

tikzscale — Absolute resizing of TikZ pictures and PGF plots without scaling text*

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1 Introduction

When dealing with graphics, there are different scaling demands. For *absolute* scaling, a width and/or height is given. Opposed to that, for *relative* scaling, a horizontal and/or vertical scaling factor is needed. This package only is about absolute scaling of tikzpicture environments. The different absolute scaling demands and their solutions are shown in table 1.

The tikzscale package adds and improves certain forms of absolute scaling for TikZ and PGFPlots, respectively. These scaling methods are the ones which are most useful, maybe even the only ones which are needed. During the scaling, the text sizes and line widths are left unscaled, which avoids inconsistency and visual distraction. PGFPlots itself can scale absolutely, but an approximation is used to achieve that. The tikzscale package uses optimization algorithms and warns if the scaling is not exact.

Using tikzscale all relevant scaling methods share the same user interface with the well known `\includegraphics` command, enabling some of its features like automatic file extension detection for TikZ and PGFPlots, too. Furthermore, the `\includegraphics` command is improved to look-up relative paths in the correct subdirectory, if a \LaTeX project is organized in subdirectories.

Relative scaling methods are mostly useless, as the sizes of the used images are often arbitrary, either determined by some resolution for rastered images or some arbitrary unit vector size for vector images, TikZ and PGFPlots. For traditional images and TikZ pictures, only proportional scaling methods giving either a width or a height make sense, as otherwise they get heavily distorted if the original aspect ratio is changed. As PGFPlots can handle different aspect ratios and aspect ratios are normally not predefined for plots, its requirement is the opposite: Both width and height are needed to avoid getting arbitrary sizes. For some special plots, the axis ratio can be given, as well. These requirements lead to the marked blue colors in table 1.

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Table 1: Absolute graphic scaling methods. If multiple methods are available, the most native one is shown. Methods which **approximate** the scaling are shown in orange text color. **Recommended** methods are shown in blue textcolor.

(a) Scaling with scaled text and line widths.

scale	Images	TikZ/PGFPlots
to width	<code>\includegraphics</code>	<code>\resizebox</code>
proportionally	<code>[width=<i>unit</i>]</code>	<code>{<i>width</i>}{!}</code>
to width	<code>\resizebox</code>	<code>\resizebox</code>
keeping height	<code>{<i>width</i>}{\height}</code>	<code>{<i>width</i>}{\height}</code>
to height	<code>\includegraphics</code>	<code>\resizebox</code>
proportionally	<code>[height=<i>unit</i>]</code>	<code>{!}{<i>height</i>}</code>
to height	<code>\resizebox</code>	<code>\resizebox</code>
keeping width	<code>{\width}{<i>height</i>}</code>	<code>{\width}{<i>height</i>}</code>
to width	<code>\includegraphics</code>	<code>\resizebox</code>
and height	<code>[width=<i>unit</i>,height=<i>unit</i>]</code>	<code>{<i>width</i>}{<i>height</i>}</code>

(b) Scaling with unscaled text and line widths without tikzscale.

scale	Images	TikZ	PGFPlots
to width	—	—	<code>[width=<i>unit</i>]</code>
proportionally	—	—	—
to width	—	—	—
keeping height	—	—	—
to height	—	—	<code>[height=<i>unit</i>]</code>
proportionally	—	—	—
to height	—	—	—
keeping width	—	—	—
to width	—	—	<code>[width=<i>unit</i>,height=<i>unit</i>]</code>
and height	—	—	—

(c) Scaling with unscaled text and line widths with tikzscale.

scale	Images	TikZ	PGFPlots
to width	—	<code>\includegraphics</code>	<code>\includegraphics</code>
proportionally	—	<code>[width=<i>unit</i>]</code>	<code>[width=<i>unit</i>]</code>
to width	—	—	—
keeping height	—	—	—
to height	—	<code>\includegraphics</code>	<code>\includegraphics</code>
proportionally	—	<code>[height=<i>unit</i>]</code>	<code>[height=<i>unit</i>]</code>
to height	—	—	—
keeping width	—	—	—
to width	—	—	<code>\includegraphics</code>
and height	—	—	<code>[width=<i>unit</i>,height=<i>unit</i>]</code>

2 Usage and Examples

Loading the `tikzscale` package without loading other packages, does not do anything useful.

2.1 TikZ

If the `tikzscale` and the `tikz` packages are loaded, the `\includegraphics` command can be used to input and scale a `tikzpicture` environment located in a separate file.

