

---

[1]Some examples are adapted from the Wikipedia page `https://en.wikipedia.org/wiki/Characteristic_function_(probability_theory)`

$$
\begin{aligned}
\varphi_X(t) &= \mathrm{E}\left[e^{itX}\right] \\
&= \int e^{itx} f(x) dx \\
&= \int_0^1 e^{itx} dx \\
&= \int_0^1 \left(\cos(tx) + i\sin(tx)\right) dx \\
&= \left(\frac{\sin(tx)}{t} - i\frac{\cos(tx)}{t}\right)\Big|_0^1 \\
&= \frac{\sin(t)}{t} - i\left(\frac{\cos(t) - 1}{t}\right) \\
&= \frac{i\sin(t)}{it} + \frac{\cos(t) - 1}{it} \\
&= \frac{e^{it} - 1}{it}
\end{aligned}
$$

Note that we used the fact $e^{ix} = \cos(x) + i\sin(x)$ twice.

引理 4.2. *For any two random variables X_1, X_2, they both have the same probability distribution if and only if*

$$
\varphi_{X_1}(t) = \varphi_{X_2}(t)
$$

定理 4.3. *If $X_1, \ldots, X_n$ are independent random variables, and $a_1, \ldots, a_n$ are some constants, then the characteristic function of the linear combination $S_n = \sum_{i=1}^n a_i X_i$ is*

$$
\varphi_{S_n}(t) = \prod_{i=1}^n \varphi_{X_i}(a_i t) = \varphi_{X_1}(a_1 t) \cdots \varphi_{X_n}(a_n t)
$$

命题 4.4. *The distribution of the sum of independent Poisson random variables $X_i \sim \mathrm{Pois}(\lambda_i)$, $i = 1, 2, \cdots, n$ is $\mathrm{Pois}(\sum_{i=1}^n \lambda_i)$.*

证明. The characteristic function of $X \sim \mathrm{Pois}(\lambda)$ is $\varphi_X(t) = e^{\lambda(e^{it} - 1)}$. Let $P_n = \sum_{i=1}^n X_i$. We know from Theorem 4.3 that

$$\varphi_{P_n}(t) = \prod_{i=1}^{n} \varphi_{X_i}(t)$$
$$= \prod_{i=1}^{n} e^{\lambda_i(e^{it}-1)}$$
$$= e^{\sum_{i=1}^{n} \lambda_i(e^{it}-1)}$$

This is the characteristic function of a Poisson random variable with the parameter $\lambda = \sum_{i=1}^{n} \lambda_i$. From Lemma 4.2, we know the distribution of P_n is $\mathrm{Pois}(\sum_{i=1}^{n} \lambda_i)$. $\qquad\square$

注 1. In some cases, it is very convenient and easy to figure out the distribution of the sum of independent random variables using characteristic functions.

推论 **4.5.** *The characteristic function of the sum of two independent random variables X_1 and X_2 is the product of characteristic functions of X_1 and X_2, i.e.,*

$$\varphi_{X_1+X_2}(t) = \varphi_{X_1}(t)\varphi_{X_2}(t)$$

练习 **4.1** (Characteristic Function of the Sample Mean)**.** Let $\bar{X} = \sum_{i=1}^{n} \frac{1}{n} X_i$ be the sample mean of n independent and identically distributed random variables, each with characteristic function φ_X. Compute the characteristic function of $\bar{X}$.

解答**.** Applying Theorem 4.3, we have

$$\varphi_{\bar{X}}(t) = \prod_{i=1}^{n} \varphi_{X_i}\left(\frac{t}{n}\right) = \left[\varphi_X\left(\frac{t}{n}\right)\right]^n .$$

4.2.3 Special headers

There are a few special types of first-level headers that will be processed differently in **bookdown**. The first type is an unnumbered header that starts with the token (PART). This kind of headers are translated to part titles. If you are familiar with LaTeX, this basically means \part{}. When your book has a large number of chapters, you may want to organize them into parts, e.g.,

```
# (PART) Part I {-}

# Chapter One
```

```
4
5   # Chapter Two
6
7   # (PART) Part II {-}
8
9   # Chapter Three
```

A part title should be written right before the first chapter title in this part. You can use `(PART\*)` (the backslash before `*` is required) instead of `(PART)` if a part title should not be numbered.

The second type is an unnumbered header that starts with `(APPENDIX)`, indicating that all chapters after this header are appendices, e.g.,

```
1   # Chapter One
2
3   # Chapter Two
4
5   # (APPENDIX) Appendix {-}
6
7   # Appendix A
8
9   # Appendix B
```

The numbering style of appendices will be automatically changed in LaTeX/PDF and HTML output (usually in the form A, A.1, A.2, B, B.1, . . .). This feature is not available to e-books or Word output.

4.2.4　Text references

You can assign some text to a label and reference the text using the label elsewhere in your document. This can be particularly useful for long figure/table captions (Section 4.4 and 4.5), in which case you normally will have to write the whole character string in the chunk header (e.g., `fig.cap = "A long long figure caption."`) or your R code (e.g., `kable(caption = "A long long table caption.")`). It is also useful when these captions contain special HTML or LaTeX characters, e.g., if the figure caption contains an underscore, it works in the HTML output but may not work in LaTeX output because the underscore must be escaped in LaTeX.

The syntax for a text reference is `(ref:label) text`, where `label` is a unique label[1] through-

---

[1] You may consider using the code chunk labels.

out the document for `text`. It must be in a separate paragraph with empty lines above and below it. The paragraph must not be wrapped into multiple lines, and should not end with a white space. For example,

```
1  (ref:foo) Define a text reference **here**.
```

Then you can use `(ref:foo)` in your figure/table captions. The text can contain anything that Markdown supports, as long as it is one single paragraph. Here is a complete example:

```
1  A normal paragraph.
2
3  (ref:foo) A scatterplot of the data `cars` using **base** R graphics.
4
5  ```{r foo, fig.cap='(ref:foo)'}
6  plot(cars)  # a scatterplot
7  ```
```

Text references can be used anywhere in the document (not limited to figure captions). It can also be useful if you want to reuse a fragment of text in multiple places.

4.3 R code

There are two types of R code in R Markdown/**knitr** documents: R code chunks, and inline R code. The syntax for the latter is `` `r R_CODE` ``, and it can be embedded inline with other document elements. R code chunks look like plain code blocks, but have `{r}` after the three backticks and (optionally) chunk options inside `{}`, e.g.,

```
1  ```{r chunk-label, echo = FALSE, fig.cap = 'A figure caption.'}
2  1 + 1
3  rnorm(10)  # 10 random numbers
4  plot(dist ~ speed, cars)  # a scatterplot
5  ```
```

To learn more about **knitr** chunk options, see Xie [1] or the web page `http://yihui.name/knitr/options`. For books, additional R code can be executed before/after each chapter; see `before_chapter_script` and `after_chapter_script` in Section **??**.

4.4　Figures

By default, figures have no captions in the output generated by **knitr**, which means they will be placed wherever they were generated in the R code. Below is such an example.

```r
par(mar = c(4, 4, .1, .1))
plot(pressure, pch = 19, type = 'b')
```
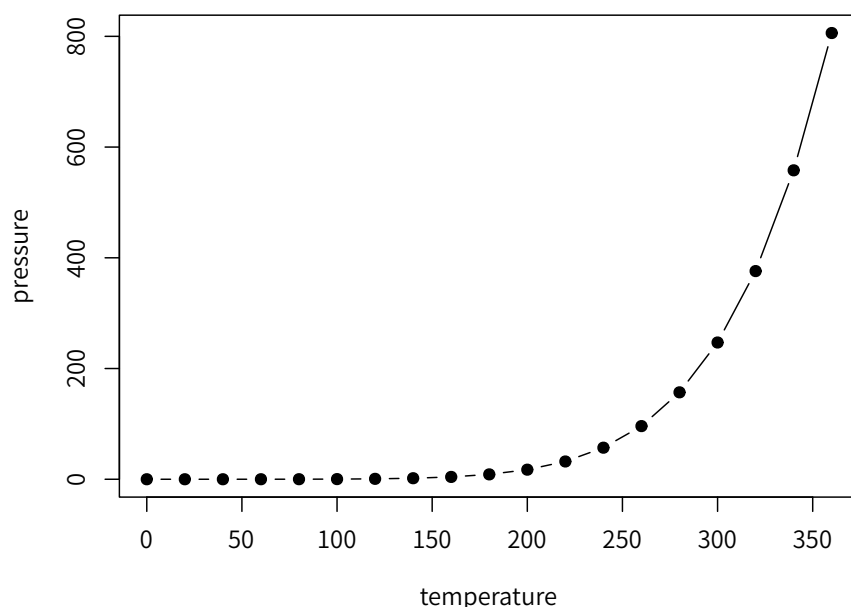

The disadvantage of typesetting figures in this way is that when there is not enough space on the current page to place a figure, it may either reach the bottom of the page (hence exceeds the page margin), or be pushed to the next page, leaving a large white margin at the bottom of the current page. That is basically why there are "floating environments" in LaTeX: elements that cannot be split over multiple pages (like figures) are put in floating environments, so they can float to a page that has enough space to hold them. There is also a disadvantage of floating things forward or backward, though. That is, readers may have to jump to a different page to find the figure mentioned on the current page. This is simply a natural consequence of having to typeset things on multiple pages of fixed sizes. This issue does not exist in HTML, however, since everything can be placed continuously on one single page (presumably with infinite height), and there is no need to split anything across multiple pages of the same page size.

