

tinytable (Typst)

Easy, beautiful, and customizable tables in R

Table of contents

1	Tiny Tables	4
1.1	Width and height	4
1.2	Footnotes	6
1.3	Captions and cross-references	8
1.4	Line breaks and text wrapping	9
1.5	Output formats	9
1.6	Combination and exploration	11
1.7	Renaming columns	14
2	Formatting	14
2.1	Numbers, dates, strings, etc.	14
2.2	Significant digits and decimals	16
2.3	Math	17
2.4	Replacement	18
2.5	Escape special characters	19
2.6	Markdown	20
2.7	Custom functions	20
2.8	Captions, notes, groups, and column names	21
3	Style	22
3.1	Cells, rows, columns	23
3.2	Colors	26
3.3	Alignment	27
3.4	Font size	28
3.5	Spanning cells (merging cells)	28
3.6	Headers	31
3.7	Conditional styling	31
3.8	Vectorized styling (heatmaps)	33
3.9	Lines (borders)	35
3.10	Markdown and Word	36
4	Groups and labels	37
4.1	Rows	37
4.1.1	Styling row groups	39
4.1.2	Automatic row groups	40
4.1.3	Row matrix insertion	41
4.2	Columns	43
4.2.1	Styling column groups	44

4.2.2	Column names with delimiters	46
4.3	Case studies	46
4.3.1	Repeated column names	46
5	Themes	48
5.1	Visual themes	49
5.2	Custom themes	50
5.3	Tabular	51
5.4	LaTeX Resize	51
5.5	Placement	51
5.6	Rotate	51
5.7	Multipage	51
5.8	User-written themes	51
5.8.1	theme_mitex()	51
6	Plots and images	52
6.1	Inserting images in tables	52
6.2	Inline plots	53
6.2.1	Built-in plots	53
6.2.2	Custom plots: Base R	54
6.2.3	Custom plots: ggplot2	54
7	Customization	56
7.1	HTML	56
7.1.1	Bootstrap classes	56
7.1.2	CSS declarations	56
7.1.3	CSS rules	56
7.2	LaTeX / PDF	57
7.2.1	Preamble	57
7.2.2	Introduction to tabularray	57
7.2.3	tabularray keys	57
7.3	Shiny	57
8	Tips and Tricks	57
8.1	HTML	57
8.2	LaTeX	58
8.2.1	Preamble	58
8.2.2	setspace	58
8.2.3	Multi-line cells with minipage	59
8.2.4	Global styles	60
8.2.5	Beamer	61
8.2.6	Label and caption position	62
8.3	Typst	62
8.3.1	Quarto	62
8.3.2	Multi-page long tables	63
8.4	rowspan and colspan	63
8.5	Markdown	63

8.5.1 <code>style_tt()</code> does not apply to row headers	63
8.5.2 <code>rowspan</code> and <code>colspan</code>	64
8.6 <code>Word(.docx)</code>	64
8.7 Removing elements with <code>strip_tt()</code>	64
Bibliography	67

1 Tiny Tables

tinytable is a small but powerful R package to draw HTML, LaTeX, Word, PDF, Markdown, and Typst tables. The interface is minimalist, but it gives users direct and convenient access to powerful frameworks to create endlessly customizable tables.

Install the latest version from R-Universe or CRAN:

```
install.packages("tinytable",  
  repos = c("https://vincentarelbundock.r-universe.dev", "https://cran.r-project.org")  
)
```

This tutorial introduces the main functions of the package. It is also available as a single PDF document.

Load the library and set some global options:

```
library(tinytable)  
options(tinytable_tt_digits = 3)  
options(tinytable_latex_placement = "H")
```

Draw a first table:

```
x <- mtcars[1:4, 1:5]  
tt(x)
```

mpg	cyl	disp	hp	drat
21	6	160	110	3.9
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

1.1 Width and height

The width arguments indicating what proportion of the line width the table should cover. This argument accepts a number between 0 and 1 to control the whole table width, or a vector of numeric values between 0 and 1, representing each column.

```
tt(x, width = 0.5)
```

mpg	cyl	disp	hp	drat
21	6	160	110	3.9

mpg	cyl	disp	hp	drat
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

```
tt(x, width = 1)
```

mpg	cyl	disp	hp	drat
21	6	160	110	3.9
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

We can control individual columns by supplying a vector. In that case, the sum of `width` elements determines the full table width. For example, this table takes 70% of available width, with the first column 3 times as large as the other ones.

```
tt(x, width = c(.3, .1, .1, .1, .1))
```

mpg	cyl	disp	hp	drat
21	6	160	110	3.9
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

When the sum of the width vector exceeds 1, it is automatically normalized to full-width. This is convenient when we only want to specify column width in relative terms:

```
tt(x, width = c(3, 2, 1, 1, 1))
```

mpg	cyl	disp	hp	drat
21	6	160	110	3.9
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

When specifying a table width, the text is automatically wrapped to appropriate size:

```
lorem <- data.frame(  
  Lorem = "Sed ut perspiciatis unde omnis iste natus error sit voluptatem  
accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo  
inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo.",  
  Ipsum = " Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit  
aut fugit, sed quia consequuntur magni dolores eos."  
)  
  
tt(lorem, width = 3 / 4)
```

Lorem	Ipsum
Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo.	Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos.

The height argument controls the height of each row in em units:

```
tt(mtcars[1:4, 1:5], height = 3)
```

mpg	cyl	disp	hp	drat
21	6	160	110	3.9
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

1.2 Footnotes

The notes argument accepts single strings or named lists of strings:

```
n <- "Fusce id ipsum consequat ante pellentesque iaculis eu a ipsum. Mauris id  
ex in nulla consectetur aliquam. In nec tempus diam. Aliquam arcu nibh,
```

```
dapibus id ex vestibulum, feugiat consequat erat. Morbi feugiat dapibus
malesuada. Quisque vel ullamcorper felis. Aenean a sem at nisi tempor pretium
sit amet quis lacus."
```

```
tt(lorem, notes = n, width = 1)
```

Lorem	Ipsum
Sed ut perspiciatis unde omnis iste natus error sit voluptatem accusantium doloremque laudantium, totam rem aperiam, eaque ipsa quae ab illo inventore veritatis et quasi architecto beatae vitae dicta sunt explicabo.	Nemo enim ipsam voluptatem quia voluptas sit aspernatur aut odit aut fugit, sed quia consequuntur magni dolores eos.
Fusce id ipsum consequat ante pellentesque iaculis eu a ipsum. Mauris id ex in nulla consectetur aliquam. In nec tempus diam. Aliquam arcu nibh, dapibus id ex vestibulum, feugiat consequat erat. Morbi feugiat dapibus malesuada. Quisque vel ullamcorper felis. Aenean a sem at nisi tempor pretium sit amet quis lacus.	

When notes is a named list, the names are used as identifiers and displayed as superscripts:

```
tt(x, notes = list(a = "Blah.", b = "Blah blah."))
```

mpg	cyl	disp	hp	drat
21	6	160	110	3.9
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

^a Blah.

^b Blah blah.

We can also add markers in individual cells by providing coordinates:

```
tt(x, notes = list(
  a = list(i = 0:1, j = 1, text = "Blah."),
  b = "Blah blah."
))
```

mpg ^a	cyl	disp	hp	drat
21 ^a	6	160	110	3.9

mpg ^a	cyl	disp	hp	drat
21	6	160	110	3.9
22.8	4	108	93	3.85
21.4	6	258	110	3.08

^a Blah.

^b Blah blah.

1.3 Captions and cross-references

In Quarto, one should always specify captions cross-references using chunk options, and should *not* use the caption argument. This is because Quarto automatically post-processes tables, and may introduce conflict with the captions inserted by `tinytable`. For example:

```
@tbl-blah shows that...

```{r}
#| label: tbl-blah
#| tbl-cap: "Blah blah blah"
library(tinytable)
tt(mtcars[1:4, 1:4])
```
```

And here is the rendered version of the code chunk above:

Table 1 shows that...

```
library(tinytable)
tt(mtcars[1:4, 1:4])
```

Table 1: Blah blah blah

| mpg | cyl | disp | hp |
|------|-----|------|-----|
| 21 | 6 | 160 | 110 |
| 21 | 6 | 160 | 110 |
| 22.8 | 4 | 108 | 93 |
| 21.4 | 6 | 258 | 110 |

One exception to the injunction above is when rendering a Quarto document to LaTeX using `theme_latex(multipage = TRUE, rowhead = 1)`. In that case, one must *avoid* using the Quarto chunk option, because these options trigger Quarto post-processing that will conflict with the `longtblr` environment used to split long tables across multiple pages.

The alternative is to use to refer to tables using standard LaTeX syntax: `\ref{tbl-ex-multipage}`. Then, use the `caption` argument in `tt()` to specify both the label and the caption:

```
tt(iris, caption = "Example table.\\label{tbl-ex-multipage}") |>
  theme_latex(multipage = TRUE, rowhead = 1)
```

For standalone tables in any format (i.e., outside Quarto), you can use the `caption` argument like so:

```
tt(x, caption = "Blah blah.\\label{tbl-blah}")
```

1.4 Line breaks and text wrapping

Manual line breaks work slightly different in LaTeX (PDF), HTML, and Typst. This table shows the three strategies. For HTML, we insert a `
` tag. For LaTeX, we wrap the string in curly braces `{}`, and then insert two (escaped) backslashes: `\\`. For Typst, we insert an escaped backslash followed by a space.

```
d <- data.frame(
  "{Sed ut \\ \\ perspiciatis unde}",
  "dicta sunt<br> explicabo. Nemo",
  "bacon\\ baconator"
) |> setNames(c("LaTeX", "HTML", "Typst"))
tt(d, width = 1)
```

| LaTeX | HTML | Typst |
|------------------------------|----------------------------|--------------------|
| {Sed ut \ perspiciatis unde} | dicta sunt explicabo. Nemo | bacon
baconator |

1.5 Output formats

`tinytable` can produce tables in HTML, Word, Markdown, LaTeX, Typst, PDF, or PNG format. An appropriate output format for printing is automatically selected based on (1) whether the function is called interactively, (2) is called within RStudio, and (3) the output format of the Rmarkdown or Quarto document, if applicable. Alternatively, users can specify the print format in `print()` or by setting a global option:

```
tt(x) |> print("markdown")
tt(x) |> print("html")
tt(x) |> print("latex")

options(tinytable_print_output = "markdown")
```

With the `save_tt()` function, users can also save tables directly to PNG (images), PDF or Word documents, and to any of the basic formats. All we need to do is supply a valid file name with the appropriate extension (ex: `.png`, `.html`, `.pdf`, etc.):

```
tt(x) |> save_tt("path/to/file.png")
tt(x) |> save_tt("path/to/file.pdf")
tt(x) |> save_tt("path/to/file.docx")
tt(x) |> save_tt("path/to/file.html")
tt(x) |> save_tt("path/to/file.tex")
tt(x) |> save_tt("path/to/file.md")
```