As an example create the following `.tex`-file.

```
\documentclass{minimal}
\usepackage{tikz}
\usepackage{tikzscale}
\begin{document}
  \includegraphics[width=0.5\linewidth]{linewidth.tikz}
\end{document}
```

Furthermore create the following `.tikz`-file and save it as `linewidth.tikz` in the same directory as the above `.tex`-file.

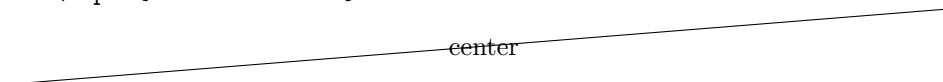
```
\begin{tikzpicture}
  \draw (0,0) - node {center} (\linewidth,1);
\end{tikzpicture}
```

The result of the compiled `.tex`-file should look like this.



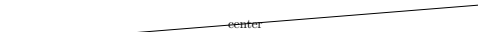
So although the original `tikzpicture` itself has the width of a complete line, it gets proportionally scaled down to half the width while being loaded from the `\includegraphics` command. Neither the line's thickness nor the text `center` are scaled. Compare the output to

```
\input{linewidth.tikz}
```



and

```
\resizebox{0.5\linewidth}{!}{\input{linewidth.tikz}}
```



to see `tikzscale`'s benefit.

2.2 PGFPlots

2.2.1 Scaling of width and height

If the `pgfplots` package is loaded together with the `tikzscale` package, the user interface is the same. Instead of giving either a width or a height, both have to be given for `pgfplots`. Otherwise a default axis ratio is assumed (see section 2.2.2).

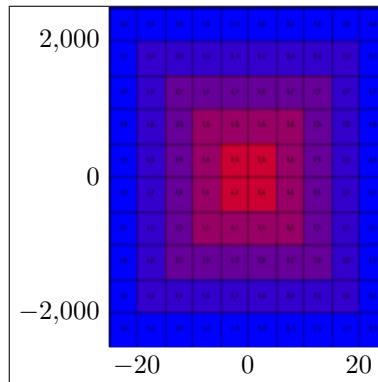


Figure 1: Using options `width=0.4\linewidth` and `height=0.4\linewidth` results in an overall quadratic graphic with overall width and height set to 40% of the linewidth.

So,

```
\input{pgfplots-test.tikz}
\begin{tikzpicture}\begin{axis}[width=3cm,height=2cm] ...
```

becomes

```
\includegraphics[width=3cm,height=2cm]{pgfplots-test.tikz}
\begin{tikzpicture}\begin{axis} ....
```

The benefit is a more accurate scaling algorithm, as the scaling with PGFPlots can be quite coarse. Another win is the unified interface, which simplifies the sharing of plots between projects enormously, as one file and thus one plot can be included in different projects with different sizes.

2.2.2 Scaling using axis ratio

The scaling described in the previous section scales the whole plot including all axis descriptions and legends to the given width and height. It can thus happen, that the plotted figure has a different size ratio than expected, if the x and y descriptions have different sizes as shown in figure 1. Sometimes, the x-axis and the y-axis should have a specific ratio, e.g. being equal, ignoring the axis description and other things. This is normally achieved by using PGFPlots' option `scale only axis`. Unfortunately, if this option would be used, a plot might be unsharable between two projects, if they have different requirements for the axis ratio. Thus, this option should not be used in such a case.

Instead, in `\includegraphics` there is a new option `axisratio` which must be used together with either width or height. It scales the whole plot including the axis description to the given width or height as in figure 2 while keeping the graphical part at a given axis ratio, where the ratio is defined by width divided

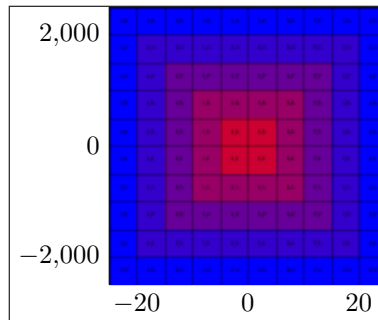


Figure 2: Using options `width=0.4\linewidth` and `axisratio=1` results in an quadratic graphic area with overall width set to 40% of the linewidth. The height follows from these constraints, so that the overall plot is not quadratic in general.

by height. The graphical part is thus not quadratic in general. If `axisratio` is omitted, i.e. only either height or width are given, it is assumed to be 1.

