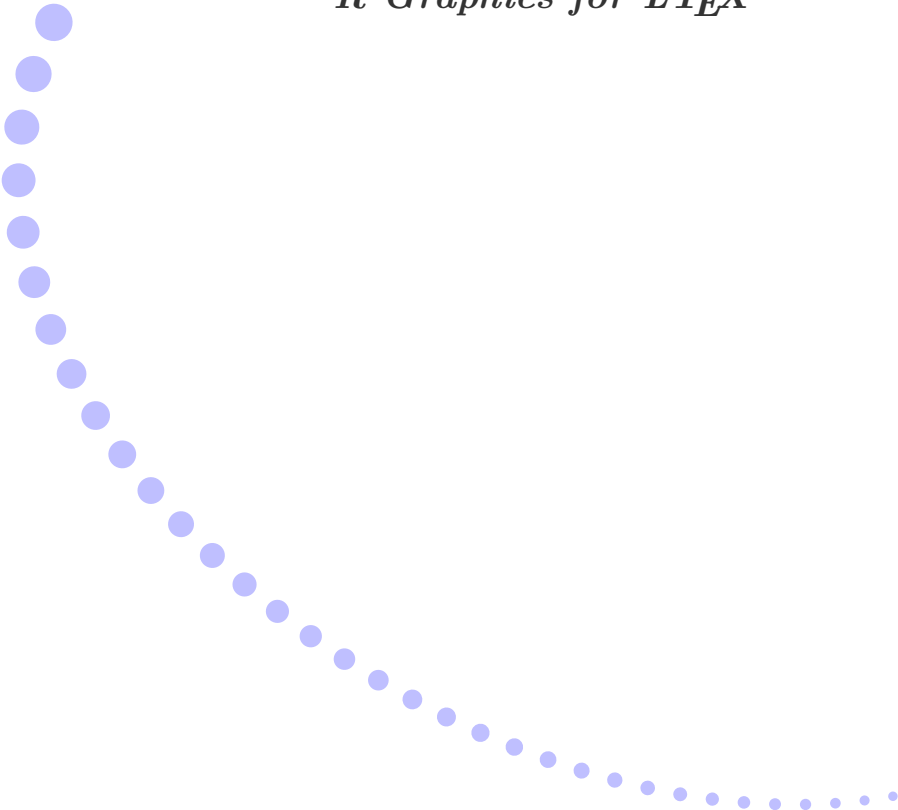


# TikZ Device

*R Graphics for L<sup>A</sup>T<sub>E</sub>X*



# The **tikzDevice** Package

<http://r-forge.r-project.org/projects/tikzdevice>

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## Caveat Utilitor

This is a friendly reminder that the **tikzDevice** package is currently considered by its designers to be a **beta work**. This package has been released in the hopes that it will help users produce exceptional graphics, leading to an increase in the quality of reports and other materials using those graphics.

However, the package has not been tested in an extensive variety of situations beyond those that have been dreamed up by the designers. Therefore, it is very likely that this package will help produce exceptional crashes, leading to an increase in the quantity of swearing by R and users affected by those crashes.

We hope this package will improve with time and attain a level of usability and trustability at which it may be labeled “stable”. Until then the package, including this documentation, may undergo significant changes in form and function. During the beta period the actual implementation of the package may differ significantly from what is described in this documentation.

In fact, the documentation may differ significantly from what is described in the documentation.

Thanks for giving it a try!

*-The tikzDevice Team*

## 1 Introduction

The **tikzDevice** package allows for R graphics output in a native  $\text{\LaTeX}$  format. That is, the output of the `tikz()` function is plain-text files that can be interpreted using *TikZ*, a package for  $\text{\LaTeX}$ . These files can be directly included in  $\text{\LaTeX}$  documents by way of the `\input{}` statement. Allowing  $\text{\LaTeX}$  to handle both typesetting and figure composition bestows the resulting document with a clean, unified look as there are no discontinuities in the size and selection of fonts used in the output.

This document is divided into three parts. The first part describes the functions that the package makes available to the R user and provides examples of their capabilities. Besides the R environment, use of the *TikZ* device device requires the user to have a working  $\text{\LaTeX}$  compiler along with an installed version of the *TikZ* package. The second part of this documentation offers suggestions on how to get these tools working properly.