`save_tt()` can also return a string with the table in it, for further processing in R. In the first case, the table is printed to console with `cat()`. In the second case, it returns as a single string as an R object.

```
tt(mtcars[1:10, 1:5]) |>
  group_tt(
    i = list(
      "Hello" = 3,
      "World" = 8
    ),
    j = list(
      "Foo" = 2:3,
      "Bar" = 4:5
    )
  ) |>
  print("markdown")
```

```
+-----+-----+-----+-----+
|      | Foo      | Bar      |
+-----+-----+-----+-----+
| mpg  | cyl  | disp | hp  | drat |
+=====+=====+=====+=====+
| 21   | 6    | 160  | 110 | 3.9  |
+-----+-----+-----+-----+
| 21   | 6    | 160  | 110 | 3.9  |
+-----+-----+-----+-----+
| Hello |      |      |      |      |
+-----+-----+-----+-----+
| 22.8 | 4    | 108  | 93  | 3.85 |
+-----+-----+-----+-----+
| 21.4 | 6    | 258  | 110 | 3.08 |
+-----+-----+-----+-----+
| 18.7 | 8    | 360  | 175 | 3.15 |
+-----+-----+-----+-----+
| 18.1 | 6    | 225  | 105 | 2.76 |
```

```

+-----+-----+-----+-----+-----+
| 14.3 | 8   | 360  | 245 | 3.21 |
+-----+-----+-----+-----+
| World |
+-----+-----+-----+-----+
| 24.4 | 4   | 147  | 62  | 3.69 |
+-----+-----+-----+-----+
| 22.8 | 4   | 141  | 95  | 3.92 |
+-----+-----+-----+-----+
| 19.2 | 6   | 168  | 123 | 3.92 |
+-----+-----+-----+-----+

```

```

tt(mtcars[1:10, 1:5]) |>
  group_tt(
    i = list(
      "Hello" = 3,
      "World" = 8
    ),
    j = list(
      "Foo" = 2:3,
      "Bar" = 4:5
    )
  ) |>
  save_tt("markdown")

```

```

[1] "+-----+-----+-----+-----+-----+\n|   | Foo   | Bar   |
\n+-----+-----+-----+-----+-----+\n| mpg | cyl | disp | hp | drat |
\n+=====+=====+=====+=====+=====+\n| 21  | 6   | 160  | 110 | 3.9  |
\n+-----+-----+-----+-----+-----+\n| 21  | 6   | 160  | 110 | 3.9  |
\n+-----+-----+-----+-----+-----+\n| Hello
\n+-----+-----+-----+-----+-----+\n| 22.8 | 4   | 108  | 93  | 3.85 |
\n+-----+-----+-----+-----+-----+\n| 21.4 | 6   | 258  | 110 | 3.08 |
\n+-----+-----+-----+-----+-----+\n| 18.7 | 8   | 360  | 175 | 3.15 |
\n+-----+-----+-----+-----+-----+\n| 18.1 | 6   | 225  | 105 | 2.76 |
\n+-----+-----+-----+-----+-----+\n| 14.3 | 8   | 360  | 245 | 3.21 |
\n+-----+-----+-----+-----+-----+\n| World
\n+-----+-----+-----+-----+-----+\n| 24.4 | 4   | 147  | 62  | 3.69 |
\n+-----+-----+-----+-----+-----+\n| 22.8 | 4   | 141  | 95  | 3.92 |
\n+-----+-----+-----+-----+-----+\n| 19.2 | 6   | 168  | 123 | 3.92 |
\n+-----+-----+-----+-----+-----+"

```

1.6 Combination and exploration

Tables can be explored, modified, and combined using many of the usual base R functions:

```
a <- tt(mtcars[1:2, 1:2])
a
```

| mpg | cyl |
|-----|-----|
| 21 | 6 |
| 21 | 6 |

```
dim(a)
```

```
[1] 2 2
```

```
ncol(a)
```

```
[1] 2
```

```
nrow(a)
```

```
[1] 2
```

```
names(a)
```

```
[1] "mpg" "cyl"
```

Tables can be combined with the usual `rbind()` function:

```
a <- tt(mtcars[1:3, 1:2], caption = "Combine two tiny tables.")
b <- tt(mtcars[4:5, 8:10])

rbind(a, b)
```

| mpg | cyl | vs | am | gear |
|------|-----|----|----|------|
| 21 | 6 | NA | NA | NA |
| 21 | 6 | NA | NA | NA |
| 22.8 | 4 | NA | NA | NA |
| NA | NA | vs | am | gear |

| mpg | cyl | vs | am | gear |
|-----|-----|----|----|------|
| NA | NA | 1 | 0 | 3 |
| NA | NA | 0 | 0 | 3 |

```
rbind(a, b) |> format_tt(replace = "")
```

| mpg | cyl | vs | am | gear |
|------|-----|----|----|------|
| 21 | 6 | | | |
| 21 | 6 | | | |
| 22.8 | 4 | | | |
| | | vs | am | gear |
| | | 1 | 0 | 3 |
| | | 0 | 0 | 3 |

The `rbind2()` S4 method is slightly more flexible than `rbind()`, as it supports arguments `headers` and `use_names`.

Omit y header:

```
rbind2(a, b, headers = FALSE)
```

| mpg | cyl | vs | am | gear |
|------|-----|----|----|------|
| 21 | 6 | NA | NA | NA |
| 21 | 6 | NA | NA | NA |
| 22.8 | 4 | NA | NA | NA |
| NA | NA | 1 | 0 | 3 |
| NA | NA | 0 | 0 | 3 |

Bind tables by position rather than column names:

```
rbind2(a, b, use_names = FALSE)
```

| mpg | cyl | gear |
|------|-----|------|
| 21 | 6 | NA |
| 21 | 6 | NA |
| 22.8 | 4 | NA |

| mpg | cyl | gear |
|-----|-----|------|
| vs | am | gear |
| 1 | 0 | 3 |
| 0 | 0 | 3 |

1.7 Renaming columns

As noted above, `tinytable` tries to be standards-compliant, by defining methods for many base R functions. The benefit of this approach is that instead of having to learn a `tinytable`-specific syntax, users can rename columns using all the tools they already know:

```
a <- tt(mtcars[1:2, 1:2])
names(a) <- c("a", "b")
a
```

| a | b |
|----|---|
| 21 | 6 |
| 21 | 6 |

In a pipe-based workflow, we can use the `setNames()` function from base R:

```
mtcars[1:2, 1:2] |>
  tt() |>
  setNames(c("a", "b"))
```

| a | b |
|----|---|
| 21 | 6 |
| 21 | 6 |

2 Formatting

```
library(tinytable)
options(tinytable_tt_digits = 3)
options(tinytable_latex_placement = "H")
x <- mtcars[1:4, 1:5]
```

2.1 Numbers, dates, strings, etc.

The `tt()` function is minimalist; it's intended purpose is simply to draw nice tables. Users who want to format numbers, dates, strings, and other variables in different ways should process their data *before* supplying it to the `tt()` table-drawing function. To do so, we can use the `format_tt()` function supplied by the `tinytable`.

In a very simple case—such as printing 2 significant digits of all numeric variables—we can use the `digits` argument of `tt()`:

```
dat <- data.frame(
  w = c(143002.2092, 201399.181, 100188.3883),
  x = c(1.43402, 201.399, 0.134588),
  y = as.Date(sample(1:1000, 3), origin = "1970-01-01"),
  z = c(TRUE, TRUE, FALSE)
)

tt(dat, digits = 2)
```

| w | x | y | z |
|--------|-------|------------|-------|
| 143002 | 1.43 | 1972-08-25 | TRUE |
| 201399 | 201.4 | 1972-08-23 | TRUE |
| 100188 | 0.13 | 1972-02-17 | FALSE |

We can get more fine-grained control over formatting by calling `format_tt()` after `tt()`, optionally by specifying the columns to format with `j`:

```
tt(dat) |>
  format_tt(
    j = 2:4,
    digits = 1,
    date = "%B %d %Y",
    bool = tolower
  ) |>
  format_tt(
    j = 1,
    digits = 2,
    num_mark_big = " ",
    num_mark_dec = ",",
    num_zero = TRUE,
    num_fmt = "decimal"
  )
```

| w | x | y | z |
|------------|-------|------------------|-------|
| 143 002,21 | 1.4 | August 25 1972 | true |
| 201 399,18 | 201.4 | August 23 1972 | true |
| 100 188,39 | 0.1 | February 17 1972 | false |

We can use a regular expression in `j` to select columns, and the `?sprintf` function to format strings, numbers, and to do string interpolation (similar to the `glue` package, but using Base R):

```

dat <- data.frame(
  a = c("Burger", "Halloumi", "Tofu", "Beans"),
  b = c(1.43202, 201.399, 0.146188, 0.0031),
  c = c(98938272783457, 7288839482, 29111727, 93945)
)
tt(dat) |>
  format_tt(j = "a", sprintf = "Food: %s") |>
  format_tt(j = 2, digits = 1) |>
  format_tt(j = "c", digits = 2, num_suffix = TRUE)

```

| a | b | c |
|----------------|---------|------|
| Food: Burger | 1.432 | 99T |
| Food: Halloumi | 201.399 | 7.3B |
| Food: Tofu | 0.146 | 29M |
| Food: Beans | 0.003 | 94K |

Finally, if you like the `format_tt()` interface, you can use it directly with numbers, vectors, or data frames:

```
format_tt(pi, digits = 1)
```

```
[1] "3"
```

```
format_tt(dat, digits = 1, num_suffix = TRUE)
```

```

      a      b      c
1 Burger    1 99T
2 Halloumi 201 7B
3   Tofu   0.1 29M
4   Beans 0.003 94K

```

2.2 Significant digits and decimals

By default, `format_tt()` formats numbers to ensure that the smallest value in a vector (column) has at least a certain number of significant digits. For example,

```

k <- data.frame(x = c(0.000123456789, 12.4356789))
tt(k, digits = 2)

```

| |
|----------|
| x |
| 0.00012 |
| 12.43568 |

We can alter this behavior to ensure to round significant digits on a per-cell basis, using the `num_fmt` argument in `format_tt()`:

```
tt(k) |> format_tt(digits = 2, num_fmt = "significant_cell")
```

| |
|---------|
| x |
| 0.00012 |
| 12 |

The numeric formatting options in `format_tt()` can also be controlled using global options:

```
options("tinytable_tt_digits" = 2)
options("tinytable_format_num_fmt" = "significant_cell")
tt(k)
```

| |
|---------|
| x |
| 0.00012 |
| 12 |

2.3 Math

To insert LaTeX-style mathematical expressions in a `tinytable`, we enclose the expression in dollar signs: `$. . . $`. Note that you must double backslashes in mathematical expressions in R strings.

In LaTeX, expression enclosed between `$$` will automatically rendered as a mathematical expression.

In HTML, users must first load the MathJax JavaScript library to render math. This can be done in two ways. First, one can use a global option. This will insert MathJax scripts alongside every table, which is convenient, but could enter in conflict with other scripts if the user (or notebook) has already inserted MathJax code:

```
options(tinytable_html_mathjax = TRUE)
```

Alternatively, users can load MathJax explicitly in their HTML file. In a Quarto notebook, this can be done by using a code chunk like this:

```

````{=html}
<script id="MathJax-script" async src="https://cdn.jsdelivr.net/npm/mathjax@3/
es5/tex-mml-chtml.js"></script>
<script>
MathJax = {
 tex: {
 inlineMath: [['$', '$'], ['\\(', '\\)']]
 },
 svg: {
 fontCache: 'global'
 }
};
</script>
````

```

Then, we can do:

```

dat <- data.frame(Math = c(
  "$x^2 + y^2 = z^2$",
  "$\\frac{1}{2}$"
))
tt(dat) |> style_tt(j = 1, align = "c")

```

To avoid inserting \dots in every cell manually, we can use the `math` argument of `format_tt()`:

```

options(tinytable_html_mathjax = TRUE)

dat <- data.frame("y^2 = e^x" = c(-2, -pi), check.names = FALSE)

tt(dat, digits = 3) |> format_tt(math = TRUE)

```

| |
|-------------|
| $y^2 = e^x$ |
| -2 |
| -3.14 |

Note that math rendering may not work automatically in Rmarkdown document. See the notebooks vignette for advice on Rmarkdown documents.