2.3 Hints for TikZ and PGFPlots

The whole `tikzpicture` environment must be in a separate file. This allows sharing of graphics between different \TeX projects and a unified user interface via `\includegraphics`. Having `tikzpicture` environments directly in a `.tex`-file is not supported, i.e. they do not benefit from the `tikzscale` package. Multiple `tikzpicture` environments in one `.tikz`-file are not supported, either. Put things which always belong together in a shared `tikzpicture` environment and things which might be used separately in the future in separate files for code sharing across projects. The file ending may be omitted in the `\includegraphics` command, if it is one of `.tikz`, `.TIKZ`, `.TikZ`, `.pgf` or `.PGF`. At the moment, use only *either* width *or* height for normal (i.e. non-PGFPlots) `tikzpicture` environments and use width *and* height or one of both optionally together with `axisratio` for `tikzpicture` environments containing a PGFPlots' axis environment.

2.4 currfile

If the `tikzpicture` package is loaded together with the `currfile` package, another feature is activated. Suppose you have your project organized in the following directory tree with `directories` shown in blue color:

```
projectDirectory
  main.tex
  firstChapter
    firstChapter.tex
    firstGraphicOfFirstChapter.jpeg
    secondGraphicOfFirstChapter.tikz
  secondChapter
```

```
secondChapter.tex
firstGraphicOfSecondChapter.tikz
secondGraphicOfSecondChapter.jpeg
```

Further suppose the chapter.tex files are `\input`ted in main.tex. Calling `\includegraphics{firstGraphicOfFirstChapter.jpeg}` in firstChapter.tex normally does not work. The reason is that the `\input{firstChapter.tex}` command in main.tex copies the content of firstChapter.tex into main.tex, so when the `\includegraphics` command is called, it is called from within project-Directory, thus the relative path lookup of firstGraphicOfFirstChapter.jpeg fails. Instead the command `\includegraphics{firstChapter/firstGraphicOfFirstChapter.jpeg}` can be used (example for a Unix system), but this is tedious and counter-intuitive.

If both tikzscale and currfile are loaded, the limitation is fixed, so that both `\includegraphics` commands succeed. Note, that this functionality supports the traditional graphic formats, too, and is also available without loading the TikZ or PGFPlots packages, although the package's name might imply otherwise.

3 Compatibility

Using both the externalization library and tikzscale seems to have a race condition when a makefile is used with multiple jobs (`-jX` with $X > 1$). The probability of getting errors increases with the number of jobs. For $X = 1$, obviously, no race condition could be observed. You should either avoid using mode *list and make* or have only one job if you want to be on the safe side.

Note, that there was a **bug** in the externalization library, which has been fixed on 25th of December in 2012, so you might want to use a more recent version of TikZ of PGFPlots.

3.1 Load Order

There is no constraint regarding the load order known, yet. TikZ, PGFPlots and currfile might all be loaded or not in all possible combinations and orders before or after tikzscale.

3.2 Externalization library

TikZ' externalization library is supported. Its use is highly recommended, as tikzscale renders some graphics multiple times to get the correct size. The savings by using the externalization library can thus be huge.

4 Further Ideas

- It might be a good idea to use the file names as figure names, but probably only if the name was not already set by the user. Additionally, there must be taken care to not try to write into a directory where there is no write access (e.g. reading a graphic from a system wide TeX installation)
- if graphic files are located in a subdirectory, the externalized files should also be in that subdirectory.
- allow in-file graphics by redefining the tikzpicture environment and accepting tikzscale and tikz options. The tikzscale options are evaluated using key filtering (tikz library) and the tikz options are forwarded.
- the package can test if a pgfplot is used (needed if normal TikZ graphics should be stretchable) by changing `\tikzscale@width` and or `\tikzscale@height` and measuring. If nothing changes, it must be a normal tikzpicture (the argument does not hold the other way round).
- it may be better to use the **depth as well**
- The final sizing parameters should be saved per figure in the aux file. The first rendering each run should be performed with the aux file's parameters into an sbox. The scaling algorithms should only be called, if the sizing requirements are not met. The purpose is similar to the externalization library.
- Using something like `[x=5pt]` as an argument to the axis environment, e.g. to scale the units in bar plots, is problematic, as tikzscale changes the behaviour, i.e. stops the scaling.

5 Contributions

- Jake
 - Encouraged the author to create this package.
- Dr. Christian Feuersänger
 - Encouraged the author to create this package and created PGFPlots.
 - Answered many questions and had a lot of good ideas regarding the externalization and beyond.
 - Fixed problems in the externalization library when used with tikzscale.
- David Carlisle
 - Created the `\xcmd` macro for this package, which is used in the documentation.