The third part of the documentation is intended for those who are curious as to the details of how this package has been implemented. It attempts to explain how the *TikZ* package does the things that it does and why it chooses to do them that way. The authors have attempted to write this part of the documentation in a way that is accessible to users as well as developers. This has been done in the hope that this project may serve as a case study in creating an R graphics device. This part of the documentation may also help those considering undertaking the transition from casual package-building to full-on hacking of the R internals.

## Part I

# Usage and Examples

## 2 Loading the Package

The functions in the **tikzDevice** package are made accessible in the R environment by using either the `library()` or `require()` functions like so:

```
require(tikzDevice)
```

Upon loading, the package will search for a usable  $\text{\LaTeX}$  compiler. Access to  $\text{\LaTeX}$  is essential for the device to produce correct output as the compiler is queried for font metrics several times during device output. For more information on why communication between the device and  $\text{\LaTeX}$  is necessary, see [Part III](#). If the search for a compiler is successful the package startup message should look similar to the following:

```
filehash: Simple key-value database (2.0-1 2008-12-19)
tikzDevice: A Device for R Graphics Output in PGF/TikZ Format (v0.3.5)
Checking for a LaTeX compiler...

pdfTeX 3.1415926-1.40.9-2.2 (Web2C 7.5.7)
kpathsea version 3.5.7
...

A working LaTeX compiler was found in:
    The R environment variable R_LATEXCMD

Global option tikzLatex set to:
    /usr/texbin/latex
```

If a working  $\text{\LaTeX}$  compiler cannot be found, the **tikzDevice** package will fail to load and a warning message will be displayed:

```
An appropriate LaTeX compiler could not be found.
Access to LaTeX is currently required in order for the
TikZ device to produce output.

The following places were tested for a valid LaTeX compiler:

    A pre-existing value of the global option tikzLatex
    The R environment variable R_LATEXCMD
    The R environment variable R_PDFLATEXCMD
    The global option latexcmd
    The PATH using the command latex
    The PATH using the command pdflatex
...

Error : .onLoad failed in 'loadNamespace' for 'tikzDevice'
Error: package/namespace load failed for 'tikzDevice'
```

In this case, **tikzDevice** has done its very best to locate a working compiler and came up empty. For information on how to deal with this situation, consult [Part II](#) of this documentation.

## 3 The tikz() Function

### 3.1 Description

The **tikz()** function provides most of the functionality of the **tikzDevice** package. This function is responsible for creating new R graphics devices that translate the output of graphics functions to the *TikZ* format. The device supports many levels of output that range from stand-alone  $\text{\LaTeX}$  documents that may

be compiled directly to code chunks that must be incorporated into existing L<sup>A</sup>T<sub>E</sub>X documents using the `\include{}` function.

## 3.2 Usage

The `tikz()` function opens a new graphics device and may be called with the following arguments:

```
tikz(file = "Rplots.tex", width = 7, height = 7,  
      bg="white", fg="black", standAlone = FALSE, bareBones = FALSE )
```

**file** A character string indicating the desired path to the output file. It is recommended, but not required, that the filename end in `.tex`.

**width** The width of the output figure, in **inches**.

**height** The height of the output figure, in **inches**.

**bg** The starting background color for the plot.

**fg** The starting foreground color for the plot.

**standAlone** A logical value indicating whether the resulting file should be suitable for direct processing by L<sup>A</sup>T<sub>E</sub>X.

**bareBones** A logical value indicating whether the resulting TikZcode produced without being placed within a L<sup>A</sup>T<sub>E</sub>X `tikzpicture` environment.

The first five options should be familiar to anyone who has used the default graphics devices shipped with R. The options `file`, `width`, `height`, `bg` and `fg` represent the standard graphics parameters currently implemented by `tikzDevice`. The last two options, `standAlone` and `bareBones`, are specific to the `tikz()` graphics device and affect the structure the output file. Using these options `tikz()` supports three modes of output:

- Graphics production as complete L<sup>A</sup>T<sub>E</sub>X files suitable for compilation.
- Graphics production as complete figures suitable for inclusion in L<sup>A</sup>T<sub>E</sub>X files.
- Graphics production as raw figure code suitable for inclusion in an enclosing `tikzpicture` environment in a L<sup>A</sup>T<sub>E</sub>X file.