2.4 Replacement

Missing values can be replaced by a custom string using the `replace` argument:

```

tab <- data.frame(a = c(NA, 1, 2), b = c(3, NA, 5))

tt(tab)

```

| a | b |
|----|----|
| NA | 3 |
| 1 | NA |
| 2 | 5 |

```
tt(tab) |> format_tt(replace = "-")
```

| a | b |
|---|---|
| - | 3 |
| 1 | - |
| 2 | 5 |

Warning: When using quarto=TRUE, the dash may be interpreted as the start of a list.

We can also specify multiple value replacements at once using a named list of vectors:

```
tmp <- data.frame(x = 1:5, y = c(pi, NA, NaN, -Inf, Inf))
dict <- list("-", c(NA, NaN), "-∞" = -Inf, "∞" = Inf)
tt(tmp) |> format_tt(replace = dict, digits = 2)
```

| x | y |
|---|-----|
| 1 | 3.1 |
| 2 | - |
| 3 | - |
| 4 | -∞ |
| 5 | ∞ |

2.5 Escape special characters

LaTeX and HTML use special characters to indicate strings which should be interpreted rather than displayed as text. For example, including underscores or dollar signs in LaTeX can cause compilation errors in some documents. To display those special characters, we need to substitute or escape them with backslashes, depending on the output format. The escape argument of `format_tt()` can be used to do this automatically:

```
dat <- data.frame(
  "LaTeX" = c("Dollars $", "Percent %", "Underscore _", "Backslash \\"),
  "HTML" = c("<br>", "<sup>4</sup>", "<emph>blah</emph>", "&"),
  "Typst" = c("Dollars $", "Percent %", "Underscore _", "Backslash \\")
```

```
)  
  
tt(dat) |> format_tt(escape = TRUE)
```

| LaTeX | HTML | Typst |
|--------------|-------------------|--------------|
| Dollars \$ |
 | Dollars \$ |
| Percent % | ⁴ | Percent % |
| Underscore _ | <emph>blah</emph> | Underscore _ |
| Backslash \ | & | Backslash \ |

When applied to a `tt()` table, `format_tt()` will determine the type of escaping to do automatically. When applied to a string or vector, we must specify the type of escaping to apply:

```
format_tt("_ Dollars $", escape = "latex")
```

```
[1] "\\_ Dollars \\$"
```

2.6 Markdown

LaTeX and HTML only

2.7 Custom functions

On top of the built-in features of `format_tt`, a custom formatting function can be specified via the `fn` argument. The `fn` argument takes a function that accepts a single vector and returns a string (or something that coerces to a string like a number).

```
tt(x) |>  
  format_tt(j = "mpg", fn = function(x) paste(x, "mi/gal")) |>  
  format_tt(j = "drat", fn = \(\x) signif(x, 2))
```

| mpg | cyl | disp | hp | drat |
|-------------|-----|------|-----|------|
| 21 mi/gal | 6 | 160 | 110 | 3.9 |
| 21 mi/gal | 6 | 160 | 110 | 3.9 |
| 22.8 mi/gal | 4 | 108 | 93 | 3.8 |
| 21.4 mi/gal | 6 | 258 | 110 | 3.1 |

For example, the `scales` package which is used internally by `ggplot2` provides a bunch of useful tools for formatting (e.g. dates, numbers, percents, logs, currencies, etc.). The `label_*`() functions can be passed to the `fn` argument.

Note that we call `format_tt(escape = TRUE)` at the end of the pipeline because the column names and cells include characters that need to be escaped in LaTeX: `_`, `%`, and `$`. This last call is superfluous in HTML.

```
thumbdrives <- data.frame(
  date_lookup = as.Date(c("2024-01-15", "2024-01-18", "2024-01-14",
    "2024-01-16")),
  price = c(18.49, 19.99, 24.99, 24.99),
  price_rank = c(1, 2, 3, 3),
  memory = c(16e9, 12e9, 10e9, 8e9),
  speed_benchmark = c(0.6, 0.73, 0.82, 0.99)
)

tt(thumbdrives) |>
  format_tt(j = 1, fn = scales::label_date("%B %d %Y")) |>
  format_tt(j = 2, fn = scales::label_currency()) |>
  format_tt(j = 3, fn = scales::label_ordinal()) |>
  format_tt(j = 4, fn = scales::label_bytes()) |>
  format_tt(j = 5, fn = scales::label_percent()) |>
  format_tt(escape = TRUE)
```

| date_lookup | price | price_rank | memory | speed_benchmark |
|-----------------|---------|------------|--------|-----------------|
| January 15 2024 | \$18.49 | 1st | 16 GB | 60% |
| January 18 2024 | \$19.99 | 2nd | 12 GB | 73% |
| January 14 2024 | \$24.99 | 3rd | 10 GB | 82% |
| January 16 2024 | \$24.99 | 3rd | 8 GB | 99% |

2.8 Captions, notes, groups, and column names

The `format_tt()` function can also be used to format captions, notes, and column names.

```
tab <- data.frame(
  "A_B" = rnorm(5),
  "B_C" = rnorm(5),
  "C_D" = rnorm(5))

tt(tab, digits = 2, notes = "_Source_: Simulated data.") |>
  group_tt(i = list("Down" = 1, "Up" = 3)) |>
  format_tt("colnames", fn = \(x) sub("_", " / ", x)) |>
  format_tt("notes", markdown = TRUE) |>
  format_tt("groupi", replace = list("↓" = "Down", "↑" = "Up"))
```

| A / B | B / C | C / D |
|-------|-------|-------|
| ↓ | | |

| A / B | B / C | C / D |
|---------|-------|-------|
| 0.7335 | -0.82 | -1.47 |
| -0.0057 | 0.23 | -0.69 |
| ↑ | | |
| -0.7603 | 2.06 | -0.47 |
| 1.1621 | -0.77 | 0.88 |
| -0.1298 | -1.48 | 0.5 |

Source: Simulated data.

3 Style

The main styling function for the `tinytable` package is `style_tt()`. Via this function, you can access three main interfaces to customize tables:

1. A general interface to frequently used style choices which works for both HTML and LaTeX (PDF): colors, font style and size, row and column spans, etc. This is accessed through several distinct arguments in the `style_tt()` function, such as `italic`, `color`, etc.
2. A specialized interface which allows users to use the powerful `tabularray` package to customize LaTeX tables. This is accessed by passing `tabularray` settings as strings to the inner and outer arguments of `theme_latex()`.
3. A specialized interface which allows users to use the powerful Bootstrap framework to customize HTML tables. This is accessed by passing CSS declarations and rules to the `bootstrap_css` and `bootstrap_css_rule` arguments of `style_tt()`.

These functions can be used to customize rows, columns, or individual cells. They control many features, including:

- Text color
- Background color
- Widths
- Heights
- Alignment
- Text Wrapping
- Column and Row Spacing
- Cell Merging
- Multi-row or column spans
- Border Styling
- Font Styling: size, underline, italic, bold, strikethrough, etc.
- Header Customization

The `style_*`() functions can modify individual cells, or entire columns and rows. The portion of the table that is styled is determined by the `i` (rows) and `j` (columns) arguments.

```
library(tinytable)
options(tinytable_tt_digits = 3)
options(tinytable_latex_placement = "H")
x <- mtcars[1:4, 1:5]
```

3.1 Cells, rows, columns

To style individual cells, we use the `style_cell()` function. The first two arguments—`i` and `j`—identify the cells of interest, by row and column numbers respectively. To style a cell in the 2nd row and 3rd column, we can do:

```
tt(x) |>
  style_tt(
    i = 2,
    j = 3,
    background = "black",
    color = "white"
  )
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

The `i` and `j` accept vectors of integers to modify several cells at once:

```
tt(x) |>
  style_tt(
    i = 2:3,
    j = c(1, 3, 4),
    italic = TRUE,
    color = "orange"
  )
```

| mpg | cyl | disp | hp | drat |
|-------------|-----|------------|------------|------|
| 21 | 6 | 160 | 110 | 3.9 |
| <i>21</i> | 6 | <i>160</i> | <i>110</i> | 3.9 |
| <i>22.8</i> | 4 | <i>108</i> | <i>93</i> | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

We can style all cells in a table by omitting both the `i` and `j` arguments:

```
tt(x) |> style_tt(color = "orange")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

We can style entire rows by omitting the `j` argument:

```
tt(x) |> style_tt(i = 1:2, color = "orange")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

We can style entire columns by omitting the `i` argument:

```
tt(x) |> style_tt(j = c(2, 4), bold = TRUE)
```

| mpg | cyl | disp | hp | drat |
|------|------------|------|------------|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

The `j` argument accepts integer vectors, character vectors, but also a string with a Perl-style regular expression, which makes it easier to select columns by name:

```
tt(x) |> style_tt(j = c("mpg", "drat"), color = "orange")
```

| mpg | cyl | disp | hp | drat |
|------------|-----|------|-----|-------------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

```
tt(x) |> style_tt(j = "mpg|drat", color = "orange")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

Here we use a “negative lookahead” to exclude certain columns:

```
tt(x) |> style_tt(j = "^(?!drat|mpg)", color = "orange")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

Of course, we can also call the `style_tt()` function several times to apply different styles to different parts of the table:

```
tt(x) |>
  style_tt(i = 1, j = 1:2, color = "orange") |>
  style_tt(i = 1, j = 3:4, color = "green")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

The `i` argument also accepts unquoted expressions for non-standard evaluation. This allows us to style rows based on data conditions:

```
tt(x) |>
  style_tt(i = mpg > 21, background = "lightblue", bold = TRUE)
```

| mpg | cyl | disp | hp | drat |
|-------------|----------|------------|------------|-------------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

3.2 Colors

The color and background arguments in the `style_tt()` function are used for specifying the text color and the background color for cells of a table created by the `tt()` function. This argument plays a crucial role in enhancing the visual appeal and readability of the table, whether it's rendered in LaTeX or HTML format. The way we specify colors differs slightly between the two formats:

For HTML Output:

- Hex Codes: You can specify colors using hexadecimal codes, which consist of a # followed by 6 characters (e.g., #CC79A7). This allows for a wide range of colors.
- Keywords: There's also the option to use color keywords for convenience. The supported keywords are basic color names like black, red, blue, etc.

For LaTeX Output:

- Hexadecimal Codes: Similar to HTML, you can use hexadecimal codes.
- Keywords: LaTeX supports a different set of color keywords, which include standard colors like black, red, blue, as well as additional ones like cyan, darkgray, lightgray, etc.
- Color Blending: An advanced feature in LaTeX is color blending, which can be achieved using the xcolor package. You can blend colors by specifying ratios (e.g., white!80!blue or green!20!red).
- Luminance Levels: The ninecolors package in LaTeX offers colors with predefined luminance levels, allowing for more nuanced color choices (e.g., "azure4", "magenta8").