If we assign a figure caption to a code chunk via the chunk option `fig.cap`, R plots will be put into figure environments, which will be automatically labeled and numbered, and can also be cross-referenced. The label of a figure environment is generated from the label of the code chunk, e.g., if the chunk label is `foo`, the figure label will be `fig:foo` (the prefix `fig:` is added

before `foo`). To reference a figure, use the syntax `\ref {label}`,[1] where `label` is the figure label, e.g., `fig:foo`.

To take advantage of Markdown formatting *within* the figure caption, you will need to use text references (see Section 4.2.4). For example, a figure caption that contains `_italic text_` will not work when the output format is LaTeX/PDF, since the underscore is a special character in LaTeX, but if you use text references, `_italic text_` will be translated to LaTeX code when the output is LaTeX.

> If you want to cross-reference figures or tables generated from a code chunk, please make sure the chunk label only contains *alphanumeric* characters (a-z, A-Z, 0-9), slashes (/), or dashes (-).

The chunk option `fig.asp` can be used to set the aspect ratio of plots, i.e., the ratio of figure height/width. If the figure width is 6 inches (`fig.width = 6`) and `fig.asp = 0.7`, the figure height will be automatically calculated from `fig.width * fig.asp = 6 * 0.7 = 4.2`. Figure 4–1 is an example using the chunk options `fig.asp = 0.7`, `fig.width = 6`, and `fig.align = 'center'`, generated from the code below:

```
par(mar = c(4, 4, .1, .1))
plot(pressure, pch = 19, type = 'b')
```

The actual size of a plot is determined by the chunk options `fig.width` and `fig.height` (the size of the plot generated from a graphical device), and we can specify the output size of plots via the chunk options `out.width` and `out.height`. The possible value of these two options depends on the output format of the document. For example, `out.width = '30%'` is a valid value for HTML output, but not for LaTeX/PDF output. However, **knitr** will automatically convert a percentage value for `out.width` of the form `x%` to `(x / 100) \linewidth`, e.g., `out.width = '70%'` will be treated as `.7\linewidth` when the output format is LaTeX. This makes it possible to specify a relative width of a plot in a consistent manner. Figure 4–2 is an example of `out.width = 70%`.

```
par(mar = c(4, 4, .1, .1))
plot(cars, pch = 19)
```

---

[1] Do not forget the leading backslash! And also note the parentheses `()` after `ref`; they are not curly braces `{}`.
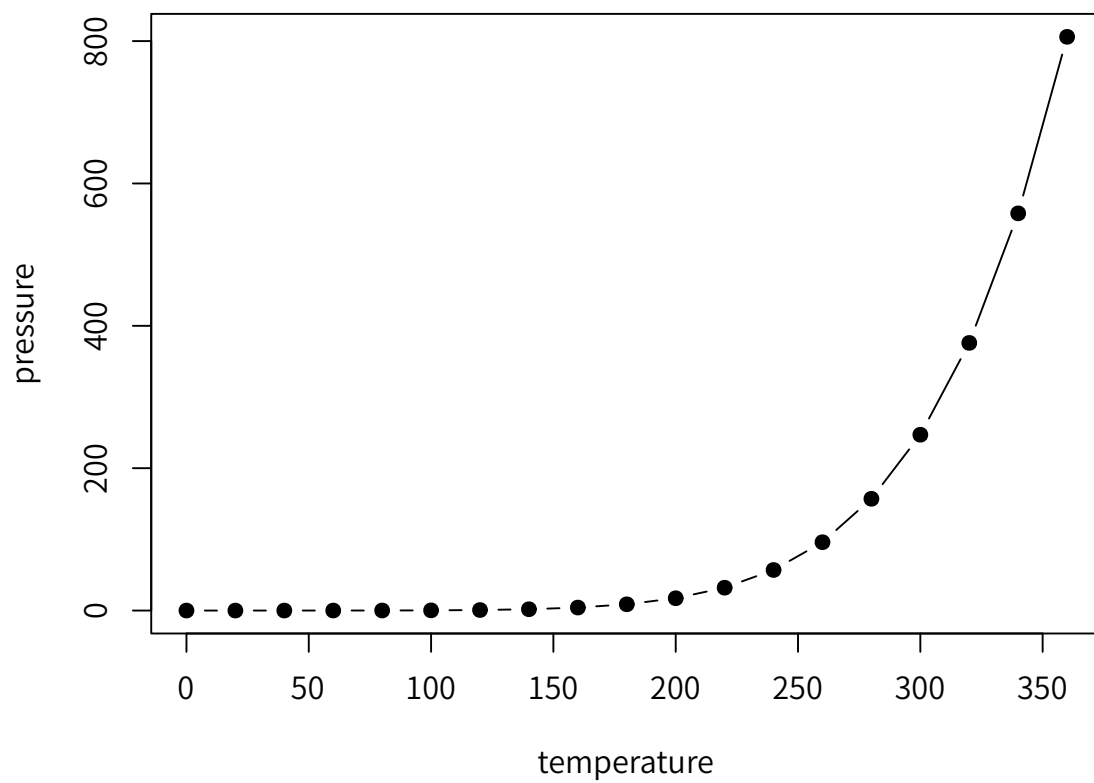
图 4–1 A figure example with the specified aspect ratio, width, and alignment.
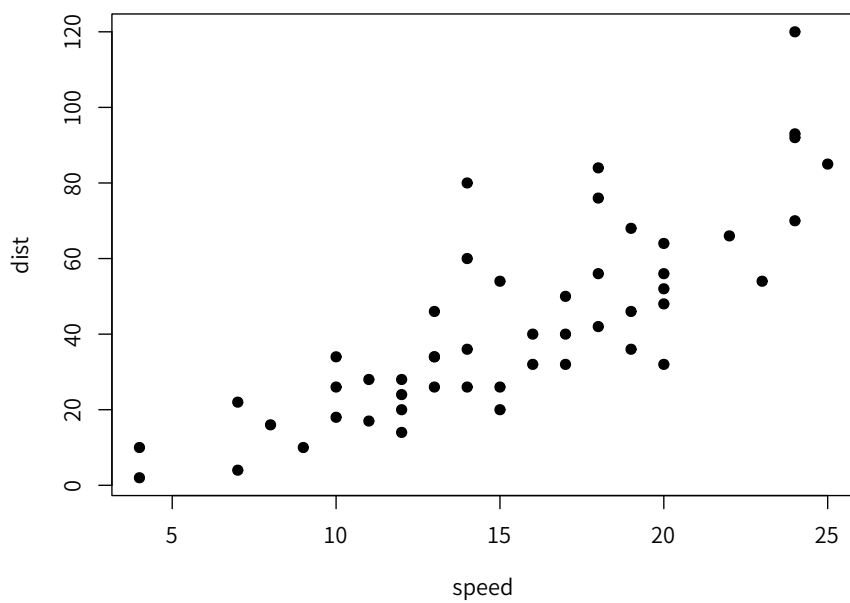
图 4–2 A figure example with a relative width 70%.
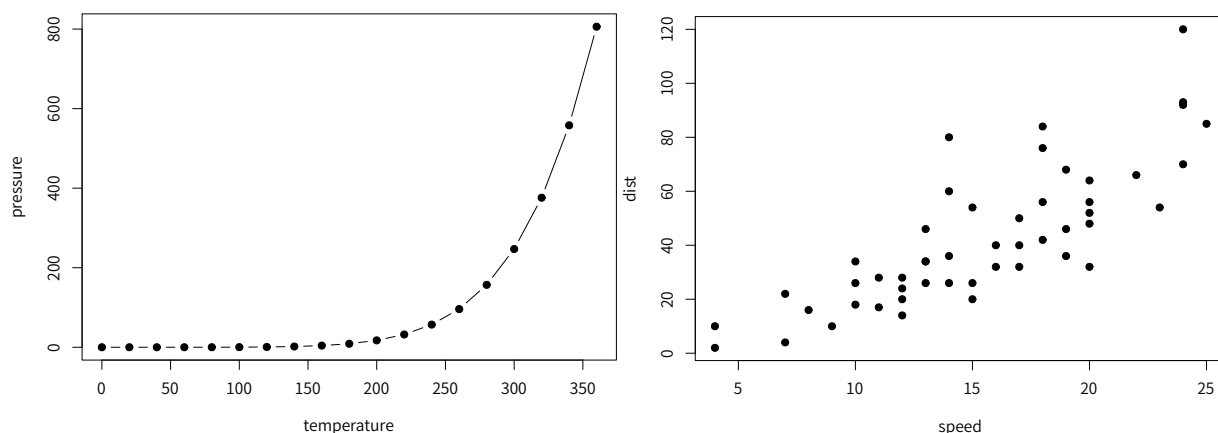
图 4–3 Two plots placed side by side.