The next section provides examples of how to use each type of output.

## 3.3 Examples

### 3.3.1 Default Mode

The most common use of the `tikz()` function is to produce a plot that will be included in another L<sup>A</sup>T<sub>E</sub>X document, such as a report. Running the following example in langR will produce a very simple graphic using the `plot()` function.

```
require(tikzDevice)  
tikz('simpleEx.tex',width=3.5,height=3.5)  
plot(1,main='Hello World!')  
dev.off()
```

You may notice that when using `tikz()`, R appears to “lag” or “hang” when you execute commands such as `plot()`. This is because the `tikz` graphics device must query the L<sup>A</sup>T<sub>E</sub>X compiler for string widths and font metrics. For a normal plot, this may happen dozens or hundreds of times- hence R becomes unresponsive

for a while. The good news is that the `tikz()` code is designed to cache the results of these computations so they need only be performed once for each string or character. By default, these values are stored in a temporary cache file which is deleted when R is shut down. [section 4](#) explains how to assign a permanent cache file that can be preserved between R sessions. For the details of why calling the  $\text{\LaTeX}$  compiler is necessary, see [Part III](#).

A simple  $\text{\LaTeX}$  document is then required to display the output of the basic `tikz()` command. This document must include the `TikZ` as one of the packages that it loads. The `TikZ` package provides several optional libraries that provide additional functionality, however none of these libraries are currently required to use the output of `tikz()`. Inside the  $\text{\LaTeX}$  document, the contents of the file `simpleEx.tex` are imported using the `\include{}` command.

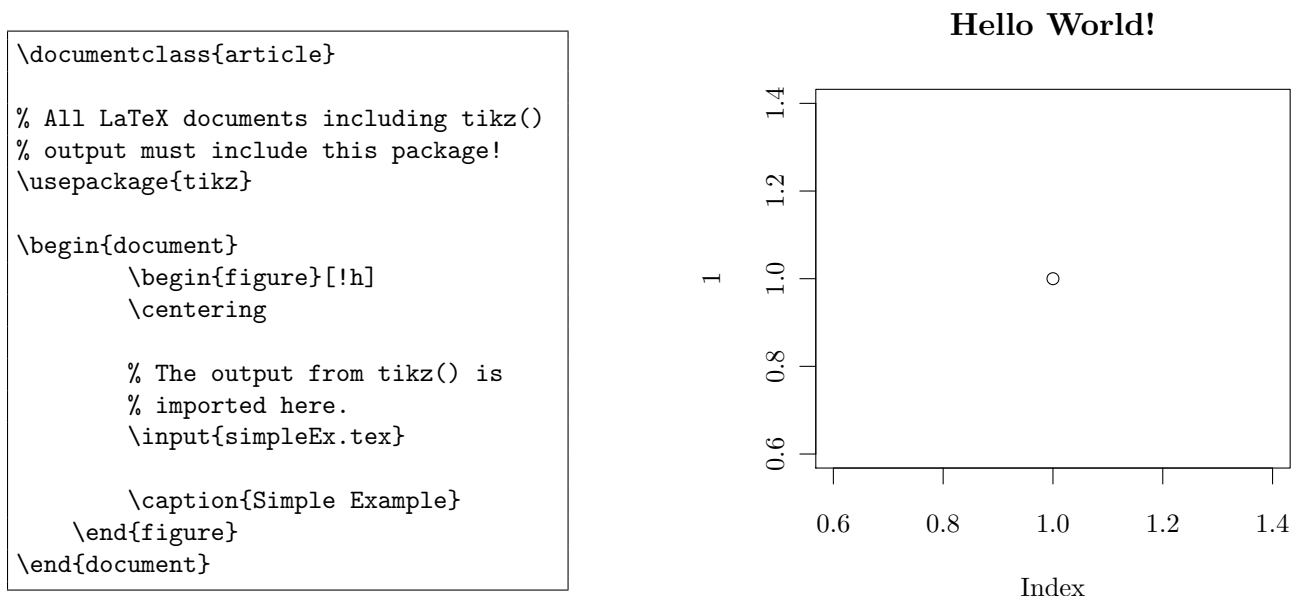


Figure 1: Example of simple `tikz()` usage.