- Prof. Kai Arzheimer
 - Reported a bug when not using TikZ without PGFPlots, which lead to a fix.
 - Reported a bug that a non-existent macro is used, which lead to a fix.
- devendra
 - Reported bugs when using the externalization library together with tikzscale, which lead to a fix.

6 Implementation

The basic idea is to first get the correct file name (i.e. find the path and the file extension), then determine the graphic type (i.e. TikZ or something else) and call either the original includegraphics command or the tikzscale command. Tikzpictures are then plotted into an invisible box and their size is measured. If their measured size differs from the requested size, they are replotted with corrected parameters to get the requested size. The correctly sized plots are then really plotted.

`\tikzexternal`

1 `\AtEndPreamble{%`

Activate the output of the graphics sizes into the dpth files (one file per graphic). This key is used if the externalization library is activated to check if the scaling is correct, otherwise the code is not needed.

2 `\ifExternalizationLoaded{%`
 3 `\pgfkeys{/pgf/images/external info}%`
 4 `}{}%`

Provide dummy commands, if the externalization library has not been loaded during the preamble.

5 `\ProvideDocumentCommand{\tikzsetnextfilename}{m}{}%`
 6 `\ProvideDocumentCommand{\tikzsetexternalprefix}{m}{}%`
 7 `\ProvideDocumentCommand{\tikzexternaldisable}{}{}%`
 8 `\ProvideDocumentCommand{\tikzexternalenable}{}{}%`

The check `\tikzifexternalizehasbeencalled` from file `tikzexternalshared.code.tex` is not exactly what is needed in `tikzscale`, as it always stays true after it has been set by `\tikzexternalize`. Instead, add a check whether externalization is active and set it to false if externalization has not been loaded for simplification. Thus, whether externalization is active can be checked without checking if it has been loaded at all. The initial state of `\tikzscale@externalizationActive` is not trivially known, as an arbitrary combination and order of `\tikzexternaldisable` and `\tikzexternalenable` commands could have been used before the end of the preamble. In the long run, `tikzexternalshared.code.tex` should offer that check.

Until then, we can check whether `\tikz=\tikzexternal@origtikz` (i.e. externalization disabled) or `\tikz=\tikzexternal@tikz@replacement` (i.e. externalization enabled) holds (if neither of both holds, this indicates a problem, e.g. another package redefining the command). This is, of course, only needed if the externalization library has been loaded at all. Please note, the implementation of this check as a macro is possible, because `tikzscale` redefines `tikzpicture`, whereas the externalization library redefines `tikz`, so there is no conflict.

```

9 \def\tikzscale@ifExternalizationActive#1#2{%
10 \ifExternalizationLoaded{%
11 \ifdefequal{\tikz}{\tikzexternal@tikz@replacement}{%
12 #1%
13 }{%
14 \ifdefequal{\tikz}{\tikzexternal@origtikz}{%
15 }{%
16 \PackageWarning{tikzscale}{Status of externalization is unknown, thus I assume it is deactivated}
17 }%

```

It's important, that this code is below the above code, as the below code can change the meaning of `\tikz` through side effects.

```

18 #2%
19 }%
20 }{%
21 #2%
22 }%
23 }%

```

`\tikzscale@scale`

```

24 \@ifpackageloaded{tikz}{%

```

Set a minimum accuracy `tikzscale` tries to achieve. TeX's accuracy is limited, thus, e.g. 0.04 pt, cannot always be achieved independent of the number of iterations. Use the **value** (0.1 pt in an experiment) which is used for overfull paragraph warnings, too.

```

25 \newlength{\tikzscale@accuracy}%
26 \setlength{\tikzscale@accuracy}{\hfuzz}%

```

This is needed in normal TikZ pictures and in PGFPlots, but as the `pgfplots` package loads the `tikz` package, it is fine to define it here.

```

27 \def\maxTestIterations{10}%
28 }{}%
29 }

```

This command draws the plot's border at the right text border, so that thick points or label descriptions can reach into the margin. This should be limited to PGFPlots only if activated.