Note that the keywords used in LaTeX and HTML are slightly different.

```
tt(x) |> style_tt(i = 1:4, j = 1, color = "#FF5733")
```

| mpg | cyl | disp | hp | drat |
|-----|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

Note that when using Hex codes in a LaTeX table, we need extra declarations in the LaTeX preamble. See ?tt for details.

3.3 Alignment

To align columns, we use a single character, or a string where each letter represents a column:

```
dat <- data.frame(
  a = c("a", "aaa", "aaaaa"),
  b = c("b", "bbb", "bbbbbb"),
  c = c("c", "ccc", "ccccc")
)

tt(dat) |> style_tt(j = 1:3, align = "c")
```

| a | b | c |
|-------|--------|-------|
| a | b | c |
| aaa | bbb | ccc |
| aaaaa | bbbbbb | ccccc |

```
tt(dat) |> style_tt(j = 1:3, align = "lcr")
```

| a | b | c |
|-------|--------|-------|
| a | b | c |
| aaa | bbb | ccc |
| aaaaa | bbbbbb | ccccc |

In LaTeX documents (only), we can use decimal-alignment:

```
z <- data.frame(pi = c(pi * 100, pi * 1000, pi * 10000, pi * 100000))
tt(z) |>
  format_tt(j = 1, digits = 8, num_fmt = "significant_cell") |>
  style_tt(j = 1, align = "d")
```

| pi |
|-----------|
| 314.15927 |

| pi |
|-----------|
| 3141.5927 |
| 31415.927 |
| 314159.27 |

3.4 Font size

The font size is specified in em units.

```
tt(x) |> style_tt(i = 1:4, j = "mpg|hp|qsec", fontsize = 1.5)
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|------------|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

3.5 Spanning cells (merging cells)

Sometimes, it can be useful to make a cell stretch across multiple columns or rows, for example when we want to insert a label. To achieve this, we can use the `colspan` argument. Here, we make the 2nd cell of the 2nd row stretch across three columns and two rows:

```
tt(x) |> style_tt(
  i = 2, j = 2,
  colspan = 3,
  rowspan = 2,
  align = "c",
  alignv = "m",
  color = "white",
  background = "black",
  bold = TRUE
)
```

| mpg | cyl | disp | hp | drat |
|------|----------|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | | | 3.9 |
| 22.8 | | | | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

Here is the original table for comparison:

```
tt(x)
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

Spanning cells can be particularly useful when we want to suppress redundant labels:

```
tab <- aggregate(mpg ~ cyl + am, FUN = mean, data = mtcars)
tab <- tab[order(tab$cyl, tab$am), ]
tab
```

```
  cyl am      mpg
1   4  0 22.90000
4   4  1 28.07500
2   6  0 19.12500
5   6  1 20.56667
3   8  0 15.05000
6   8  1 15.40000
```

```
tt(tab, digits = 2) |>
  style_tt(i = c(1, 3, 5), j = 1, rowspan = 2, alignv = "t")
```

| cyl | am | mpg |
|-----|----|-----|
| 4 | 0 | 23 |
| | 1 | 28 |
| 6 | 0 | 19 |
| | 1 | 21 |
| 8 | 0 | 15 |
| | 1 | 15 |

The rowspan feature is also useful to create multi-row labels. For example, in this table there is a linebreak, but all the text fits in a single cell:

```
tab <- data.frame(Letters = c("A<br>B", ""), Numbers = c("First", "Second"))
```

```
tt(tab) |>
  theme_html(class = "table-bordered")
```

| Letters | Numbers |
|---------|---------|
| AB | First |
| | Second |

Now, we use `colspan` to ensure that that cells in the first column take up less space and are combined into one:

```
tt(tab) |>
  theme_html(class = "table-bordered") |>
  style_tt(1, 1, rowspan = 2)
```

| Letters | Numbers |
|---------|---------|
| AB | First |
| | Second |

We can combine several spans to create complex tables like this one:

```
df <- structure(list(
  Col1 = c("Col Header", "Item 0", "Item 1", "Item 2", "Total"),
  Col2 = c("Span 1", "X", "xx", "xx", "xxxx"),
  Col2.1 = c("Span 1", "Y", "xx", "xx", "xxxx"),
  Col2.2 = c("Span 2", "X", "xx", "xx", "xxxx"),
  Col2.3 = c("Span 2", "Y", "xx", "xx", "xxxx")),
  class = "data.frame", row.names = c(NA, -5L))
df |>
  setNames(NULL) |>
  tt() |>
  style_tt(1, 1, rowspan = 2, bold = TRUE) |>
  style_tt(1, c(2, 4), colspan = 2, bold = TRUE) |>
  style_tt(5, c(2, 4), colspan = 2) |>
  theme_grid()
```

| Col Header | Span 1 | Span 1 | Span 2 | Span 2 |
|------------|--------|--------|--------|--------|
| Item 0 | X | Y | X | Y |
| Item 1 | xx | xx | xx | xx |
| Item 2 | xx | xx | xx | xx |
| Total | xxxx | xxxx | xxxx | xxxx |

3.6 Headers

The header can be omitted from the table by using the `colnames` argument.

```
tt(x, colnames = FALSE)
```

| | | | | |
|------|---|-----|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

The first is row 0, and higher level headers (ex: column spanning labels) have negative indices like `-1`. They can be styled as expected:

```
tt(x) |> style_tt(i = 0, color = "white", background = "black")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

When styling columns without specifying `i`, the headers are styled in accordance with the rest of the column:

```
tt(x) |> style_tt(j = 2:3, color = "white", background = "black")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

3.7 Conditional styling

We can use the standard `which` function from Base R to create indices and apply conditional styling on rows. And we can use a regular expression in `j` to apply conditional styling on columns:

```
k <- mtcars[1:10, c("mpg", "am", "vs")]
```

```
tt(k) |>
  style_tt(
    i = which(k$am == k$vs),
    background = "teal",
    color = "white"
  )
```

| mpg | am | vs |
|------|----|----|
| 21 | 1 | 0 |
| 21 | 1 | 0 |
| 22.8 | 1 | 1 |
| 21.4 | 0 | 1 |
| 18.7 | 0 | 0 |
| 18.1 | 0 | 1 |
| 14.3 | 0 | 0 |
| 24.4 | 0 | 1 |
| 22.8 | 0 | 1 |
| 19.2 | 0 | 1 |

We can also use non-standard evaluation to apply conditional styling directly with unquoted expressions:

```
tt(k) |>
  style_tt(i = mpg > 22, background = "lightgreen", bold = TRUE)
```

| mpg | am | vs |
|-------------|----------|----------|
| 21 | 1 | 0 |
| 21 | 1 | 0 |
| 22.8 | 1 | 1 |
| 21.4 | 0 | 1 |
| 18.7 | 0 | 0 |
| 18.1 | 0 | 1 |
| 14.3 | 0 | 0 |
| 24.4 | 0 | 1 |
| 22.8 | 0 | 1 |

| mpg | am | vs |
|------|----|----|
| 19.2 | 0 | 1 |

Users can also supply a logical matrix of the same size as `x` to indicate which cell should be styled. For example, we can change the colors of certain entries in a correlation matrix as follows:

```
cormat <- data.frame(cor(mtcars[1:5]))
tt(cormat, digits = 2) |>
  style_tt(i = abs(cormat) > .8, background = "black", color = "white")
```

| mpg | cyl | disp | hp | drat |
|-------|-------|-------|-------|-------|
| 1 | -0.85 | -0.85 | -0.78 | 0.68 |
| -0.85 | 1 | 0.9 | 0.83 | -0.7 |
| -0.85 | 0.9 | 1 | 0.79 | -0.71 |
| -0.78 | 0.83 | 0.79 | 1 | -0.45 |
| 0.68 | -0.7 | -0.71 | -0.45 | 1 |

3.8 Vectorized styling (heatmaps)

The `color`, `background`, and `fontsize` arguments are vectorized. This allows easy specification of different colors in a single call:

```
tt(x) |>
  style_tt(
    i = 1:4,
    color = c("red", "blue", "green", "orange")
  )
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

When using a single value for a vectorized argument, it gets applied to all values:

```
tt(x) |>
  style_tt(
    j = 2:3,
    color = c("orange", "green"),
  )
```

```
background = "black"
)
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

We can also produce more complex heatmap-like tables to illustrate different font sizes in em units:

```
# font sizes
fs <- seq(.1, 2, length.out = 20)

# headless table
k <- data.frame(matrix(fs, ncol = 5))

# colors
bg <- hcl.colors(20, "Inferno")
fg <- ifelse(as.matrix(k) < 1.7, tail(bg, 1), head(bg, 1))

# table
tt(k, width = .7, theme = "void", colnames = FALSE) |>
  style_tt(j = 1:5, align = "ccccc") |>
  style_tt(
    i = 1:4,
    j = 1:5,
    color = fg,
    background = bg,
    fontsize = fs
  )
```

| | | | | |
|-----|-----|-----|-----|-----|
| 0.1 | 0.5 | 0.9 | 1.3 | 1.7 |
| 0.2 | 0.6 | 1 | 1.4 | 1.8 |
| 0.3 | 0.7 | 1.1 | 1.5 | 1.9 |
| 0.4 | 0.8 | 1.2 | 1.6 | 2 |

3.9 Lines (borders)

The `style_tt` function allows us to customize the borders that surround each cell of a table, as well as horizontal and vertical rules. To control these lines, we use the `line`, `line_width`, and `line_color` arguments. Here's a brief overview of each of these arguments:

- `line`: This argument specifies where solid lines should be drawn. It is a string that can consist of the following characters:
 - "t": Draw a line at the top of the cell, row, or column.
 - "b": Draw a line at the bottom of the cell, row, or column.
 - "l": Draw a line at the left side of the cell, row, or column.
 - "r": Draw a line at the right side of the cell, row, or column.
 - You can combine these characters to draw lines on multiple sides, such as "tbl" to draw lines at the top, bottom, and left sides of a cell.
- `line_width`: This argument controls the width of the solid lines in em units (default: 0.1 em). You can adjust this value to make the lines thicker or thinner.
- `line_color`: Specifies the color of the solid lines. You can use color names, hexadecimal codes, or other color specifications to define the line color.

Here is an example where we draw lines around every border ("t", "b", "l", and "r") of specified cells.

```
tt(x, theme = "void") |>
  style_tt(
    i = 0:3,
    j = 1:3,
    line = "tblr",
    line_width = 0.4,
    line_color = "orange"
  )
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

And here is an example with horizontal rules:

```
tt(x, theme = "void") |>
  style_tt(i = 0, line = "t", line_color = "orange", line_width = 0.4) |>
  style_tt(i = 1, line = "t", line_color = "purple", line_width = 0.2) |>
  style_tt(i = 4, line = "b", line_color = "orange", line_width = 0.4)
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

```
dat <- data.frame(1:2, 3:4, 5:6, 7:8)

tt(dat, theme = "void", colnames = FALSE) |>
  style_tt(
    line = "tblr", line_color = "white", line_width = 0.5,
    background = "blue", color = "white"
  )
```

| | | | |
|---|---|---|---|
| 1 | 3 | 5 | 7 |
| 2 | 4 | 6 | 8 |

3.10 Markdown and Word

Styling for Markdown and Word tables is more limited than for the other formats. In particular:

- The only supported arguments are: **bold**, *italic*, and **strikeout**.
- Headers inserted by `group_tt()` cannot be styled using the `style_tt()` function.