One of the most exciting aspects of the `tikz()` function is that it allows the inclusion of arbitrary  $\text{\LaTeX}$  code in plotting commands. An important issue to note is that many  $\text{\LaTeX}$  commands are prefixed by the backslash, `\`, character. This character has a special meaning as an escape character in many computing applications, including R. Therefore, it is necessary to place two backslashes, `\\`, in the input to R commands in order to cause one to appear in the output. The next example demonstrates how to use  $\text{\LaTeX}$  commands in plot annotation.

```

require(tikzDevice)
tikz('latexEx.tex',width=3.5,height=3.5)

x <- rnorm(5)
y <- x + rnorm(5,sd=0.25)

model <- lm(y~x)
rsq <- summary( model )$r.squared
rsq <- signif(rsq,4)

plot(x,y,main='Hello \\LaTeX!')
abline(model,col='red')

mtext( paste("Linear model:  $R^2$ =",
            rsq,"$" ),line=0.5)

dev.off()

```

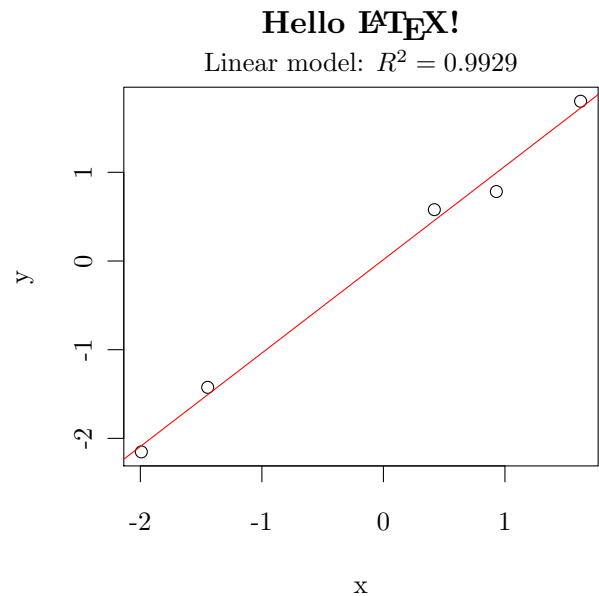


Figure 2: A more complicated example of `tikz()` usage incorporating natively rendered  $\text{\LaTeX}$  commands.

### 3.3.2 bareBones Mode

The `barBones` is designed to facilitate inclusion of `tikz()` output as part of a larger graphic. Normally `tikz()` packages the commands it produces as a self-contained figure. This is done by placing the `\begin{tikzpicture}` and `\end{tikzpicture}` commands at the beginning and end of the output file. When `bareBones` is invoked, the `tikzpicture` environment is omitted which allows the output to be embedded inside a `tikzpicture` of the users own construction.

```

require(tikzDevice)
tikz('bareBonesExample.tex',width=4,height=4,bareBones=T)

x <- c(0,cumsum(rnorm(25)))
y <- c(0,cumsum(rnorm(25)))

plot(x, y, type="l" )

title("A Brownian Motion")

dev.off()

```

The resulting code may then be used inside a `tikzpicture` environment using the `\include{}` command. The included code must be wrapped in a `scope` environment that contains the options `x=1pt` and `y=1pt`. This informs TikZ of the units being used in the coordinates of the plot output. The options `xshift` and `yshift` may also be applied to the `scope` in order to position the plot. The following code demonstrates how to embed `bareBones` output in a `tikzpicture`

```

\begin{tikzpicture}

    \draw[clip] (-0.25,-0.25) rectangle (4.25in,4.25in);

```



```

\begin{scope}[x=1pt,y=1pt,yshift=0.25in]
    \input{figs/bareBonesExample}
\end{scope}

\node[anchor=south west,draw,rounded corners] (start) at (0,0)
    {TikZ can draw Brownian Motions as Well!};

\coordinate (current point) at (start.east);
\coordinate (old velocity) at (0,-5);
\coordinate (new velocity) at (rand,rand);

\foreach \i in {25,26,...,50} {

    \draw[blue!\i,ultra thick,line cap=round,x=1cm,y=1cm]
        (current point) .. controls ++([scale=-1]old velocity)
            and ++(new velocity) ..
            ++(rand, rand) coordinate(current point);

    \coordinate(old velocity) at (new velocity);
    \coordinate(new velocity) at (rand,rand);
}

\end{tikzpicture}