If you want to put multiple plots in one figure environment, you must use the chunk option `fig.show = 'hold'` to hold multiple plots from a code chunk and include them in one environment. You can also place plots side by side if the sum of the width of all plots is smaller than or equal to the current line width. For example, if two plots have the same width `50%`, they will be placed side by side. Similarly, you can specify `out.width = '33%'` to arrange three plots on one line. Figure 4–3 is an example of two plots, each with a width of `50%`.

```
1  par(mar = c(4, 4, .1, .1))
2  plot(pressure, pch = 19, type = 'b')
3  plot(cars, pch = 19)
```

Sometimes you may have certain images that are not generated from R code, and you can include them in R Markdown via the function `knitr::include_graphics()`. Figure 4–4 is an example of three **knitr** logos included in a figure environment. You may pass one or multiple image paths to the `include_graphics()` function, and all chunk options that apply to normal R plots also apply to these images, e.g., you can use `out.width = '33%'` to set the widths of these images in the output document.

```
1  knitr::include_graphics(rep('figure/bookdown/knit-logo.png', 3))
```

There are a few advantages of using `include_graphics()`:

1. You do not need to worry about the document output format, e.g., when the output format is LaTeX, you may have to use the LaTeX command `\includegraphics{}` to include an image, and when the output format is Markdown, you have to use `![]()`. The function `include_graphics()` in **knitr** takes care of these details automatically.

图 4–4 Three knitr logos included in the document from an external PNG image file.

2. The syntax for controlling the image attributes is the same as when images are generated from R code, e.g., chunk options `fig.cap`, `out.width`, and `fig.show` still have the same meanings.

3. `include_graphics()` can be smart enough to use PDF graphics automatically when the output format is LaTeX and the PDF graphics files exist, e.g., an image path `foo/bar.png` can be automatically replaced with `foo/bar.pdf` if the latter exists. PDF images often have better qualities than raster images in LaTeX/PDF output. To make use of this feature, set the argument `auto_pdf = TRUE`, or set the global option `options(knitr.graphics.auto_pdf = TRUE)` to enable this feature globally in an R session.

4. You can easily scale these images proportionally using the same ratio. This can be done via the `dpi` argument (dots per inch), which takes the value from the chunk option `dpi` by default. If it is a numeric value and the chunk option `out.width` is not set, the output width of an image will be its actual width (in pixels) divided by `dpi`, and the unit will be inches. For example, for an image with the size 672 x 480, its output width will be 7 inches (`7in`) when `dpi = 96`. This feature requires the package **png** and/or **jpeg** to be installed. You can always override the automatic calculation of width in inches by providing a non-NULL value to the chunk option `out.width`, or use `include_graphics(dpi = NA)`.

4.5　Tables

For now, the most convenient way to generate a table is the function `knitr::kable()`, because there are some internal tricks in **knitr** to make it work with **bookdown** and users do not have to know anything about these implementation details. We will explain how to use other packages and functions later in this section.

Like figures, tables with captions will also be numbered and can be referenced. The `kable`

表 4–2 A table of the first 10 rows of the mtcars data.

	mpg	cyl	disp	hp	drat	wt	qsec	vs
Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0
Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0
Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1
Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0
Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1
Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1

() function will automatically generate a label for a table environment, which is the prefix `tab:` plus the chunk label. For example, the table label for a code chunk with the label `foo` will be `tab:foo`, and we can still use the syntax `\ref {label}` to reference the table. Table 4–2 is a simple example.

```
knitr::kable(
  head(mtcars[, 1:8], 10), booktabs = TRUE,
  caption = 'A table of the first 10 rows of the mtcars data.'
)
```

If you want to put multiple tables in a single table environment, wrap the data objects (usually data frames in R) into a list. See Table 4–3 for an example. Please note that this feature is only available in HTML and PDF output.

```
knitr::kable(
  list(
    head(iris[, 1:2], 3),
    head(mtcars[, 1:3], 5)
  ),
  caption = 'A Tale of Two Tables.', booktabs = TRUE
)
```

表 4–3 A Tale of Two Tables.

Sepal.Length	Sepal.Width		mpg	cyl	disp
5.1	3.5	Mazda RX4	21.0	6	160
4.9	3.0	Mazda RX4 Wag	21.0	6	160
4.7	3.2	Datsun 710	22.8	4	108
		Hornet 4 Drive	21.4	6	258
		Hornet Sportabout	18.7	8	360

When you do not want a table to float in PDF, you may use the LaTeX package **longtable**,[1] which can break a table across multiple pages. To use **longtable**, pass longtable = TRUE to kable(), and make sure to include \usepackage{longtable} in the LaTeX preamble (see Section **??** for how to customize the LaTeX preamble). Of course, this is irrelevant to HTML output, since tables in HTML do not need to float.

```
knitr::kable(
  iris[1:55, ], longtable = TRUE, booktabs = TRUE,
  caption = 'A table generated by the longtable package.'
)
```

表 4–4 A table generated by the longtable package.

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5.0	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa

---

[1]https://www.ctan.org/pkg/longtable

5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3.0	1.4	0.1	setosa
4.3	3.0	1.1	0.1	setosa
5.8	4.0	1.2	0.2	setosa
5.7	4.4	1.5	0.4	setosa
5.4	3.9	1.3	0.4	setosa
5.1	3.5	1.4	0.3	setosa
5.7	3.8	1.7	0.3	setosa
5.1	3.8	1.5	0.3	setosa
5.4	3.4	1.7	0.2	setosa
5.1	3.7	1.5	0.4	setosa
4.6	3.6	1.0	0.2	setosa
5.1	3.3	1.7	0.5	setosa
4.8	3.4	1.9	0.2	setosa
5.0	3.0	1.6	0.2	setosa
5.0	3.4	1.6	0.4	setosa
5.2	3.5	1.5	0.2	setosa
5.2	3.4	1.4	0.2	setosa
4.7	3.2	1.6	0.2	setosa
4.8	3.1	1.6	0.2	setosa
5.4	3.4	1.5	0.4	setosa
5.2	4.1	1.5	0.1	setosa
5.5	4.2	1.4	0.2	setosa
4.9	3.1	1.5	0.2	setosa
5.0	3.2	1.2	0.2	setosa
5.5	3.5	1.3	0.2	setosa
4.9	3.6	1.4	0.1	setosa
4.4	3.0	1.3	0.2	setosa
5.1	3.4	1.5	0.2	setosa
5.0	3.5	1.3	0.3	setosa

4.5	2.3	1.3	0.3	setosa
4.4	3.2	1.3	0.2	setosa
5.0	3.5	1.6	0.6	setosa
5.1	3.8	1.9	0.4	setosa
4.8	3.0	1.4	0.3	setosa
5.1	3.8	1.6	0.2	setosa
4.6	3.2	1.4	0.2	setosa
5.3	3.7	1.5	0.2	setosa
5.0	3.3	1.4	0.2	setosa
7.0	3.2	4.7	1.4	versicolor
6.4	3.2	4.5	1.5	versicolor
6.9	3.1	4.9	1.5	versicolor
5.5	2.3	4.0	1.3	versicolor
6.5	2.8	4.6	1.5	versicolor

Pandoc supports several types of Markdown tables,[1] such as simple tables, multiline tables, grid tables, and pipe tables. What `knitr::kable()` generates is a simple table like this:

```
Table: A simple table in Markdown.

 Sepal.Length   Sepal.Width   Petal.Length   Petal.Width
-------------   -----------   ------------   ------------
         5.1           3.5            1.4            0.2
         4.9           3.0            1.4            0.2
         4.7           3.2            1.3            0.2
         4.6           3.1            1.5            0.2
         5.0           3.6            1.4            0.2
         5.4           3.9            1.7            0.4
```

You can use any types of Markdown tables in your document. To be able to cross-reference a Markdown table, it must have a labeled caption of the form `Table: (\##label) Caption here`, where `label` must have the prefix `tab:`, e.g., `tab:simple-table`.

If you decide to use other R packages to generate tables, you have to make sure the label for the table environment appears in the beginning of the table caption in the form `(\##label)` (again, `label` must have the prefix `tab:`). You have to be very careful about the *portability* of the table

---

[1] `http://pandoc.org/MANUAL.html#tables`

generating function: it should work for both HTML and LaTeX output automatically, so it must consider the output format internally (check `knitr::opts_knit$get('rmarkdown.pandoc.to')`). When writing out an HTML table, the caption must be written in the `<caption></caption>` tag. For simple tables, `kable()` should suffice. If you have to create complicated tables (e.g., with certain cells spanning across multiple columns/rows), you will have to take the aforementioned issues into consideration.

4.6　Cross-references

We have explained how cross-references work for equations (Section 4.2.1), theorems (Section 4.2.2), figures (Section 4.4), and tables (Section 4.5). In fact, you can also reference sections using the same syntax `\ref {label}`, where `label` is the section ID. By default, Pandoc will generate an ID for all section headers, e.g., a section `## Hello World` will have an ID `hello-world`. We recommend you to manually assign an ID to a section header to make sure you do not forget to update the reference label after you change the section header. To assign an ID to a section header, simply add `{##id}` to the end of the section header. Further attributes of section headers can be set using standard Pandoc syntax[1].

When a referenced label cannot be found, you will see two question marks like **??**, as well as a warning message in the R console when rendering the book.

You can also create text-based links using explicit or automatic section IDs or even the actual section header text.