With the option below, the labels can be moved a bit to the left so that they reach to the text margin. `yticklabel style=align=right,inner sep=0pt,xshift=-0.1cm`

<code>\pgfmathsetglobalmacro</code>	<p>This is a general command, which might be useful for inclusion into the tikz package. It works similar to <code>\pgfmathsetglobalmacro</code> but has global scope.</p> <pre> 30 \def\pgfmathsetglobalmacro#1#2{% 31 \pgfmathparse{#2}% 32 \global\let#1\pgfmathresult% 33 }</pre>
<code>\ifTikzLibraryLoaded</code>	<p>This is a general command, which might be useful for inclusion into the tikz package. This is taken from stackexchange and simplified.</p> <pre> 34 \def\ifTikzLibraryLoaded#1#2#3{% 35 \ifcsdef{tikz@library@#1@loaded}{% 36 #2% 37 }{% 38 #3% 39 }% 40 }</pre>
<code>\ifExternalizationLoaded</code>	<pre> 41 \def\ifExternalizationLoaded#1#2{% 42 \ifTikzLibraryLoaded{external}{#1}{#2}% 43 }</pre>
<code>\edocsvlist</code>	<p>This is a general command, which might be useful for inclusion into the etoolbox package. It works similar to <code>\docsvlist</code> but expands its argument similar to <code>\def</code> vs. <code>\edef</code>, which is useful if the list is stored in a macro/variable.</p> <pre> 44 \def\edocsvlist#1{% 45 \edef\tikzscale@edocsvlist{#1}% 46 \expandafter\docsvlist\expandafter{\tikzscale@edocsvlist}% 47 }</pre>
<code>\eforcsvlist</code>	<p>These is a general command, which might be useful for inclusion into the etoolbox package. It works similar to <code>\forcsvlist</code> but expands its argument similar to <code>\def</code> vs. <code>\edef</code>, which is useful if the list is stored in a macro/variable.</p> <pre> 48 \def\eforcsvlist#1#2{% 49 \edef\tikzscale@eforcsvlist{#2}% 50 \expandafter\forcsvlist\expandafter{\expandafter#1\expandafter}\expandafter{\tikzscale@eforcsvlist}% 51 }</pre>
<code>\elseif</code>	<p>This macro provides a conditional which supports an if with an arbitrary amount of elseif (none is also ok) and an optional else. With a simplified syntax (remove the tests and the grouping) this would be worth a separate package.</p> <pre> 52 \NewDocumentCommand{\elseif}{mm}{% 53 \ifboolexpr{#1}{% 54 #2% 55 \elseif@absorb 56 }{% 57 \elseif@optional 58 }% </pre>

```

59 }
60 \NewDocumentCommand{\elseif@optional}{gg}{%
61 \IfValueTF{#1}{%
62 \IfValueTF{#2}{%
63 \ifboolexpr{#1}{%
64 #2%
65 \elseif@absorb
66 }{%
67 \elseif@optional
68 }%
69 }{%
70 #1%
71 }%
72 }-{}%
73 }
74 \NewDocumentCommand{\elseif@absorb}{g}{%
75 \IfValueTF{#1}{%
76 \elseif@absorb
77 }-{}%
78 }

```

T his command is from [Bruno Le Floch](#).

```

79 \ExplSyntaxOn
80 \NewDocumentCommand{\IfNoValueOrSplitEmptyTF}{mmm}{
81 \ifboolexpr{test {\IfNoValueTF{#1}} or test {\tl_if_eq:nnTF{#1}{}}}{}{
82 #2
83 }{
84 #3
85 }
86 }
87 \ExplSyntaxOff

```

\activatetikzscale

```
88 \AtEndPreamble{%
```

Add the TikZ file extensions to the [graphicx file extensions](#).

```

89 \def\tikzscale@tikzFileExtensions{.tikz,.TIKZ,.TikZ,.pgf,.PGF}%
90 % \def\tikzscale@tikzFileExtensions{.tikz,.TIKZ,.TikZ,.pgf,.PGF,.tex,.TEX}%
91 \DeclareGraphicsExtensions{\tikzscale@tikzFileExtensions,\Gin@extensions}%

```

The \rappicspath command is used to set additional directories, which are searched for graphics. \Ginput@path is used to get the [current content](#).

```

92 \ifdef{\currfiledir}{%
93 % \graphicspath{{\currfiledir}}\Ginput@path}%
94 \def\tikzscale@graphicspath{\currfiledir,}%
95 }{%
96 \def\tikzscale@graphicspath{}}%
97 }%

```

Save the \includegraphics [command](#) and replace it by a new more generic command, to have a consistent user interface.

```

98 \LetLtxMacro{\tikzscale@oldincludegraphics}{\includegraphics}%
99 \LetLtxMacro{\includegraphics}{\tikzscale@includegraphics}%