These limitations are due to the fact that there is no markdown syntax for the other options (ex: colors and background), and that we create Word documents by converting a markdown table to .docx via the Pandoc software.

One workaround is to style the group headers directly in their definition by using markdown syntax:

```
mtcars[1:4, 1:4] |>
  tt() |>
  group_tt(i = list("*Hello*" = 1, "__World__" = 3)) |>
  print("markdown")
```

```
+-----+-----+-----+-----+
| mpg  | cyl  | disp | hp  |
+=====+=====+=====+=====+
| *Hello*                               |
+-----+-----+-----+-----+
| 21   | 6    | 160  | 110 |
```

```

+-----+-----+-----+-----+
| 21    | 6     | 160   | 110   |
+-----+-----+-----+-----+
| __World__ |      |      |      |
+-----+-----+-----+-----+
| 22.8  | 4     | 108   | 93    |
+-----+-----+-----+-----+
| 21.4  | 6     | 258   | 110   |
+-----+-----+-----+-----+

```

4 Groups and labels

```

library(tinytable)
options(tinytable_tt_digits = 3)
options(tinytable_latex_placement = "H")
x <- mtcars[1:4, 1:5]

```

The `group_tt()` function can label groups of rows (i) or columns (j).

4.1 Rows

The `i` argument accepts a named list of integers. The numbers identify the positions where row group labels are to be inserted. The names includes the text that should be inserted:

```

dat <- mtcars[1:9, 1:8]

tt(dat) |>
  group_tt(i = list(
    "I like (fake) hamburgers" = 3,
    "She prefers halloumi" = 4,
    "They love tofu" = 7))

```

| mpg | cyl | disp | hp | drat | wt | qsec | vs |
|--------------------------|-----|------|-----|------|------|------|----|
| 21 | 6 | 160 | 110 | 3.9 | 2.62 | 16.5 | 0 |
| 21 | 6 | 160 | 110 | 3.9 | 2.88 | 17 | 0 |
| I like (fake) hamburgers | | | | | | | |
| 22.8 | 4 | 108 | 93 | 3.85 | 2.32 | 18.6 | 1 |
| She prefers halloumi | | | | | | | |
| 21.4 | 6 | 258 | 110 | 3.08 | 3.21 | 19.4 | 1 |
| 18.7 | 8 | 360 | 175 | 3.15 | 3.44 | 17 | 0 |
| 18.1 | 6 | 225 | 105 | 2.76 | 3.46 | 20.2 | 1 |
| They love tofu | | | | | | | |

| mpg | cyl | disp | hp | drat | wt | qsec | vs |
|------|-----|------|-----|------|------|------|----|
| 14.3 | 8 | 360 | 245 | 3.21 | 3.57 | 15.8 | 0 |
| 24.4 | 4 | 147 | 62 | 3.69 | 3.19 | 20 | 1 |
| 22.8 | 4 | 141 | 95 | 3.92 | 3.15 | 22.9 | 1 |

The numbers in the `i` list indicate that a label must be inserted at position # in the original table (without row groups). For example,

```
tt(head(iris)) |>
  group_tt(i = list("After 0" = 1, "After 3a" = 4, "After 3b" = 4, "After 5" =
6))
```

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
|--------------|-------------|--------------|-------------|---------|
| After 0 | | | | |
| 5.1 | 3.5 | 1.4 | 0.2 | setosa |
| 4.9 | 3 | 1.4 | 0.2 | setosa |
| 4.7 | 3.2 | 1.3 | 0.2 | setosa |
| After 3a | | | | |
| After 3b | | | | |
| 4.6 | 3.1 | 1.5 | 0.2 | setosa |
| 5 | 3.6 | 1.4 | 0.2 | setosa |
| After 5 | | | | |
| 5.4 | 3.9 | 1.7 | 0.4 | setosa |

It is also possible to use unquoted expressions (non-standard evaluation) to specify row groups. For example,

```
tmp <- do.call(rbind, by(iris, ~Species, head, n = 2))
tt(tmp) |>
  group_tt(i = Species) |>
  subset(select = ~Species) |>
  style_tt(aligned = "c") |>
  style_tt(i = "groupi", aligned = "c", color = "teal", line = "b")
```

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width |
|--------------|-------------|--------------|-------------|
| setosa | | | |
| 5.1 | 3.5 | 1.4 | 0.2 |

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width |
|--------------|-------------|--------------|-------------|
| 4.9 | 3 | 1.4 | 0.2 |
| versicolor | | | |
| 7 | 3.2 | 4.7 | 1.4 |
| 6.4 | 3.2 | 4.5 | 1.5 |
| virginica | | | |
| 6.3 | 3.3 | 6 | 2.5 |
| 5.8 | 2.7 | 5.1 | 1.9 |

4.1.1 Styling row groups

We can style group rows in the same way as regular rows (caveat: not in Word or Markdown):

```
tab <- tt(dat) |>
  group_tt(i = list(
    "I like (fake) hamburgers" = 3,
    "She prefers halloumi" = 4,
    "They love tofu" = 7))

tab |> style_tt(
  i = c(3, 5, 9),
  align = "c",
  color = "white",
  background = "gray",
  bold = TRUE)
```

| mpg | cyl | disp | hp | drat | wt | qsec | vs |
|--------------------------|-----|------|-----|------|------|------|----|
| 21 | 6 | 160 | 110 | 3.9 | 2.62 | 16.5 | 0 |
| 21 | 6 | 160 | 110 | 3.9 | 2.88 | 17 | 0 |
| I like (fake) hamburgers | | | | | | | |
| 22.8 | 4 | 108 | 93 | 3.85 | 2.32 | 18.6 | 1 |
| She prefers halloumi | | | | | | | |
| 21.4 | 6 | 258 | 110 | 3.08 | 3.21 | 19.4 | 1 |
| 18.7 | 8 | 360 | 175 | 3.15 | 3.44 | 17 | 0 |
| 18.1 | 6 | 225 | 105 | 2.76 | 3.46 | 20.2 | 1 |
| They love tofu | | | | | | | |
| 14.3 | 8 | 360 | 245 | 3.21 | 3.57 | 15.8 | 0 |
| 24.4 | 4 | 147 | 62 | 3.69 | 3.19 | 20 | 1 |

| mpg | cyl | disp | hp | drat | wt | qsec | vs |
|------|-----|------|----|------|------|------|----|
| 22.8 | 4 | 141 | 95 | 3.92 | 3.15 | 22.9 | 1 |

Calculating the location of rows can be cumbersome. Instead of doing this by hand, we can use the “groupi” shortcut to style rows and “~groupi” (the complement) to style all non-group rows.

```
tab |>
  style_tt("groupi", color = "white", background = "teal") |>
  style_tt("~groupi", j = 1, indent = 2)
```

| mpg | cyl | disp | hp | drat | wt | qsec | vs |
|--------------------------|-----|------|-----|------|------|------|----|
| 21 | 6 | 160 | 110 | 3.9 | 2.62 | 16.5 | 0 |
| 21 | 6 | 160 | 110 | 3.9 | 2.88 | 17 | 0 |
| I like (fake) hamburgers | | | | | | | |
| 22.8 | 4 | 108 | 93 | 3.85 | 2.32 | 18.6 | 1 |
| She prefers halloumi | | | | | | | |
| 21.4 | 6 | 258 | 110 | 3.08 | 3.21 | 19.4 | 1 |
| 18.7 | 8 | 360 | 175 | 3.15 | 3.44 | 17 | 0 |
| 18.1 | 6 | 225 | 105 | 2.76 | 3.46 | 20.2 | 1 |
| They love tofu | | | | | | | |
| 14.3 | 8 | 360 | 245 | 3.21 | 3.57 | 15.8 | 0 |
| 24.4 | 4 | 147 | 62 | 3.69 | 3.19 | 20 | 1 |
| 22.8 | 4 | 141 | 95 | 3.92 | 3.15 | 22.9 | 1 |

4.1.2 Automatic row groups

We can use the `group_tt()` function to group rows and label them using spanners (almost) automatically. For example,

```
# subset and sort data
df <- mtcars |>
  head(10) |>
  sort_by(~am)

# draw table
tt(df) |> group_tt(i = df$am)
```


| mpg | cyl | disp | hp | drat | wt | qsec | vs | am | gear | carb |
|------|-----|------|-----|------|------|------|----|----|------|------|
| 0 | | | | | | | | | | |
| 21.4 | 6 | 258 | 110 | 3.08 | 3.21 | 19.4 | 1 | 0 | 3 | 1 |
| 18.7 | 8 | 360 | 175 | 3.15 | 3.44 | 17 | 0 | 0 | 3 | 2 |
| 18.1 | 6 | 225 | 105 | 2.76 | 3.46 | 20.2 | 1 | 0 | 3 | 1 |
| 14.3 | 8 | 360 | 245 | 3.21 | 3.57 | 15.8 | 0 | 0 | 3 | 4 |
| 24.4 | 4 | 147 | 62 | 3.69 | 3.19 | 20 | 1 | 0 | 4 | 2 |
| 22.8 | 4 | 141 | 95 | 3.92 | 3.15 | 22.9 | 1 | 0 | 4 | 2 |
| 19.2 | 6 | 168 | 123 | 3.92 | 3.44 | 18.3 | 1 | 0 | 4 | 4 |
| 1 | | | | | | | | | | |
| 21 | 6 | 160 | 110 | 3.9 | 2.62 | 16.5 | 0 | 1 | 4 | 4 |
| 21 | 6 | 160 | 110 | 3.9 | 2.88 | 17 | 0 | 1 | 4 | 4 |
| 22.8 | 4 | 108 | 93 | 3.85 | 2.32 | 18.6 | 1 | 1 | 4 | 1 |

4.1.3 Row matrix insertion

While the traditional `group_tt(i = list(...))` approach is useful for adding individual labeled rows, sometimes you need to insert multiple rows of data at specific positions. The matrix insertion feature provides a more efficient way to do this.