- If you are happy with the section header as the link text, use it inside a single set of square brackets:
  - `[Section header text]`: example "[A single document]" via `[A single document]`
- There are two ways to specify custom link text:
  - `[link text][Section header text]`, e.g., "[non-English books][Internationalization]" via `[non-English books][Internationalization]`
  - `[link text](##ID)`, e.g., "Table stuff" via `[Table stuff](##tables)`

The Pandoc documentation provides more details on automatic section IDs[2] and implicit header references.[3]

Cross-references still work even when we refer to an item that is not on the current page of

---

[1] `http://pandoc.org/MANUAL.html#header-identifiers`

[2] `http://pandoc.org/MANUAL.html#extension-auto_identifiers`

[3] `http://pandoc.org/MANUAL.html#extension-implicit_header_references`

the PDF or HTML output. For example, see Equation (4–1) and Figure 4–4.

4.7 Custom blocks

You can generate custom blocks using the `block` engine in **knitr**, i.e., the chunk option `engine = 'block'`, or the more compact syntax ```` ```{block}````. This engine should be used in conjunction with the chunk option `type`, which takes a character string. When the `block` engine is used, it generates a `<div>` to wrap the chunk content if the output format is HTML, and a LaTeX environment if the output is LaTeX. The `type` option specifies the class of the `<div>` and the name of the LaTeX environment. For example, the HTML output of this chunk

```
```{block, type='FOO'}
Some text for this block.
```
```

will be this:

```
<div class="FOO">
Some text for this block.
</div>
```

and the LaTeX output will be this:

```
\begin{FOO}
Some text for this block.
\end{FOO}
```

It is up to the book author how to define the style of the block. You can define the style of the `<div>` in CSS and include it in the output via the `includes` option in the YAML metadata. Similarly, you may define the LaTeX environment via `\newenvironment` and include the definition in the LaTeX output via the `includes` option. For example, we may save the following style in a CSS file, say, `style.css`:

```
div.FOO {
  font-weight: bold;
  color: red;
}
```

And the YAML metadata of the R Markdown document can be:

```
1  ---
2  output:
3    bookdown::html_book:
4      includes:
5        in_header: style.css
6  ---
```

We have defined a few types of blocks for this book to show notes, tips, and warnings, etc. Below are some examples:

 R is free software and comes with ABSOLUTELY NO WARRANTY. You are welcome to redistribute it under the terms of the GNU General Public License versions 2 or 3. For more information about these matters see `http://www.gnu.org/licenses/`.

 R is free software and comes with ABSOLUTELY NO WARRANTY. You are welcome to redistribute it under the terms of the GNU General Public License versions 2 or 3. For more information about these matters see `http://www.gnu.org/licenses/`.

 R is free software and comes with ABSOLUTELY NO WARRANTY. You are welcome to redistribute it under the terms of the GNU General Public License versions 2 or 3. For more information about these matters see `http://www.gnu.org/licenses/`.

 R is free software and comes with ABSOLUTELY NO WARRANTY. You are welcome to redistribute it under the terms of the GNU General Public License versions 2 or 3. For more information about these matters see `http://www.gnu.org/licenses/`.

R is free software and comes with ABSOLUTELY NO WARRANTY. You are welcome to redistribute it under the terms of the GNU General Public License versions 2 or 3. For more information about these matters see `http://www.gnu.org/licenses/`.

The **knitr** `block` engine was designed to display simple content (typically a paragraph of plain text). You can use simple formatting syntax such as making certain words bold or italic, but more advanced syntax such as citations and cross-references will not work. However, there is an alternative engine named `block2` that supports arbitrary Markdown syntax, e.g.,

```
```{block2, type='FOO'}
Some text for this block [@citation-key].

- a list item
- another item

More text.
```
```

The `block2` engine should also be faster than the `block` engine if you have a lot of custom blocks in the document, but its implementation was based on a hack,[1] so we are not 100% sure if it is always going to work in the future. We have not seen problems with Pandoc v1.17.2 yet.

One more caveat for the `block2` engine: if the last element in the block is not an ordinary paragraph, you must leave a blank line at the end, e.g.,

```
```{block2, type='FOO'}
Some text for this block [@citation-key].

- a list item
- another item
- end the list with a blank line

```
```

The theorem and proof environments in Section 4.2.2 are actually implemented through the `block2` engine.

---

[1] `https://github.com/jgm/pandoc/issues/2453`

For all custom blocks based on the `block` or `block2` engine, there is one chunk option `echo` that you can use to show (`echo = TRUE`) or hide (`echo = FALSE`) the blocks.

4.8　Citations

Although Pandoc supports multiple ways of writing citations, we recommend you to use BibTeX databases because they work best with LaTeX/PDF output. Pandoc can process other types of bibliography databases with the utility `pandoc-citeproc` (`https://github.com/jgm/pandoc-citeproc`), but it may not render certain bibliography items correctly (especially in case of multiple authors per item), and BibTeX can do a better job when the output format is LaTeX. With BibTeX databases, you will be able to define the bibliography style if it is required by a certain publisher or journal.

A BibTeX database is a plain-text file (with the conventional filename extension `.bib`) that consists of bibliography entries like this:

```
@Manual{R-base,
  title = {R: A Language and Environment for Statistical
    Computing},
  author = {{R Core Team}},
  organization = {R Foundation for Statistical Computing},
  address = {Vienna, Austria},
  year = {2016},
  url = {https://www.R-project.org/},
}
```

A bibliography entry starts with `@type{`, where `type` may be `article`, `book`, `manual`, and so on.[1] Then there is a citation key, like `R-base` in the above example. To cite an entry, use `@key` or `[@key]` (the latter puts the citation in braces), e.g., `@R-base` is rendered as **R-base**, and `[@R-base]` generates "**R-base**". If you are familiar with the **natbib** package in LaTeX, `@key` is basically `\citet{key}`, and `[@key]` is equivalent to `\citep{key}`.

There are a number of fields in a bibliography entry, such as `title`, `author`, and `year`, etc. You may see `https://en.wikipedia.org/wiki/BibTeX` for possible types of entries and fields in BibTeX.

There is a helper function `write_bib()` in **knitr** to generate BibTeX entries automatically for R packages. Note that it only generates one BibTeX entry for the package itself at the

---

[1]The type name is case-insensitive, so it does not matter if it is `manual`, `Manual`, or `MANUAL`.

moment, whereas a package may contain multiple entries in the CITATION file, and some entries are about the publications related to the package. These entries are ignored by write_bib().

```
# the second argument can be a .bib file
knitr::write_bib(c('knitr', 'stringr'), '', width = 60)
```

```
@Manual{R-knitr,
  title = {knitr: A General-Purpose Package for Dynamic Report
    Generation in R},
  author = {Yihui Xie},
  year = {2018},
  note = {R package version 1.20},
  url = {https://CRAN.R-project.org/package=knitr},
}
@Manual{R-stringr,
  title = {stringr: Simple, Consistent Wrappers for Common
    String Operations},
  author = {Hadley Wickham},
  year = {2018},
  note = {R package version 1.3.1},
  url = {https://CRAN.R-project.org/package=stringr},
}
```

Once you have one or multiple .bib files, you may use the field bibliography in the YAML metadata of your first R Markdown document (which is typically index.Rmd), and you can also specify the bibliography style via biblio-style (this only applies to PDF output), e.g.,

```
---
bibliography: ["one.bib", "another.bib", "yet-another.bib"]
biblio-style: "apalike"
link-citations: true
---
```

The field link-citations can be used to add internal links from the citation text of the author-year style to the bibliography entry in the HTML output.

When the output format is LaTeX, citations will be automatically put in a chapter or section. For non-LaTeX output, you can add an empty chapter as the last chapter of your book. For example, if your last chapter is the Rmd file 06-references.Rmd, its content can be an inline R expression:

```
1 `r if (knitr::is_html_output()) '# References {-}'`
```

4.9 Index

Currently the index is only supported for LaTeX/PDF output. To print an index after the book, you can use the LaTeX package **makeidx** in the preamble (see Section **??**):

```
1 \usepackage{makeidx}
2 \makeindex
```

Then insert `\printindex` at the end of your book through the YAML option `includes -> after_body`. An index entry can be created via the `\index{}` command in the book body, e.g., `\index{GIT}`.

4.10 HTML widgets

Although one of R's greatest strengths is data visualization, there are a large number of JavaScript libraries for much richer data visualization. These libraries can be used to build interactive applications that can easily render in web browsers, so users do not need to install any additional software packages to view the visualizations. One way to bring these JavaScript libraries into R is through the **htmlwidgets**[1] package**[R-htmlwidgets]**.

HTML widgets can be rendered as a standalone web page (like an R plot), or embedded in R Markdown documents and Shiny applications. They were originally designed for HTML output only, and they require the availability of JavaScript, so they will not work in non-HTML output formats, such as LaTeX/PDF. Before **knitr** v1.13, you will get an error when you render HTML widgets to an output format that is not HTML. Since **knitr** v1.13, HTML widgets will be rendered automatically as screenshots taken via the **webshot** package.**[R-webshot]** Of course, you need to install the **webshot** package. Additionally, you have to install PhantomJS (`http://phantomjs.org`), since it is what **webshot** uses to capture screenshots. Both **webshot** and PhantomJS can be installed automatically from R:

```
1 install.packages('webshot')
2 webshot::install_phantomjs()
```

---

[1] `http://htmlwidgets.org`

The function `install_phantomjs()` works for Windows, OS X, and Linux. You may also choose to download and install PhantomJS by yourself, if you are familiar with modifying the system environment variable `PATH`.