```

Deactivate the new includegraphics command inside of tikzpictures, as a tikzpicture might load a PNG graphic or something and this should not be scaled by tikzscale but by TikZ or PGFPlots. Besides, the current implementation is not reentrant, so its not a good idea to call the macro recursively. The deactivation must be inside of tikzpicture, as a tikzpicture can be loaded without using includegraphics, thus it cannot be done there.

```

100 \NewDocumentCommand{\tikzscale@patchTikzpicture}{-}{%
101 \pretocmd{\tikzpicture}{\LetLtxMacro{\includegraphics}{\tikzscale@oldincludegraphics}}{-}{\PackageError{tikzscale}{\tikzpicture cannot be used here}{}%
102 \apptocmd{\endtikzpicture}{\LetLtxMacro{\includegraphics}{\tikzscale@includegraphics}}{-}{\PackageError{tikzscale}{\endtikzpicture cannot be used here}{}%
103 }%

```

Do the patching here, too, as even if externalization library is used, there is no guarantee, that `\tikzexternaldisable` or `\tikzexternalenable` is called. There is no problem in patching twice, as we are in `\AtEndPreamble`, thus externalization has already been loaded (only most probably, as always with LaTeX-dependencies).

```

104 \tikzscale@patchTikzpicture

```

If the externalization library has been loaded, prepare it for use together with tikzscale.

```

105 \ifExternalizationLoaded{%
106 %

```

`\tikzexternaldisable` and `\tikzexternalenable` normally unintentionally deactivate the tikzscale commands (as they restore the original TikZ commands), so let them restore the tikzscale commands instead.

```

107 \apptocmd{\tikzexternaldisable}{%
108 \LetLtxMacro{\includegraphics}{\tikzscale@includegraphics}%
109 \tikzscale@patchTikzpicture
110 }{-}{\PackageError{tikzscale}{Patching tikzexternaldisable failed}}%
111 %
112 \apptocmd{\tikzexternalenable}{%
113 \LetLtxMacro{\includegraphics}{\tikzscale@includegraphics}%
114 \tikzscale@patchTikzpicture
115 }{-}{\PackageError{tikzscale}{Patching tikzexternalenable failed}}%

```

Patch the externalization command to also save the axis ratio if given. Unfortunately, `\apptocmd` cannot be used, as patching fails due to "nested patching command and parameters in patch", thus, manual patching is in order.

```

116 \LetLtxMacro{\tikzscale@externalend@storeshifts}{\pgf@externalend@storeshifts}%
117 \def\pgf@externalend@storeshifts#1{%
118 \tikzscale@externalend@storeshifts{#1}%
119 \ifpgfexternal@info

```

The axis ratio can only be saved, if it has been specified. Thus, the existence of the variable in the dpth file indicates if the axis ratio has been given in the last run.

```

120 \ifdef{\requestedAxisRatio}{%

```

Write the axis ratio into the dpth file into variable `\tikzscale@oldAxisRatio` as in the macro `\pgf@externalend@storeshifts` from file `pgfcoreexternal.code.tex`.

```

121 \immediate\write#1{\noexpand\pgfexternal@restore{\noexpand\def\noexpand\tikzscale@oldAxisRatio
122 }{}}%
123 \fi
124 }%
125 }{}}%
126 }

```

`\includegraphics`

```

127 \NewDocumentCommand{\tikzscale@includegraphics}{0}{m}{%

```

This command uses an empty optional argument for compatibility with the traditional `graphicx` command. Start a group, so that changed variables during processing the current `tikzpicture` due not influence other `tikzpictures`. This is much more convenient, than resetting every single variable. Use `\begingroup` instead of `\bgroup` to simplify finding unmatched braces.

```

128 \begingroup

```

It happened at least once together with externalization, that the deactivation of the new `includegraphics` command did not work, so do it again to be safe (maybe reentrance problem with multiple `tikzpicture` calls?).

```

129 \LetLtxMacro{\includegraphics}{\tikzscale@oldincludegraphics}%

```

There is a leading space character introduced by the externalization library, if the file is input directly. Thus use a trick to avoid that space. Furthermore, TikZ introduces with a specific version an trailing space character. To get rid of all space character issues, just solve the problem here once an for all.

```

130 \edef\tikzscale@restoreEndLineChar{\endlinechar=\the\endlinechar\relax}%
131 \endlinechar=-1%

```

Find the exact file name, as the ending and the path could be omitted.

```

132 \tikzscale@findExactFileName{tikzscale@fileName}{#2}%