Instead of creating multiple named list entries, you can specify row positions as an integer vector in `i` and provide a character matrix in `j`. This is particularly useful when you want to insert the same content (like headers or separators) at multiple positions:

```
rowmat <- matrix(colnames(iris))

tt(head(iris, 7)) |>
  group_tt(i = c(2, 5), j = rowmat)
```

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
|--------------|-------------|--------------|-------------|---------|
| 5.1 | 3.5 | 1.4 | 0.2 | setosa |
| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
| 4.9 | 3 | 1.4 | 0.2 | setosa |
| 4.7 | 3.2 | 1.3 | 0.2 | setosa |
| 4.6 | 3.1 | 1.5 | 0.2 | setosa |
| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
| 5 | 3.6 | 1.4 | 0.2 | setosa |

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
|--------------|-------------|--------------|-------------|---------|
| 5.4 | 3.9 | 1.7 | 0.4 | setosa |
| 4.6 | 3.4 | 1.4 | 0.3 | setosa |

The matrix is expected to have the same number of columns as the table. However, if you provide a single-column matrix with a number of elements that is a multiple of the table's column count, it will be automatically reshaped to match the table structure. This makes it easy to provide data in a linear format:

```
rowmat <- matrix(c(
  "-", "-", "-", "-", "-",
  "/", "/", "/", "/", "/"),
  tt(head(iris, 7)) |> group_tt(i = 2, j = rowmat)
```

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
|--------------|-------------|--------------|-------------|---------|
| 5.1 | 3.5 | 1.4 | 0.2 | setosa |
| - | - | - | - | - |
| / | / | / | / | / |
| 4.9 | 3 | 1.4 | 0.2 | setosa |
| 4.7 | 3.2 | 1.3 | 0.2 | setosa |
| 4.6 | 3.1 | 1.5 | 0.2 | setosa |
| 5 | 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 |

We can also insert rows of the group matrix in different positions:

```
tt(head(iris, 7)) |> group_tt(i = c(1, 8), j = rowmat)
```

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
|--------------|-------------|--------------|-------------|---------|
| - | - | - | - | - |
| 5.1 | 3.5 | 1.4 | 0.2 | setosa |
| 4.9 | 3 | 1.4 | 0.2 | setosa |
| 4.7 | 3.2 | 1.3 | 0.2 | setosa |
| 4.6 | 3.1 | 1.5 | 0.2 | setosa |

| Sepal.Length | Sepal.Width | Petal.Length | Petal.Width | Species |
|--------------|-------------|--------------|-------------|---------|
| 5 | 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 |
| / | / | / | / | / |

4.2 Columns

The syntax for column groups is very similar, but we use the `j` argument instead. The named list specifies the labels to appear in column-spanning labels, and the values must be a vector of consecutive and non-overlapping integers that indicate which columns are associated to which labels:

```
tt(dat) |>
  group_tt(
    j = list(
      "Hamburgers" = 1:3,
      "Halloumi" = 4:5,
      "Tofu" = 7))
```

| Hamburgers | | | Halloumi | | wt | Tofu | vs |
|------------|-----|------|----------|------|------|------|----|
| mpg | cyl | disp | hp | drat | | qsec | |
| 21 | 6 | 160 | 110 | 3.9 | 2.62 | 16.5 | 0 |
| 21 | 6 | 160 | 110 | 3.9 | 2.88 | 17 | 0 |
| 22.8 | 4 | 108 | 93 | 3.85 | 2.32 | 18.6 | 1 |
| 21.4 | 6 | 258 | 110 | 3.08 | 3.21 | 19.4 | 1 |
| 18.7 | 8 | 360 | 175 | 3.15 | 3.44 | 17 | 0 |
| 18.1 | 6 | 225 | 105 | 2.76 | 3.46 | 20.2 | 1 |
| 14.3 | 8 | 360 | 245 | 3.21 | 3.57 | 15.8 | 0 |
| 24.4 | 4 | 147 | 62 | 3.69 | 3.19 | 20 | 1 |
| 22.8 | 4 | 141 | 95 | 3.92 | 3.15 | 22.9 | 1 |

We can stack several extra headers on top of one another:

```
x <- mtcars[1:4, 1:5]
tt(x) |>
  group_tt(j = list("Foo" = 2:3, "Bar" = 5)) |>
  group_tt(j = list("Hello" = 1:2, "World" = 4:5))
```

| Hello | | | World | |
|-------|-----|------|-------|------|
| mpg | Foo | | hp | Bar |
| | cyl | disp | | drat |
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

4.2.1 Styling column groups

To style column headers, we use zero or negative indices:

```
tt(x) |>
  group_tt(j = list("Foo" = 2:3, "Bar" = 5)) |>
  group_tt(j = list("Hello" = 1:2, "World" = 4:5)) |>
  style_tt(i = 0, color = "orange") |>
  style_tt(i = -1, color = "teal") |>
  style_tt(i = -2, color = "yellow")
```

| Hello | | | World | |
|-------|-----|------|-------|------|
| mpg | Foo | | hp | Bar |
| | cyl | disp | | drat |
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

Alternatively, we can use string shortcuts:

```
tt(x) |>
  group_tt(j = list("Foo" = 2:3, "Bar" = 5)) |>
  group_tt(j = list("Hello" = 1:2, "World" = 4:5)) |>
  style_tt("groupj", color = "orange") |>
  style_tt("colnames", color = "teal")
```

| Hello | | | World | |
|-------|-----|------|-------|------|
| Foo | | | Bar | |
| mpg | cyl | disp | hp | drat |
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

Here is a table with both row and column headers, as well as some styling:

```
dat <- mtcars[1:9, 1:8]
tt(dat) |>
  group_tt(
    i = list(
      "I like (fake) hamburgers" = 3,
      "She prefers halloumi" = 4,
      "They love tofu" = 7
    ),
    j = list(
      "Hamburgers" = 1:3,
      "Halloumi" = 4:5,
      "Tofu" = 7
    )
  ) |>
  style_tt(
    i = c(3, 5, 9),
    align = "c",
    background = "teal",
    color = "white"
  ) |>
  style_tt(i = -1, color = "teal")
```

| Hamburgers | | | Halloumi | | Tofu | | |
|--------------------------|-----|------|----------|------|------|------|----|
| mpg | cyl | disp | hp | drat | wt | qsec | vs |
| 21 | 6 | 160 | 110 | 3.9 | 2.62 | 16.5 | 0 |
| 21 | 6 | 160 | 110 | 3.9 | 2.88 | 17 | 0 |
| I like (fake) hamburgers | | | | | | | |
| 22.8 | 4 | 108 | 93 | 3.85 | 2.32 | 18.6 | 1 |
| She prefers halloumi | | | | | | | |
| 21.4 | 6 | 258 | 110 | 3.08 | 3.21 | 19.4 | 1 |

| Hamburgers | | | Halloumi | | | Tofu | |
|----------------|-----|------|----------|------|------|------|----|
| mpg | cyl | disp | hp | drat | wt | qsec | vs |
| 18.7 | 8 | 360 | 175 | 3.15 | 3.44 | 17 | 0 |
| 18.1 | 6 | 225 | 105 | 2.76 | 3.46 | 20.2 | 1 |
| They love tofu | | | | | | | |
| 14.3 | 8 | 360 | 245 | 3.21 | 3.57 | 15.8 | 0 |
| 24.4 | 4 | 147 | 62 | 3.69 | 3.19 | 20 | 1 |
| 22.8 | 4 | 141 | 95 | 3.92 | 3.15 | 22.9 | 1 |

4.2.2 Column names with delimiters

Group labels can be specified using column names with delimiters. For example, some of the columns in this data frame have group identifiers. Note that the first column does not have a group identifier, and that the last column has a group identifier but no column name.

```
dat <- data.frame(
  "A_D" = rnorm(3),
  "A_B_D" = rnorm(3),
  "A_B_" = rnorm(3),
  "_C_E" = rnorm(3),
  check.names = FALSE
)

tt(dat) |> group_tt(j = "_")
```

| A | | | |
|--------|---------|-------|-------|
| D | B | | C |
| | D | B | E |
| -0.105 | 0.3825 | 0.837 | 1.234 |
| 0.203 | 0.0686 | 0.77 | 0.198 |
| -0.31 | -0.4552 | 0.631 | 0.803 |

4.3 Case studies

4.3.1 Repeated column names

In some contexts, users wish to repeat the column names to treat them as group labels. Consider this dataset:

```
library(tinytable)
library(magrittr)
```

```

dat = data.frame(
  Region = as.character(state.region),
  State = row.names(state.x77),
  state.x77[, 1:3]) |>
  sort_by(~ Region + State) |>
  subset(Region %in% c("North Central", "Northeast"))
dat = do.call(rbind, by(dat, dat$Region, head, n = 3))
row.names(dat) = NULL
dat

```

| | Region | State | Population | Income | Illiteracy |
|---|---------------|---------------|------------|--------|------------|
| 1 | North Central | Illinois | 11197 | 5107 | 0.9 |
| 2 | North Central | Indiana | 5313 | 4458 | 0.7 |
| 3 | North Central | Iowa | 2861 | 4628 | 0.5 |
| 4 | Northeast | Connecticut | 3100 | 5348 | 1.1 |
| 5 | Northeast | Maine | 1058 | 3694 | 0.7 |
| 6 | Northeast | Massachusetts | 5814 | 4755 | 1.1 |

Here, we may want to repeat the column names for every region. The `group_tt()` function does not support this directly, but it is easy to achieve this effect by:

1. Insert column names as new rows in the data.
2. Create a row group variable (here: region)
3. Style the column names and group labels

Normally, we would call `style_tt(i = "groupi")` to style the row groups, but here we need the actual indices to also style one row below the groups. We can use the `@group_index_i` slot to get the indices of the row groups.

```

region_names <- unique(dat$Region)
region_indices <- rep(match(region_names, dat$Region), each = 2)

rowmat <- do.call(rbind, lapply(region_names, function(name) {
  rbind(
    c(name, rep("", 3)),
    colnames(dat)[2:5]
  )
}))

rowmat

```

| | [,1] | [,2] | [,3] | [,4] |
|------|-----------------|--------------|----------|--------------|
| [1,] | "North Central" | " | " | " |
| [2,] | "State" | "Population" | "Income" | "Illiteracy" |

```
[3,] "Northeast"      ""      ""      ""
[4,] "State"          "Population" "Income" "Illiteracy"
```

```
tab <- tt(dat[, 2:5], colnames = FALSE) |>
  group_tt(i = region_indices, j = rowmat)

idx <- tab@group_index_i[c(TRUE, diff(tab@group_index_i) != 1)]

tab |>
  style_tt(i = idx, j = 1, align = "c", colspan = 4, background = "lightgrey",
  line = "b") |>
  style_tt(i = idx + 1, line = "tb")
```

| North Central | | | |
|---------------|------------|--------|------------|
| State | Population | Income | Illiteracy |
| Illinois | 11197 | 5107 | 0.9 |
| Indiana | 5313 | 4458 | 0.7 |
| Iowa | 2861 | 4628 | 0.5 |
| Northeast | | | |
| State | Population | Income | Illiteracy |
| Connecticut | 3100 | 5348 | 1.1 |
| Maine | 1058 | 3694 | 0.7 |
| Massachusetts | 5814 | 4755 | 1.1 |

5 Themes

`tinytable` offers a very flexible theming framework, which includes a few basic visual looks, as well as other functions to apply collections of transformations to `tinytable` objects in a repeatable way. These themes can be applied by supplying a string or function to the `theme` argument in `tt()`. Alternatively, users can call the specific theme functions like `theme_stripped()`, `theme_grid()`, etc.