When **knitr** detects an HTML widget object in a code chunk, it either renders the widget normally when the current output format is HTML, or saves the widget as an HTML page and calls **webshot** to capture the screen of the HTML page when the output format is not HTML. Here is an example of a table created from the **DT** package:[R-DT]

```
1  DT::datatable(iris)
```

If you are reading this book as web pages now, you should see an interactive table generated from the above code chunk, e.g., you may sort the columns and search in the table. If you are reading a non-HTML version of this book, you should see a screenshot of the table. The screenshot may look a little different with the actual widget rendered in the web browser, due to the difference between a real web browser and PhantomJS's virtual browser.

There are a number of **knitr** chunk options related to screen-capturing. First, if you are not satisfied with the quality of the automatic screenshots, or want a screenshot of the widget of a particular state (e.g., after you click and sort a certain column of a table), you may capture the screen manually, and provide your own screenshot via the chunk option `screenshot.alt` (alternative screenshots). This option takes the paths of images. If you have multiple widgets in a chunk, you can provide a vector of image paths. When this option is present, **knitr** will no longer call **webshot** to take automatic screenshots.

Second, sometimes you may want to force **knitr** to use static screenshots instead of rendering the actual widgets even on HTML pages. In this case, you can set the chunk option `screenshot.force = TRUE`, and widgets will always be rendered as static images. Note that you can still choose to use automatic or custom screenshots.

Third, **webshot** has some options to control the automatic screenshots, and you may specify these options via the chunk option `screenshot.opts`, which takes a list like `list(delay = 2, cliprect = 'viewport')`. See the help page `?webshot::webshot` for the full list of possible options, and the package vignette[1] `vignette('intro', package = 'webshot')` illustrates the effect of these options. Here the `delay` option can be important for widgets that take long time to render: `delay` specifies the number of seconds to wait before PhantomJS takes the screenshot. If you see an incomplete screenshot, you may want to specify a longer delay (the default is 0.2

---

[1] https://cran.rstudio.com/web/packages/webshot/vignettes/intro.html

Show 10 ⋅ entries

	Sepal.Length ⬍
1	5.1
2	4.9
3	4.7
4	4.6
5	5
6	5.4

| 7 | 4.6 |

seconds).

Fourth, if you feel it is slow to capture the screenshots, or do not want to do it every time the code chunk is executed, you may use the chunk option `cache = TRUE` to cache the chunk. Caching works for both HTML and non-HTML output formats.

Screenshots behave like normal R plots in the sense that many chunk options related to figures also apply to screenshots, including `fig.width`, `fig.height`, `out.width`, `fig.cap`, and so on. So you can specify the size of screenshots in the output document, and assign figure captions to them as well. The image format of the automatic screenshots can be specified via the chunk option `dev`, and possible values are `pdf`, `png`, and `jpeg`. The default for PDF output is `pdf`, and it is `png` for other types of output. Note that `pdf` may not work as faithfully as `png`: sometimes there are certain elements on an HTML page that fail to render to the PDF screenshot, so you may want to use `dev = 'png'` even for PDF output. It depends on specific cases of HTML widgets, and you can try both `pdf` and `png` (or `jpeg`) before deciding which format is more desirable.

4.11　Web pages and Shiny apps

Similar to HTML widgets, arbitrary web pages can be embedded in the book. You can use the function `knitr::include_url()` to include a web page through its URL. When the output format is HTML, an `iframe` is used;[1] in other cases, **knitr** tries to take a screenshot of the web page (or use the custom screenshot you provided). All chunk options are the same as those for HTML widgets. One option that may require your special attention is the `delay` option: HTML widgets are rendered locally, so usually they are fast to load for PhantomJS to take screenshots, but an arbitrary URL may take longer to load, so you may want to use a larger `delay` value, e.g., use the chunk option `screenshot.opts = list(delay = 5)`.

A related function is `knitr::include_app()`, which is very similar to `include_url()`, and it was designed for embedding Shiny apps via their URLs in the output. Its only difference with `include_url()` is that it automatically adds a query parameter `?showcase=0` to the URL, if no other query parameters are present in the URL, to disable the Shiny showcase mode, which is unlikely to be useful for screenshots or iframes. If you do want the showcase mode, use `include_url()` instead of `include_app()`. Below is a Shiny app example (Figure 4–6):

```
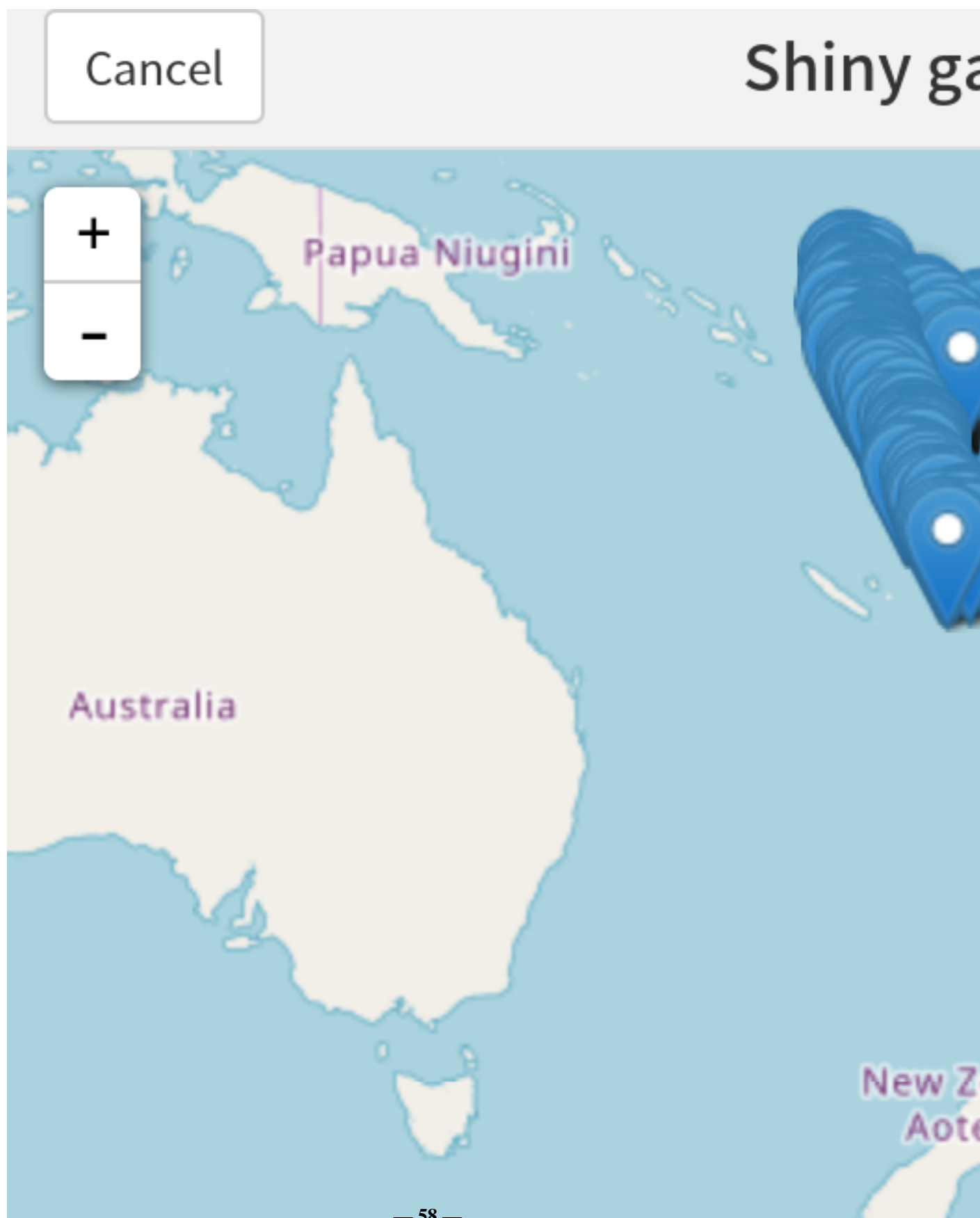knitr::include_app('https://yihui.shinyapps.io/miniUI/', height = '600
    px')
```

---

[1]An `iframe` is basically a box on one web page to embed another web page.

Again, you will see a live app if you are reading an HTML version of this book, and a static screenshot if you are reading other types of formats. The above Shiny app was created using the **miniUI** package,[R-miniUI] which provides layout functions that are particularly nice for Shiny apps on small screens. If you use normal Shiny layout functions, you are likely to see vertical and/or horizontal scrollbars in the iframes because the page size is too big to fit an iframe. When the default width of the iframe is too small, you may use the chunk option `out.width` to change it. For the height of the iframe, use the `height` argument of `include_url()`/`include_app()`.

Shiny apps may take even longer to load than usual URLs. You may want to use a conservative value for the `delay` option, e.g., 10. Needless to say, `include_url()` and `include_app()` require a working Internet connection, unless you have previously cached the chunk (but web pages inside iframes still will not work without an Internet connection).