```

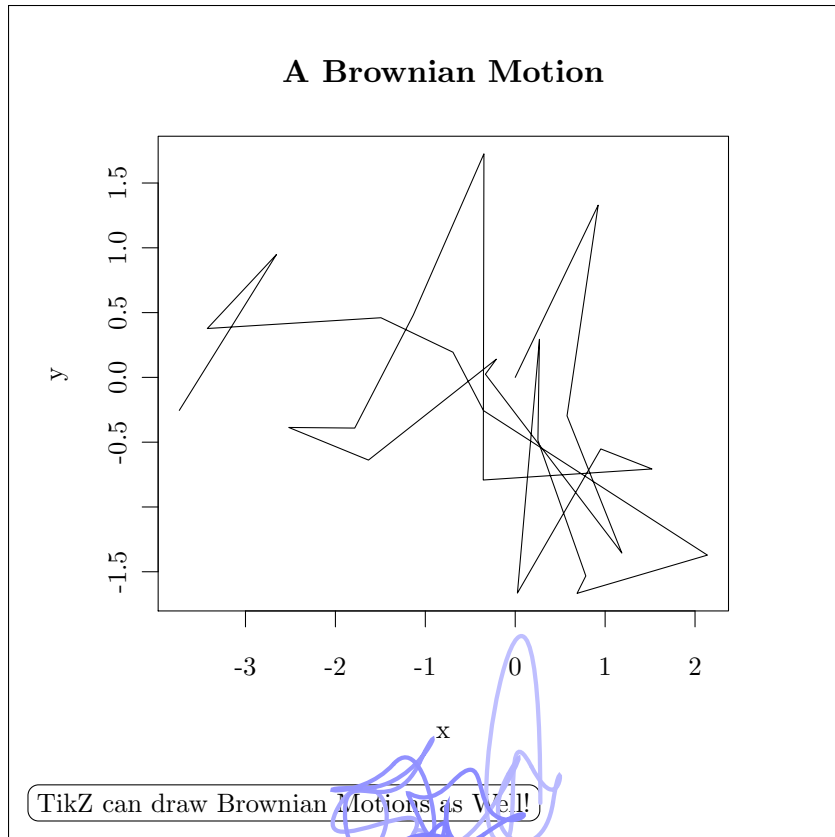


Figure 3: A TikZ drawing with embedded output from `tikz(bareBones=T)`.

### 3.3.3 standAlone Mode

When the `standAlone` option is passed to `tikz()`, the resulting `.tex` file will be a complete  $\text{\LaTeX}$  document designed to be compiled on its own. This means that in addition to `\begin{tikzpicture}` and `\end{tikzpicture}` the file will also contain `\begin{document}`, `\end{document}` and a  $\text{\LaTeX}$  preamble. The `preview` package is also used in files produced by `standAlone` and is used to crop the pages in the resulting document to the bounding boxes of the figures that it contains. Stand-alone output may be produced in the following manner:

```
require(tikzDevice)
tikz('standAloneExample.tex',standAlone=T)
plot(sin,-pi,2*pi,main="A Stand Alone TikZ Plot")
dev.off()
```

The file `standAloneExample.tex` may then be compiled to produce [standAloneExample.pdf](#). Note that files produced using the `standAlone` option cannot be included in  $\text{\LaTeX}$  documents using `\input{}`! Use `\includegraphics{}` or load the `pdfpages` package and use `\includepdf{}`.

## 4 R Options that Affect tikzDevice

## 5 The `getLatexCharMetrics()` and `getLatexStrWidth()` Functions

### 5.1 Description

### 5.2 Usage

### 5.3 Examples

## Part II

# Installation Guide

6 Installing  $\text{\LaTeX}$

7 Installing *TikZ*

8 Installing `tikzDevice`

## Part III

# Package Internals

## 9 Background

About TikZ, the PicTeX device and the story of two fortran programmers with a dream.

## 10 System Requirements

## 11 Character Metrics and String Width

### 11.1 Dictionaries

### 11.2 What the Heck are Acent, Decent and Width

## 12 On the Importance of Font and Style Consistency in Reports

## 13 The pgfSweave Package and Automatic Report Generation