The main difference between theme functions and the other options in package, is that whereas `style_tt()` and `format_tt()` aim to be output agnostic, theme functions supply transformations that can be output-specific, and which can have their own sets of distinct arguments. See below for a few examples.

```
library(tinytable)
options(tinytable_tt_digits = 3)
```



```
options(tinytable_latex_placement = "H")
x <- mtcars[1:4, 1:5]
```

5.1 Visual themes

To begin, let's explore a few of the basic looks supplied by themes:

```
tt(x, theme = "striped")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

```
tt(x) |> theme_striped()
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

```
tt(x, theme = "grid")
```

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

```
tt(x, theme = "void")
```

| mpg | cyl | disp | hp | drat |
|-----|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |

| mpg | cyl | disp | hp | drat |
|------|-----|------|-----|------|
| 21 | 6 | 160 | 110 | 3.9 |
| 22.8 | 4 | 108 | 93 | 3.85 |
| 21.4 | 6 | 258 | 110 | 3.08 |

5.2 Custom themes

Users can also define their own themes to apply consistent visual tweaks to tables. For example, this defines a themeing function and sets a global option to apply it to all tables consistently:¹

```
theme_vincent <- function(x, ...) {
  out <- x |>
    style_tt(color = "teal") |>
    theme_default()
  out@caption <- "Always use the same caption."
  out@width <- .5
  return(out)
}

options(tinytable_tt_theme = theme_vincent)

tt(mtcars[1:2, 1:2])
```

| mpg | cyl |
|-----|-----|
| 21 | 6 |
| 21 | 6 |

```
tt(mtcars[1:3, 1:3])
```

| mpg | cyl | disp |
|------|-----|------|
| 21 | 6 | 160 |
| 21 | 6 | 160 |
| 22.8 | 4 | 108 |

```
options(tinytable_tt_theme = NULL)
```

¹Note: Captions must be defined in Quarto chunks for Typst output, which explains why they are not displayed in the Typst version of this document.

Here is a slightly more complex example. The benefit of this approach is that we apply a function via the `style_tt()` function and its `finalize` argument, so we can leverage some of the object components that are only available at the printing stage:

```
theme_slides <- function(x, ...) {  
  fn <- function(table) {  
    if (isTRUE(table@output == "typst")) {  
      table@table_string <- paste0("#figure([\n", table@table_string, "\n])")  
    }  
    return(table)  
  }  
  x <- style_tt(x, finalize = fn)  
  return(x)  
}  
  
tt(head(iris), theme = theme_slides)
```

Note: the code above is not evaluated because it only applies to Typst output.

5.3 Tabular

LaTeX and HTML only.

5.4 LaTeX Resize

LaTeX only.

5.5 Placement

LaTeX only.

5.6 Rotate

LaTeX only.

5.7 Multipage

LaTeX only.

5.8 User-written themes

This section provides a few user-written themes that can be used to extend the functionality of `tinytable`. These themes are not included in the package by default, but they can be easily added to your workflow. If you would like your own custom theme to appear here, please open an issue on the `tinytable` GitHub repository or submit a pull request.

5.8.1 `theme_mitex()`

This theme was written by Kazuharu Yanagimoto. Thanks for your contribution!

The MiTeX project aims to bring LaTeX support to Typst documents. This theme replace every instance of matching pairs of dollars signs `$. $` by a MiTeX function call: `#mitex(...)`. This allows you to use LaTeX math in Typst documents.

Warning: The substitution code is very simple and it may not work properly when there are unmatched \$ symbols in the document.

```
theme_mitex <- function(x, ...) {  
  fn <- function(table) {  
    if (isTRUE(table@output == "typst")) {  
      table@table_string <- gsub(  
        "\\$(.*?)\\$",  
        "#mitex(`\\1`)",  
        table@table_string)  
    }  
    return(table)  
  }  
  x <- style_tt(x, finalize = fn)  
  return(x)  
}
```

6 Plots and images



The `plot_tt()` function can embed images and plots in a `tinytable`. We can insert images by specifying their paths and positions (*i/j*).

```
library(tinytable)  
options(tinytable_tt_digits = 3)  
options(tinytable_latex_placement = "H")  
x <- mtcars[1:4, 1:5]
```

6.1 Inserting images in tables

To insert images in a table, we use the `plot_tt()` function. The `path_img` values must be relative to the main document saved by `save_tt()` or to the Quarto (or Rmarkdown) document in which the code is executed.

```
dat <- data.frame(  
  Species = c("Spider", "Squirrel"),  
  Image = ""  
)  
  
img <- c(  
  "figures/spider.png",  
  "figures/squirrel.png"  
)  
  
tt(dat) |>  
  plot_tt(j = 2, images = img, height = 3)
```

| Species | Image |
|----------|---|
| Spider |  |
| Squirrel |  |

In HTML tables, it is possible to insert tables directly from a web address, but not in LaTeX.

6.2 Inline plots

We can draw inline plots three ways, with

1. Built-in templates for histograms, density plots, and bar plots
2. Custom plots using base R plots.
3. Custom plots using ggplot2.

To draw custom plots, one simply has to define a custom function, whose structure we illustrate below.

6.2.1 Built-in plots





There are several types of inline plots available by default. For example,









```
plot_data <- list(mtcars$mpg, mtcars$hp, mtcars$qsec)

dat <- data.frame(
  Variables = c("mpg", "hp", "qsec"),
  Histogram = "",
  Density = "",
  Bar = "",
  Line = ""
)

# random data for sparklines
lines <- lapply(1:3, \(x) data.frame(x = 1:10, y = rnorm(10)))

tt(dat) |>
  plot_tt(j = 2, fun = "histogram", data = plot_data) |>
  plot_tt(j = 3, fun = "density", data = plot_data, color = "darkgreen") |>
  plot_tt(j = 4, fun = "bar", data = list(2, 3, 6), color = "orange") |>
  plot_tt(j = 5, fun = "line", data = lines, color = "blue") |>
  style_tt(j = 2:5, align = "c")
```

| Variables | Histogram | Density | Bar | Line |
|-----------|---|---|---|---|
| mpg |  |  |  |  |

| Variables | Histogram | Density | Bar | Line |
|-----------|---|---|---|---|
| hp |  |  |  |  |
| qsec |  |  |  |  |

6.2.2 Custom plots: Base R

Important: Custom functions must have ... as an argument.

To create a custom inline plot using Base R plotting functions, we create a function that returns another function. `tinytable` will then call that second function internally to generate the plot.




This is easier than it sounds! For example:

```
f <- function(d, ...) {
  function() hist(d, axes = FALSE, ann = FALSE, col = "lightblue")
}

plot_data <- list(mtcars$mpg, mtcars$hp, mtcars$qsec)

dat <- data.frame(Variables = c("mpg", "hp", "qsec"), Histogram = "")

tt(dat) |>
  plot_tt(j = 2, fun = f, data = plot_data)
```

| Variables | Histogram |
|-----------|---|
| mpg |  |
| hp |  |
| qsec |  |

6.2.3 Custom plots: ggplot2

Important: Custom functions must have ... as an argument.

To create a custom inline plot using `ggplot2`, we create a function that returns a `ggplot` object:

```
library(ggplot2)
```

```
Attaching package: 'ggplot2'
```




```
The following object is masked from 'package:tinytable':
```

```
theme_void
```

```
f <- function(d, color = "black", ...) {
  d <- data.frame(x = d)
  ggplot(d, aes(x = x)) +
    geom_histogram(bins = 30, color = color, fill = color) +
    scale_x_continuous(expand = c(0, 0)) +
    scale_y_continuous(expand = c(0, 0)) +
    theme_void()
}

plot_data <- list(mtcars$mpg, mtcars$hp, mtcars$qsec)

tt(dat) |>
  plot_tt(j = 2, fun = f, data = plot_data, color = "pink")
```

| Variables | Histogram |
|-----------|---|
| mpg |  |
| hp |  |
| qsec |  |

We can insert arbitrarily complex plots by customizing the ggplot2 call:

```
penguins <- read.csv(
  "https://vincentarelbundock.github.io/Rdatasets/csv/palmerpenguins/penguins.
  csv",
  na.strings = ""
) |> na.omit()

# split data by species
dat <- split(penguins, penguins$species)
body <- lapply(dat, \(x) x$body_mass_g)
flip <- lapply(dat, \(x) x$flipper_length_mm)

# create nearly empty table
tab <- data.frame(
  "Species" = names(dat),
  "Body Mass" = "",
  "Flipper Length" = "",
  "Body vs. Flipper" = "",
  check.names = FALSE
)










# custom ggplot2 function to create inline plot
f <- function(d, ...) {
  ggplot(d, aes(x = flipper_length_mm, y = body_mass_g, color = sex)) +
```

```

geom_point(size = .2) +
scale_x_continuous(expand = c(0, 0)) +
scale_y_continuous(expand = c(0, 0)) +
scale_color_manual(values = c("#E69F00", "#56B4E9")) +
theme_void() +
theme(legend.position = "none")
}

# `tinytable` calls
tt(tab) |>
plot_tt(j = 2, fun = "histogram", data = body, height = 2) |>
plot_tt(j = 3, fun = "density", data = flip, height = 2) |>
plot_tt(j = 4, fun = f, data = dat, height = 2) |>
style_tt(j = 2:4, align = "c")

```

| Species | Body Mass | Flipper Length | Body vs. Flipper |
|-----------|---|---|--|
| Adelie |  |  |  |
| Chinstrap |  |  |  |
| Gentoo |  |  |  |

7 Customization

```

library(tinytable)
options(tinytable_tt_digits = 3)
options(tinytable_latex_placement = "H")
x <- mtcars[1:4, 1:5]

```

7.1 HTML

7.1.1 Bootstrap classes

7.1.2 CSS declarations

7.1.3 CSS rules

And yet another one. Some Rmarkdown documents like bookdown use older versions of Bootstrap that do not have a caption-top class. We can recreate that functionality with CSS rules and classes. For example,


```
rule <- ".bottomcaption {caption-side: bottom;}"
tt(head(iris), caption = "Hello world") |>
  theme_html(class = "table bottomcaption", css_rule = rule)
```

7.2 LaTeX / PDF

7.2.1 Preamble

7.2.2 Introduction to tabularray

7.2.3 tabularray keys

7.3 Shiny

tinytable is a great complement to Shiny for displaying HTML tables in a web app. The styling in a tinytable is applied by JavaScript functions and CSS. Thus, to ensure that this styling is preserved in a Shiny app, one strategy is to bake the entire page, save it in a temporary file, and load it using the `includeHTML` function from the `shiny` package. This approach is illustrated in this minimal example:

```
library("shiny")
library("tinytable")

fn <- paste(tempfile(), ".html")
tab <- tt(mtcars[1:5, 1:4]) |>
  style_tt(i = 0:5, color = "orange", background = "black") |>
  save_tt(fn)

shinyApp(
  ui = fluidPage(
    fluidRow(column(
      12, h1("This is test of tinytable"),
      shiny::includeHTML(fn)
    ))
  ),
  server = function(input, output) {
  }
)
```

8 Tips and Tricks

8.1 HTML

- Relative widths tables: `table-layout: fixed` vs `auto`.

8.2 LaTeX

8.2.1 Preamble

tinytable uses the tabulararray package from your LaTeX distribution to draw tables. tabulararray, in turn, provides special tblr, talltblr, and longtblr environments to display tabular data.

When rendering a document from Quarto or Rmarkdown directly to PDF, tinytable will populate the LaTeX preamble automatically with all the required packages (except when code chunks are cached). For standalone LaTeX documents, these commands should be inserted in the preamble manually:

```
\usepackage{tabulararray}
\usepackage{float}
\usepackage{graphicx}
\usepackage{rotating}
\usepackage[normalem]{ulem}
\UseTblrLibrary{booktabs}
\UseTblrLibrary{siunitx}
\newcommand{\tinytableTabulararrayUnderline}[1]{\underline{#1}}
\newcommand{\tinytableTabulararrayStrikeout}[1]{\sout{#1}}
\NewTableCommand{\tinytableDefineColor}[3]{\definecolor{#1}{#2}{#3}}
```

8.2.2 setspace

Some users have encountered unexpected spacing behavior when generating tables that are *not* wrapped in a `\begin{table}` environment (ex: `multipage` or `raw tblr`).