第五章 R 语言的强力支持

5.1 准备工作

有时间，欢迎先阅读 pandoc 手册 以及第四章的内容。这里写几个简单的例子。

5.2 关于数据的例子

5.3 关于图片的排版

5.4 其他例子

换种写法，

```
1 $ make
```

```
1 # make
```

代码 5–1 这是有标题的，注释语句

```
1 # make
```

代码 5–2 一段 C 代码

```c
1  #include <stdio.h>
2  #include <unistd.h>
3  #include <sys/types.h>
4  #include <sys/wait.h>
5
6  int main() {
7    pid_t pid;
8
9    switch ((pid = fork())) {
10   case -1:
11     printf("fork failed\n");
12     break;
13   case 0:
14     /* child calls exec */
15     execl("/bin/ls", "ls", "-l", (char*)0);
16     printf("execl failed\n");
```

```
17        break;
18     default:
19        /* parent uses wait to suspend execution until child finishes */
20        wait((int*)0);
21        printf("is completed\n");
22        break;
23     }
24
25     return 0;
26  }
```

5.5   本单位曾经用过的流程图

下面用 R 语言画一个流程图。

部门名称：某某学院		流程名称：有点用哦		
编　号：B1103492		概　要：胡扯		
责任主体	某某大学	某某学院	某某科系	某某实验室
节点	A	B	C	D
1		开始		
2		计划准备		
3		制定计划	提出意见	提出意见
4	否 审批 是	组织讨论		
5		下发计划		
6		结束		
单位名称：上海西南某高校		公开程度：不给你看	第1页（共30页）	
撰写单位：某某学校		签发人：不告诉你们	签发日期：2018-06-19	

图 5–1 上海交大

Figure 5–1 SJTU

第六章 天黑路滑，居安思危

pandoc 的那些坑，还没有填平，只能绕着走。

https://github.com/jgm/pandoc/issues/4716

在行内，如果输入数学公式，最好直接用 `$` 给括起来。Markdown 的那个 `` ` `` 数学模式功能被我给关闭了，见 `./tex/template.tex`

```
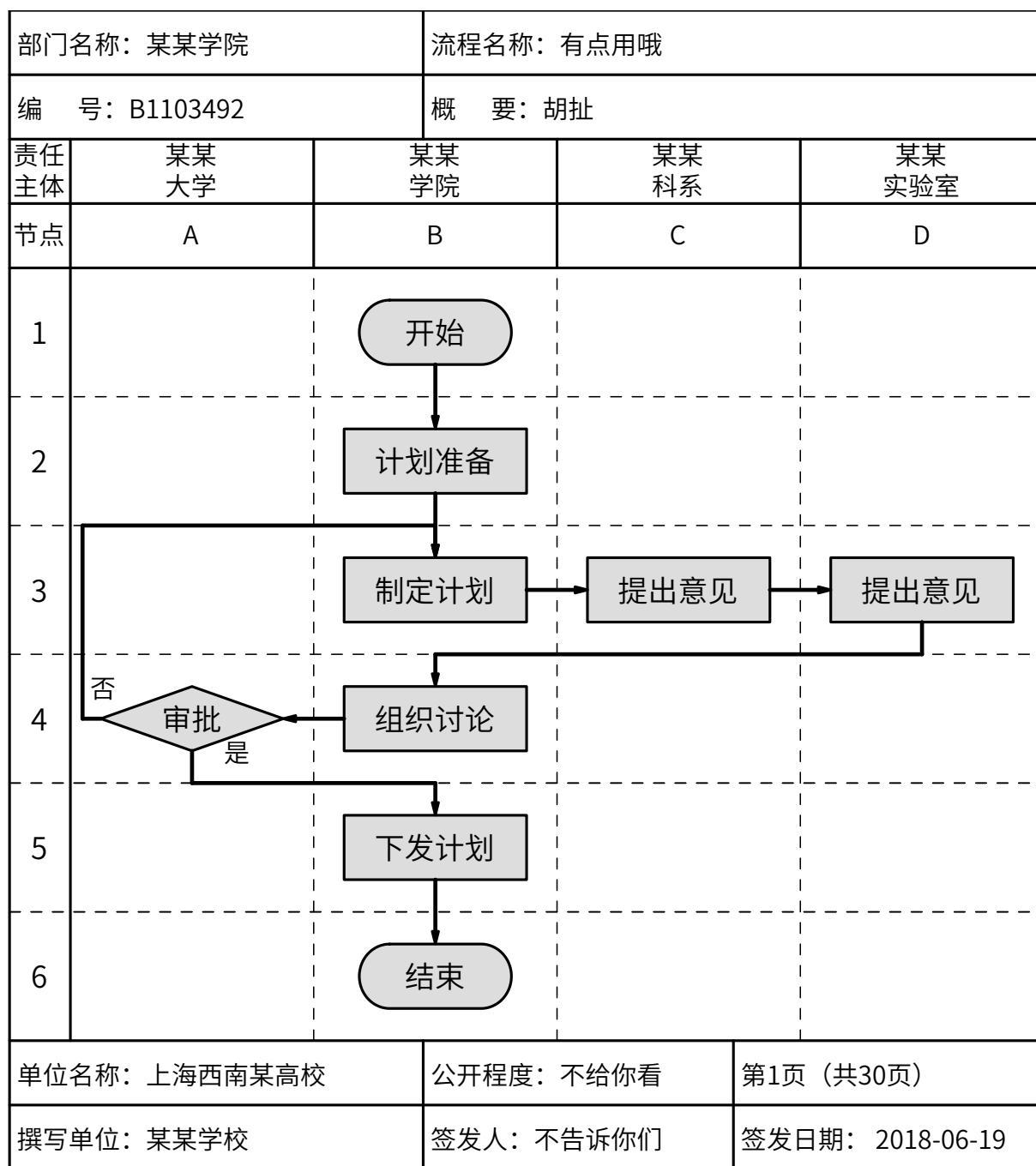1  \usepackage{listings}
2  % https://github.com/jgm/pandoc/issues/4716
3  % lstinline 对数学模式存在 bug，等修复后可以改为如下方式
4  % \newcommand{\passthrough}[1]{#1}
5  \newcommand{\passthrough}[1]{\lstset{mathescape=false}#1\lstset{
       mathescape=true}}
```

所以，暂时没有发现啥问题了。

全文总结

这里是全文总结内容。

2015 年 2 月 28 日，中央在北京召开全国精神文明建设工作表彰暨学雷锋志愿服务大会，公布全国文明城市（区）、文明村镇、文明单位名单。上海交通大学荣获全国文明单位称号。

全国文明单位这一荣誉是对交大人始终高度重视文明文化工作的肯定，是对交大长期以来文明创建工作成绩的褒奖。在学校党委、文明委的领导下，交大坚持将文明创建工作纳入学校建设世界一流大学的工作中，全体师生医护员工群策群力、积极开拓，落实国家和上海市有关文明创建的各项要求，以改革创新、科学发展为主线，以质量提升为目标，聚焦文明创建工作出现的重点和难点，优化文明创建工作机制，传播学校良好形象，提升社会美誉度，显著增强学校软实力。2007 至 2012 年间，上海交大连续三届荣获''上海市文明单位''称号，成为创建全国文明单位的新起点。

上海交大自启动争创全国文明单位工作以来，凝魂聚气、改革创新，积极培育和践行社会主义核心价值观。坚持统筹兼顾、多措并举，将争创全国文明单位与学校各项中心工作紧密结合，着力构建学校文明创建新格局，不断提升师生医护员工文明素养，以''冲击世界一流大学汇聚强大精神动力''为指导思想，以''聚焦改革、多元推进、以评促建、丰富内涵、彰显特色''为工作原则，并由全体校领导群策领衔''党的建设深化、思想教育深入、办学成绩显著、大学文化丰富、校园环境优化、社会责任担当''六大板块共 28 项重点突破工作，全面展现近年来交大文明创建工作的全貌和成就。

进入新阶段，学校将继续开拓文明创建工作新格局，不断深化工作理念和工作实践，创新工作载体、丰富活动内涵、凸显创建成效，积极服务于学校各项中心工作和改革发展的大局面，在上级党委、文明委的关心下，在学校党委的直接领导下，与时俱进、开拓创新，为深化内涵建设、加快建成世界一流大学、推动国家进步和社会发展而努力奋斗！

上海交通大学医学院附属仁济医院也获得全国文明单位称号。

附录 A 那些年踩过的坑

A.1 trying to use CRAN without setting a mirror

复制的模板，无法运行。原来小问题不断啊。https://github.com/rstudio/bookdown/issues/578

A.2 ！LaTeX Error: Environment Shaded undefined

这是因为删除了 shaded 相关代码导致的。恢复后即可。https://stackoverflow.com/questions/50702134/bookdown-latex-error-environment-shaded-undefined

A.3 LaTeX Error: Option clash for package hyperref

```
1  # ./_output.ymd
2  template: null
```

模板默认为空并非真空，实际上是默认的模板，你不知道默认模板里有哪些内容，只好自己写。

https://stackoverflow.com/questions/50559445/bookdown-latex-error-opt

A.4 模板前的中括号的文字怎么传送过来？

https://github.com/rstudio/bookdown/issues/583

A.5 代码框的实现

https://stackoverflow.com/questions/50773489/how-to-knitr-rmarkdown-c

A.6 怎么实现图像标题中英双语

https://github.com/yihui/knitr/issues/1554

A.7 如何兼容 bookdown 的定理环境

https://github.com/sjtug/SJTUThesis/issues/343

A.8 如何把自由自在的切换数学模式和非数学模式

遇到如下问题

```
! File ended while scanning use of \lst@InsideConvert@ey.
<inserted text>
                \par
```