```

Check if the found file is a TikZ file.

```

133 \tikzscale@isTikzFile{tikzscale@testTikzFile}{\tikzscale@fileName}%
134 \ifcsdef{tikzscale@testTikzFile}{%
135 \tikzscale@includetikz[#1]{\tikzscale@fileName}%
136 }{%
137 \tikzscale@oldincludegraphics[#1]{\tikzscale@fileName}%
138 }%
139 \tikzscale@restoreEndLineChar
140 \endgroup
141 }%

```

`\tikzscale@findExactFileName`

Find the exact file name of a graphic file by testing several paths and file endings if there are degrees of freedom. The file name is saved in the command sequence name given by the first argument.

```

142 \NewDocumentCommand{\tikzscale@findExactFileName}{mm}{%

```

Delete the return variable if it already exists to allow checking if a file has been found.

```
143 \csundef{#1}%
```

Create a helper function used inside the file ending evaluation.

```
144 \def\tikzscale@checkDirectory##1{%
145 \def\tikzscale@checkExtension####1{%
146 \IfFileExists{##1#2####1}{%
147 \csdef{#1}{##1#2####1}%
148 \listbreak
149 }{}%
150 }%
```

Test all possible file extensions and do not forget that the extension might already be given. \Gin@extensions returns the **current content** set by \DeclareGraphicsExtensions.

```
151 \forcsvlist{\tikzscale@checkExtension}{\Gin@extensions}%
152 }%
153 \forcsvlist{\tikzscale@checkDirectory}{\tikzscale@graphicspath}%
```

If no file has been found, return the given file name, as includegraphics should try its best.

```
154 \ifcsundef{#1}{%
155 \csdef{#1}{#2}%
156 }{}%
157 }
```

\tikzscale@findExactFileName The first argument is the macro name (without backslash), which gets defined if the file is a tikzfile. The second argument is the file name.

```
158 \NewDocumentCommand{\tikzscale@isTikzFile}{mm}{%
```

Create a helper function used inside the evaluation.

```
159 \def\do##1{%
160 \IfEndWith{#2}{##1}{%
161 \csdef{#1}{}%
162 \listbreak
163 }{}%
164 }%
```

Delete macro so that defining it is really indicating something.

```
165 \csundef{#1}%
166 \docsvlist{\tikzscale@tikzFileExtensions}%
167 }
```

\pgfkeys This is **similarly** done.

```
168 \pgfkeys{
169 /tikzscale/.is family, /tikzscale,
170 width/.code = {\pgfmathsetmacro{\requestedWidth}{#1}},
171 width/.value required,
172 height/.code = {\pgfmathsetmacro{\requestedHeight}{#1}},
173 height/.value required,
174 axisratio/.code = {\pgfmathsetmacro{\requestedAxisRatio}{#1}},
```

```

175 axisratio/.value required
176 }

\tikzscale@includetikz \tikzscale@includetikz{\filename}
\tikzscale@includetikz[width=1cm]{\filename}
\tikzscale@includetikz[height=1cm]{\filename}
\tikzscale@includetikz[height=1cm,width=1cm]{\filename}
\tikzscale@includetikz[width=1cm,height=1cm]{\filename}
This command allows the inclusion of a tikz file like a graphics file. Thus in-
stead of writing \includegraphics[width=\linewidth]fileWithoutEnding write
\tikzscale@includetikz[width=\linewidth]fileWithoutEnding If only one of
width or height are given, scale proportionally to fulfill the requirement. If both
are given, scale non-proportionally to required width and height. Therefore, for
normal tikzpictures only give either width or height, as the aspect ratio is already
determined by the coordinate limits in the tikzpicture, but give width and height
for PGFPlots, as the aspect ratio is unknown for these plots. \NewEnviron could
be used to handle something like verbose in a tikzpicture, but at the moment, this
is unsupported.
177 \NewDocumentCommand{\tikzscale@includetikz}{0{m}}{%
Check the keys here already, as they are needed both to see if already externalized
files fulfill their requirements and to handle unexternalized files.
178 \pgfkeys{/tikzscale, #1}%
Check if the current graphic should be either drawn and scaled or simply included.
As externalization can get activated or deactivated at any time (if the library has
been loaded in the preamble), check in every call what to do.
179 \tikzscale@ifExternalizationActive{%
If externalization library has been loaded and is active, draw and scale the graphic
if it is to be externalized.
180 \tikzifexternalizingnext{%
181 \tikzscale@includetikzUnexternalized[#1]{#2}%
182 }{%
183 \tikzscale@includetikzWithExternalization{#2}%
184 }%
185 }{%
Always draw and scale the graphic if externalization library has not been loaded
or is deactivated.
186 \tikzscale@includetikzUnexternalized[#1]{#2}%
187 }%
188 }

\tikzscale@includetikzUnexternalized

189 \NewDocumentCommand{\tikzscale@includetikzUnexternalized}{0{m}}{%
190 \elseif{test {\ifundef{\requestedWidth}} and test {\ifundef{\requestedHeight}} and test {\ifun
If no option is given, directly load the content, as nothing should get scaled.
191 \input{#2}%
192 }{test {\ifdef{\requestedWidth}} and test {\ifdef{\requestedHeight}}}{%