One issue stems from the fact that the `\begin{table}` environment resets any spacing commands in the preamble or body by default, such as:

```
\usepackage{setspace}
\doublespacing
```

This means that when using `theme_latex(environment="tabular")` —which does not wrap the table in a table environment— the spacing is *not* reset, and tables are double spaced. This is not a bug, since double-spacing is in fact what the user requested. Nevertheless, the behavior can seem surprising for those used to the automagical table environment spacing reset.

One workaround is to add the following to the document preamble when using `multipage/longtblr`:

```
\usepackage{etoolbox}
\AtBeginEnvironment{longtblr}{\begin{singlespacing}}
\AtEndEnvironment{longtblr}{\end{singlespacing}}
```

Example Quarto doc:

```

---
title: longtblr and setspace
format:
  pdf:
    include-in-header:
      - text: |
          % Tinytable preamble
          \usepackage{tabularray}
          \usepackage{float}
          \usepackage{graphicx}
          \usepackage{codehigh}
          \usepackage[normalem]{ulem}
          \UseTblrLibrary{booktabs}
          \UseTblrLibrary{siunitx}
          \newcommand{\tinytableTabularrayUnderline}[1]{\underline{#1}}
          \newcommand{\tinytableTabularrayStrikeout}[1]{\sout{#1}}
          \NewTableCommand{\tinytableDefineColor}[3]{\definecolor{#1}{#2}{#3}}
          % Spacing Commands
          \usepackage{setspace}
          \doublespacing
          % Fix Spacing in longtblr
          \usepackage{etoolbox}
          \AtBeginEnvironment{longtblr}{\begin{singlespacing}}
          \AtEndEnvironment{longtblr}{\end{singlespacing}}
---

```\{=latex}
\begin{longtblr}[%% tabularray outer open
] %% tabularray outer close
{ %% tabularray inner open
colspec={Q[]Q[]Q[]Q[]},
} %% tabularray inner close
\toprule
foo & bar & baz \\
foo & bar & baz \\
foo & bar & baz \\
\bottomrule
\end{longtblr}
```

```

8.2.3 Multi-line cells with minipage

In some contexts, users may want create cells with LaTeX or markdown code that spans multiple lines. This usually works well for HTML tables. But sometimes, in LaTeX, multi-line content with special environments must be wrapped in a minipage environment.

In the example that follows, we create a Markdown list using asterisks. Then, we call `litedown::mark()` to render that list as bullet points (an `itemize` environment in LaTeX). Finally, we define a custom function called `minipagify` to wrap the bullet point in a `minipage` environment.

```
library(tinytable)
library(litedown)

dat <- data.frame(
  A = c("Blah *blah* blah", "- Thing 1\n- Thing 2"),
  B = c("6%", "$5.29")
)

# wrap in a minipage environment
minipagify <- function(x) {
  sprintf(
    "\\minipage{\\textwidth}%s\\endminipage",
    sapply(x, litedown::mark, "latex")
  )
}

# only in LaTeX
is_latex <- identical(knitr::pandoc_to(), "latex")
is_html <- identical(knitr::pandoc_to(), "html")

tab <- tt(dat, width = c(0.3, 0.2)) |>
  style_tt(j = 2, align = "c") |>
  format_tt(j = 2, escape = TRUE) |>
  format_tt(j = 1, fn = if (is_latex) minipagify else identity) |>
  format_tt(j = 1, fn = if (is_html) litedown::mark else identity)

tab
```

| A | B |
|-----------------------|--------|
| Blah blah blah | 6% |
| • Thing 1 | \$5.29 |
| • Thing 2 | |

8.2.4 Global styles

`tabularray` allows very powerful styling and themeing options. See the reference manual for more information.

For example, you can change the size of footnotes in all tables of a document with:

```

---
format:
  pdf:
    keep-tex: true
    header-includes: |
      \SetTblrStyle{foot}{font=\LARGE}
---

```{r}
library(tinytable)
library(magrittr)
tt(head(iris), notes = "Blah blah")
```

```

8.2.5 Beamer

Due to a bug in the upstream package `rmarkdown`, Quarto or Rmarkdown presentations compiled to Beamer cannot include adequate package loading commands in the preamble automatically. This bug prevents `tinytable::usepackage_latex()` from modifying the preamble. Here's a workaround.

Save this LaTeX code as `preamble.tex`:

```

\RequirePackage{tabularray}
\RequirePackage{booktabs}
\RequirePackage{float}
\usepackage[normalem]{ulem}
\usepackage{graphicx}
\UseTblrLibrary{booktabs}
\UseTblrLibrary{siunitx}
\NewTableCommand{\tinytableDefineColor}[3]{\definecolor{#1}{#2}{#3}}
\newcommand{\tinytableTabularrayUnderline}[1]{\underline{#1}}
\newcommand{\tinytableTabularrayStrikeout}[1]{\sout{#1}}

```

Then, load `preamble.tex` in your YAML header:

```

---
output:
  beamer_presentation:
    includes:
      in_header: preamble.tex
---

```

With these changes, the table should appear with colors as expected.

8.2.6 Label and caption position

In LaTeX, we can use `tabularray` options in the preamble or the table to change the location of the label and caption. The example below shows a Quarto document with caption at the bottom.

```
---
output:
  pdf_document:
header-includes:
  - \usepackage{tabularray}
---

```{=latex}
\DefTblrTemplate{firsthead,middlehead,lasthead}{default}{}
\DefTblrTemplate{firstfoot,middlefoot}{default}{}
\DefTblrTemplate{lastfoot}{default}%
{
 \UseTblrTemplate{caption}{default}
}
```

```{r, echo=FALSE}
library(modelsummary)
library(tinytable)
mod <- list()
mod[['One variable']] <- lm(mpg ~ hp, mtcars)
mod[['Two variables']] <- lm(mpg ~ hp + drat, mtcars)

modelsummary(mod,
 title = "Regression Models")|>
 theme_latex(outer = "label={tblr:test}")
```

Table \ref{tblr:test}
```

8.3 Typst

8.3.1 Quarto

By default `tinytable` uses Quarto's own figure handling to set captions and figure blocks. This allows cross-references to work. For this to work well, users should specify *both* the table label and the table caption explicitly using chunk options. Note that the label must imperatively start with `tbl-`:

```
#| label: tbl-example
#| tbl-cap: This is an example table
library(tinytable)
tt(head(iris))
```

Alternatively, users can disable Quarto table handling and rely on internal `tinytable` options instead.

```
options(tinytable_quarto_figure = FALSE)
```

Doing this will prevent styles to bleed over from one table to the next.

8.3.2 Multi-page long tables

The Typst tables created by `tinytable` are automatically broken across pages with repeated headers. However, in Quarto documents, the Quarto software wraps tables in a non-breakable `#figure` environment. This can break the display of long tables. One solution is to use a raw Typst code block to set Figures to be breakable:

```
---
format: typst
---

```{=typst}
#show figure: set block(breakable: true)
```

```{r}
#| tbl-cap: "blah blah blah"
#| label: tbl-blah
library(tinytable)
tt(head(iris, 50))
```
```

8.4 rowspan and colspan

If a table has cells that span across the full table (`colspan` equal to `nrow(tab)`), the `rowspan` argument can collapse multiple rows into a single cell. See this forum post for explanation why:

<https://forum.typst.app/t/why-is-a-rowspan-cell-with-colspan-equal-to-number-of-columns-seemingly-only-spanning-one-row/5047>

8.5 Markdown

8.5.1 style_tt() does not apply to row headers

This is an important limitation, but it is difficult to get around. See this issue for discussion: <https://github.com/vincentarelbundock/tinytable/issues/125>

Users can use markdown styling directly in `group_tt()` to circumvent this. This is documented in the tutorial.

8.5.2 rowspan and colspan

These arguments are already implemented in the form of “pseudo-spans”, meaning that we flush the content of adjacent cells, but do not modify the row or column borders. This is probably adequate for most needs.

One alternative would be to remove line segments in `finalize_grid()`. I tried this but it is tricky and the results were brittle, so I rolled it back. I’m open to considering a PR if someone wants to contribute code, but please discuss the feature design in an issue with me before working on this.

8.6 Word (.docx)

Word document documents are created in two steps:

1. Generates a markdown table.
2. Call the external Pandoc software to convert the markdown table to a Word document.

This workflow limits the range of styling options available in Word. Indeed, many arguments in the `style_tt()` function do not have formal markdown notation to represent them, and are thus not available. For example, while *italic*, **bold**, and ~~strikeout~~, are supported, *color* and *background* are not.

Note that other `tinytable` functions such as `group_tt()` and `format_tt()` and `plot_tt()` should work as expected in Word.

Users who want full styling capabilities in Word can save tables as image files and insert them in their documents. Here is an example Quarto notebook illustrating this workflow.

```
---
format: docx
---

```{r}
#| out-width: "50%"
library(tinytable)

options(tinytable_save_overwrite = TRUE)

tt(mtcars[1:10, 1:5]) |>
 style_tt(j = 2:3, background = "black", color = "white") |>
 save_tt("table_01.png")

knitr::include_graphics("table_01.png")
```
```

8.7 Removing elements with strip_tt()

In some cases, it is useful to remove elements of an existing `tinytable` object. For example, packages like `modelsummary` often return tables with default styling—such as borders and lines

in specific position. If the user adds group labels manually, the original lines and borders will be misaligned.

The code below produces a regression table with group labels but misaligned horizontal rule.

```
#!/ warning: false
library(modelsummary)
library(tinytable)

mod <- lm(mpg ~ factor(cyl) + hp + wt - 1, data = mtcars)

modelsummary(mod) |>
  group_tt(
    i = list(
      "Cylinders" = 1,
      "Others" = 7
    )
  )
```

| | (1) |
|--------------|---------|
| Cylinders | |
| factor(cyl)4 | 35.846 |
| | (2.041) |
| factor(cyl)6 | 32.487 |
| | (2.811) |
| factor(cyl)8 | 32.660 |
| | (3.835) |
| Others | |
| hp | -0.023 |
| | (0.012) |
| wt | -3.181 |
| | (0.720) |
| Num.Obs. | 32 |
| R2 | 0.989 |
| R2 Adj. | 0.986 |
| AIC | 154.5 |
| BIC | 163.3 |
| Log.Lik. | -71.235 |

| | (1) |
|------|------|
| RMSE | 2.24 |

To fix this, we can strip the lines and add them back in the correct position.

```
modelsummary(mod) |>
  strip_tt(line = TRUE) |>
  group_tt(
    i = list(
      "Cylinders" = 1,
      "Others" = 7
    )
  ) |>
  style_tt(i = 12, line = "b", line_width = .05)
```

| | (1) |
|--------------|---------|
| Cylinders | |
| factor(cyl)4 | 35.846 |
| | (2.041) |
| factor(cyl)6 | 32.487 |
| | (2.811) |
| factor(cyl)8 | 32.660 |
| | (3.835) |
| Others | |
| hp | -0.023 |
| | (0.012) |
| wt | -3.181 |
| | (0.720) |
| Num.Obs. | 32 |
| R2 | 0.989 |
| R2 Adj. | 0.986 |
| AIC | 154.5 |
| BIC | 163.3 |
| Log.Lik. | -71.235 |
| RMSE | 2.24 |

Bibliography