这个是因为数学模式导致的，可以在不需要数学模式的地方插入

```
\lstset{mathescape=false}

\lstset{mathescape=true}
```

这是 pandoc 的一个问题，已经提交。

https://github.com/jgm/pandoc/blob/master/src/Text/Pandoc/Writers/LaTeX.hs#L1048#L1053

期待后面可以更好的使用 $ 符号。

附录 B　愚公移山

－ 先秦　列御寇

太行、王屋二山，方七百里，高万仞，本在冀州之南，河阳之北。

北山愚公者，年且九十，面山而居。惩山北之塞，出入之迂也，聚室而谋曰："吾与汝毕力平险，指通豫南，达于汉阴，可乎？"杂然相许。其妻献疑曰："以君之力，曾不能损魁父之丘，如太行、王屋何？且焉置土石？"杂曰："投诸渤海之尾，隐土之北。"遂率子孙荷担者三夫，叩石垦壤，箕畚运于渤海之尾。邻人京城氏之孀妻有遗男，始龀，跳往助之。寒暑易节，始一返焉。

河曲智叟笑而止之曰："甚矣，汝之不惠！以残年余力，曾不能毁山之一毛，其如土石何？"北山愚公长息曰："汝心之固，固不可彻，曾不若孀妻弱子。虽我之死，有子存焉；子又生孙，孙又生子；子又有子，子又有孙；子子孙孙无穷匮也，而山不加增，何苦而不平？"河曲智叟亡以应。

操蛇之神闻之，惧其不已也，告之于帝。帝感其诚，命夸娥氏二子负二山，一厝朔东，一厝雍南。自此，冀之南，汉之阴，无陇断焉。

附录 C 模板更新记录

2018 年 05 月 29 日 发布 RMarkdown/Bookdown 分支，位于 github，当前处于草稿中。

2018 年 1 月 v0.10 发布，项目转移至 SJTUG 名下，并增加了英文模版，修改了默认字体设置。

2016 年 12 月 v0.9.5 发布，改用 GB7714-2015 参考文献风格。

2016 年 11 月 v0.9.4 发布，增加算法和流程图。

2015 年 6 月 19 日 v0.9 发布，适配 ctex 2.x 宏包，需要使用 TeXLive 2015 编译。

2015 年 3 月 15 日 v0.8 发布，使用 biber/biblatex 组合替代 BɪʙTEX，带来更强大稳定的参考文献处理能力；添加 enumitem 宏包增强列表环境控制能力；完善宏包文字描述。

2015 年 2 月 15 日 v0.7 发布，增加盲审选项，调用外部工具插入扫描件。

2015 年 2 月 14 日 v0.6.5 发布，修正一些小问题，缩减 git 仓库体积，仓库由 sjtu-thesis-template-latex 更名为 SJTUThesis。

2014 年 12 月 17 日 v0.6 发布，学士、硕士、博士学位论文模板合并在了一起。

2013 年 5 月 26 日 v0.5.3 发布，更正 subsubsection 格式错误，这个错误导致如 "1.1 小结" 这样的标题没有被正确加粗。

2012 年 12 月 27 日 v0.5.2 发布，更正拼写错误。在 diss.tex 加入 ack.tex。

2012 年 12 月 21 日 v0.5.1 发布，在 LATEX 命令和中文字符之间留了空格，在 Makefile 中增加 release 功能。

2012 年 12 月 5 日 v0.5 发布，修改说明文件的措辞，更正 Makefile 文件，使用 metalog 宏包替换 xltxtra 宏包，使用 mathtools 宏包替换 amsmath 宏包，移除了所有 CJKtilde(~) 符号。

2012 年 5 月 30 日 v0.4 发布，包含交大学士、硕士、博士学位论文模板。模板在 github 上管理和更新。

2010 年 12 月 5 日 v0.3a 发布，移植到 XƎTEX/LATEX 上。

2009 年 12 月 25 日 v0.2a 发布，模板由 CASthesis 改名为 sjtumaster。在 diss.tex 中可以方便地改变正文字号、切换但双面打印。增加了不编号的一章 "全文总结"。添加了可伸缩符号 (等号、箭头) 的例子，增加了长标题换行的例子。

2009 年 11 月 20 日 v0.1c 发布，增加了 Linux 下使用 ctex 宏包的注意事项、.bib 条目的规范要求，修正了 ctexbook 与 listings 共同使用时的断页错误。

2009 年 11 月 13 日 v0.1b 发布，完善了模板使用说明，增加了定理环境、并列子图、

三线表格的例子。

2009 年 11 月 12 日上海交通大学硕士学位论文 LATEX 模板发布，版本 0.1a。

附录 D 流程图绘制

试着画个流程图
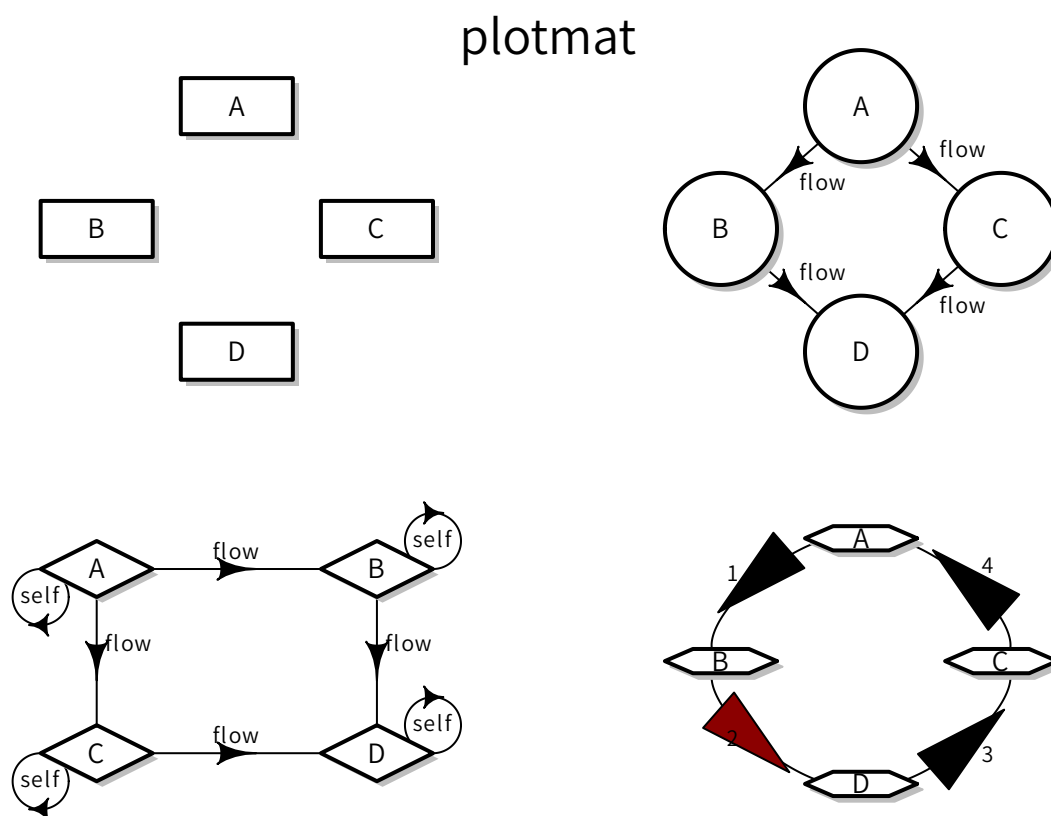
修改一个流程图

箭头表示

	segmentarrow
	curvedarrow
	straightarrow
	treearrow
	bentarrow
	selfarrow
	splitarrow
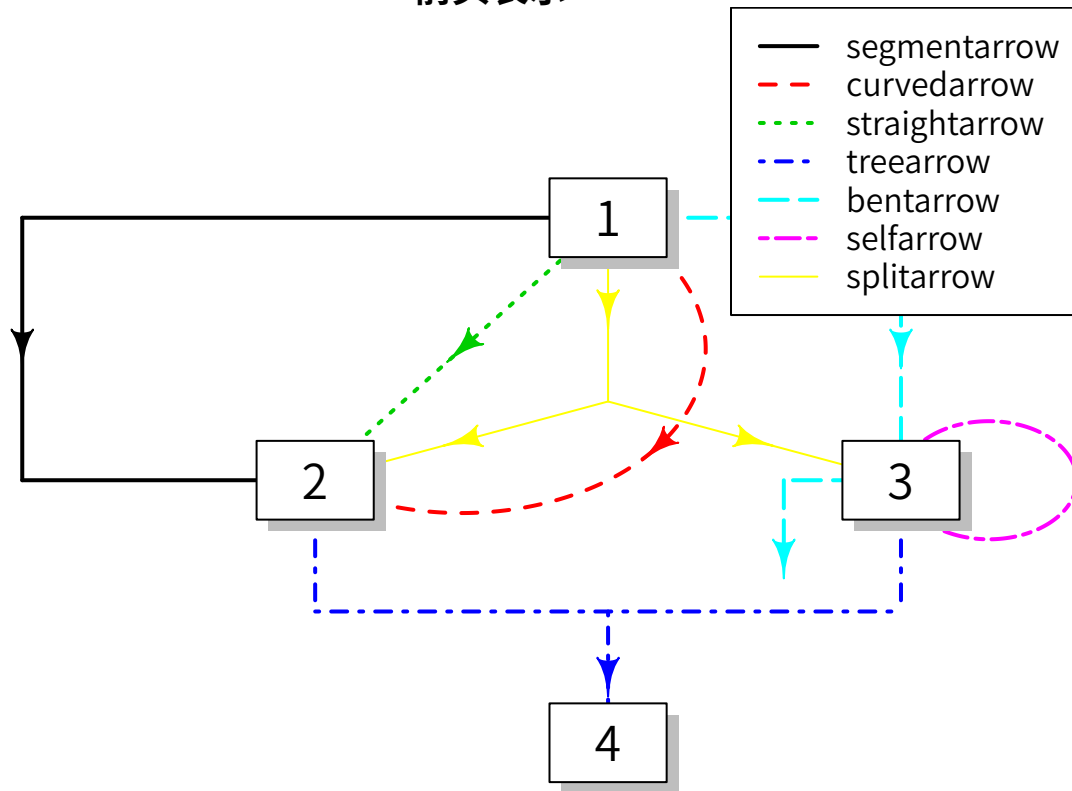
segmentarrow
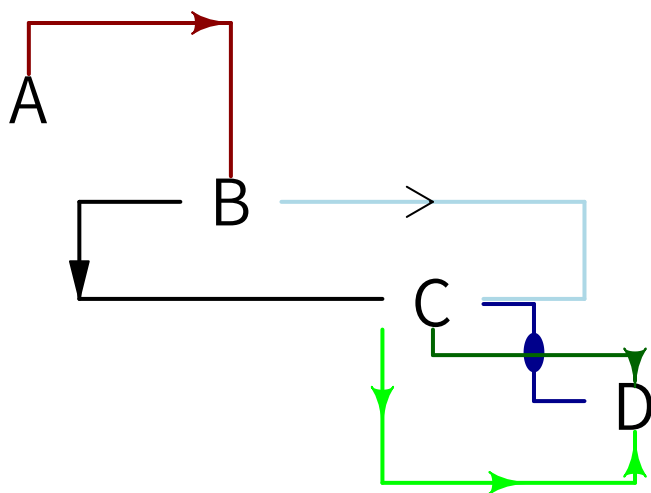
附录 E   Maxwell Equations

选择二维情况，有如下的偏振矢量：

$$\mathbf{E} = E_z(r,\theta)\hat{\mathbf{z}} \tag{E–1a}$$

$$\mathbf{H} = H_r(r,\theta))\hat{\mathbf{r}} + H_\theta(r,\theta)\hat{\boldsymbol{\theta}} \tag{E–1b}$$

对上式求旋度：

$$\nabla \times \mathbf{E} = \frac{1}{r}\frac{\partial E_z}{\partial \theta}\hat{\mathbf{r}} - \frac{\partial E_z}{\partial r}\hat{\boldsymbol{\theta}} \tag{E–2a}$$

$$\nabla \times \mathbf{H} = \left[\frac{1}{r}\frac{\partial}{\partial r}(rH_\theta) - \frac{1}{r}\frac{\partial H_r}{\partial \theta}\right]\hat{\mathbf{z}} \tag{E–2b}$$

因为在柱坐标系下，$\overline{\overline{\mu}}$ 是对角的，所以 Maxwell 方程组中电场 $\mathbf{E}$ 的旋度：

$$\nabla \times \mathbf{E} = \mathbf{i}\omega\mathbf{B} \tag{E–3a}$$

$$\frac{1}{r}\frac{\partial E_z}{\partial \theta}\hat{\mathbf{r}} - \frac{\partial E_z}{\partial r}\hat{\boldsymbol{\theta}} = \mathbf{i}\omega\mu_r H_r\hat{\mathbf{r}} + \mathbf{i}\omega\mu_\theta H_\theta\hat{\boldsymbol{\theta}} \tag{E–3b}$$

所以 $\mathbf{H}$ 的各个分量可以写为：

$$H_r = \frac{1}{\mathbf{i}\omega\mu_r}\frac{1}{r}\frac{\partial E_z}{\partial \theta} \tag{E–4a}$$

$$H_\theta = -\frac{1}{\mathbf{i}\omega\mu_\theta}\frac{\partial E_z}{\partial r} \tag{E–4b}$$

同样地，在柱坐标系下，$\overline{\overline{\epsilon}}$ 是对角的，所以 Maxwell 方程组中磁场 $\mathbf{H}$ 的旋度：

$$\nabla \times \mathbf{H} = -\mathbf{i}\omega\mathbf{D} \tag{E–5a}$$

$$\left[\frac{1}{r}\frac{\partial}{\partial r}(rH_\theta) - \frac{1}{r}\frac{\partial H_r}{\partial \theta}\right]\hat{\mathbf{z}} = -\mathbf{i}\omega\overline{\overline{\epsilon}}\mathbf{E} = -\mathbf{i}\omega\epsilon_z E_z\hat{\mathbf{z}} \tag{E–5b}$$

$$\frac{1}{r}\frac{\partial}{\partial r}(rH_\theta) - \frac{1}{r}\frac{\partial H_r}{\partial \theta} = -\mathbf{i}\omega\epsilon_z E_z \tag{E–5c}$$

由此我们可以得到关于 E_z 的波函数方程：

$$\frac{1}{\mu_\theta \epsilon_z} \frac{1}{r} \frac{\partial}{\partial r} \left(r \frac{\partial E_z}{\partial r} \right) + \frac{1}{\mu_r \epsilon_z} \frac{1}{r^2} \frac{\partial^2 E_z}{\partial \theta^2} + \omega^2 E_z = 0 \tag{E–6}$$

参考文献

[1] XIE Y. Dynamic Documents with R and knitr[M/OL]. 2nd. Boca Raton, Florida: Chapman, Hall/CRC, 2015. `http://yihui.name/knitr/`.

[2] 崔万照, 马伟, 邱乐德, 等. 电磁超介质及其应用[M]. 北京: 国防工业出版社, 2008.

[3] CHEN H, CHAN C T. Acoustic cloaking in three dimensions using acoustic metamaterials[J]. Applied Physics Letters, 2007, 91: 183518.

[4] KIM S, WOO N, YEOM H Y, et al. Design and Implementation of Dynamic Process Management for Grid-enabled MPICH[C]// The 10th European PVM/MPI Users' Group Conference. Venice, Italy: [s.n.], 2003.

[5] JOANNOPOULOS J D, JOHNSON S G, WINN J N. Photonic Crystals: Molding the Flow of Light[M]. [S.l.]: Princeton University Press, 2008.

[6] 猪八戒. 论流体食物的持久保存[D]. 北京: 广寒宫大学, 2005.

[7] 1363-2000 I S. IEEE Standard Specifications for Public-Key Cryptography[M]. New York: IEEE, 2000.

[8] CHEN H, WU B I, ZHANG B, et al. Electromagnetic Wave Interactions with a Metamaterial Cloak[J]. Physical Review Letters, 2007, 99(6): 63903.

[9] KOCHER C, JAFFE J, JUN B. Differential Power Analysis[C]// WIENER M. Advances in Cryptology (CRYPTO '99). Ed. by WIENER M. Vol. 1666. Lecture Notes in Computer Science. [S.l.]: Springer-Verlag, 1999: 388–397.

[10] 王重阳, 黄药师, 欧阳峰, 等. 武林高手论文集[C]// 第 N 次华山论剑. 西安, 中国: 中国古籍出版社, 2006.

[11] JEYAKUMAR A R. Metamori: A library for Incremental File Checkpointing[D]. Blacksburg: Virgina Tech, 2004.

[12] 沙和尚. 论流沙河的综合治理[D]. 北京: 清华大学, 2005.

[13] ZADOK E. FiST: A System for Stackable File System Code Generation[D]. USA: Computer Science Department, Columbia University, 2001.

[14] 白云芬. 信用风险传染模型和信用衍生品的定价[D]. 上海: 上海交通大学, 2008.

[15]   WOO A, BAILEY D, YARROW M, et al. The NAS Parallel Benchmarks 2.0[R/OL]. The
       Pennsylvania State University CiteSeer Archives, 1995. `http://www.nasa.org/`.

[16]   萧钰. 出版业信息化迈人快车道[J/OL]. 2001. `http://www.creader.com/`
       `news/20011219/200112190019.html`.

[17]   CHRISTINE M. Plant physiology: plant biology in the Genome Era[J/OL]. Science,
       1998, 281: 331–332. `http://www.sciencemag.org/cgi/collection/`
       `anatmorp`.

[18]   R Core Team. R: A Language and Environment for Statistical Computing[M/OL]. Vi-
       enna, Austria: [s.n.], 2012. `http://www.R-project.org/`.

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攻读学位期间发表的学术论文

[1] CHEN H, CHAN C T. Acoustic cloaking in three dimensions using acoustic metamaterials[J]. Applied Physics Letters, 2007, 91:183518.

[2] CHEN H, WU B I, ZHANG B, et al. Electromagnetic Wave Interactions with a Metamaterial Cloak[J]. Physical Review Letters, 2007, 99(6):63903.

攻读学位期间参与的项目

[1] 973 项目 "XXX"

[2] 自然基金项目 "XXX"

[3] 国防项目 "XXX"