```

If width and height are given, the content must be a pgfplot, so scale it. The plot currently only had approximately the given size without calling the `resizeTo` macro, due to a (known) bug in PGFPlots.

```
193 \tikzscale@resizePlotTo{#2}%
194 }{\test {\ifdef{\requestedAxisRatio}}}{%
195 \tikzscale@includeAxisRatio{#2}%
196 }{\test {\ifundef{\requestedAxisRatio}}}{%}
```

Use this test as a check if PGFPlots has been loaded.

```
197 \ifdef{\pgfplotsset}{%
```

If only either width or height is given it can be a normal tikzpicture or a plot with `axisratio=1`. Let's guess that it is a plot with default `axisratio`. If the guess is wrong, the called function detects that scaling the plot does not work and automatically calls `\tikzscale@includeNormalTikzpicture`.

```
198 \def\requestedAxisRatio{1}%
199 \tikzscale@includeAxisRatio{#2}%
200 }{%}
```

If PGFPlots has not been loaded, it can only be a TikZPicture.

```
201 \tikzscale@includeNormalTikzpicture{#2}%
202 }%
203 }{%
204 % Everything else results in an error.
205 \tikzscale@invalidKeyError{#2}%
206 }%
207 }
```

`\includetikzWithExternalization`

This macro includes a tikzpicture file using the externalization library. As a precondition, the externalization must be loaded and active.

```
208 \NewDocumentCommand{\tikzscale@includetikzWithExternalization}{m}{%
```

Try to load a dpth file to get the sizes `pgfexternalwidth` and `pgfexternalheight` as well as `tikzscale@oldAxisRatio` of the externalized graphic.

```
209 \tikzexternalgetnextfilename{\tikzscale@externalizationName}%
210 \pgfexternalreaddpth{\tikzscale@externalizationName}%
```

Check if the next figure has to be remade. If no dpth file exist, it need not and must not be remade, as otherwise no md5-file is generated and thus one extra compilation run is necessary.

```
211 \IfFileExists{\tikzscale@externalizationName.dpth}{%
212 \tikzscale@checkRequestedSizeChanges
213 }{%
214 \input{#1}%
215 }
```

`\scale@checkRequestedSizeChanges`

```
216 \NewDocumentCommand{\tikzscale@checkRequestedSizeChanges}{}{%}
```


Check if the sizes are still correct, i.e. agree with the sizes of the externalized PDF graphic. The saved axis ratio from the last run is checked, too, as it might have been changed by the user between the last run and the current run.

```

217 \ifdef{\requestedWidth}{%
218 \ifdef{\pgfexternalwidth}{%
219 \tikzscale@ifSizeDifference{\requestedWidth - \pgfexternalwidth}{%
220 \tikzset{external/remake next}%
221 % \PackageWarning{tikzscale}{Regenerate \tikzscale@externalizationName \MessageBreak because
222 % \tikzscale@warnIfSizeDifference{\requestedWidth}{\pgfexternalwidth}{#2}%
223 }{}%
224 }{%
225 \tikzset{external/remake next}%
226 % \PackageWarning{tikzscale}{Regenerate \tikzscale@externalizationName \MessageBreak because
227 }%
228 }{}%
229 \ifdef{\requestedHeight}{%
230 \ifdef{\pgfexternalheight}{%
231 \tikzscale@ifSizeDifference{\requestedHeight - \pgfexternalheight}{%
232 \tikzset{external/remake next}%
233 % \PackageWarning{tikzscale}{Regenerate \tikzscale@externalizationName \MessageBreak because
234 }{}%
235 }{%
236 \tikzset{external/remake next}%
237 % \PackageWarning{tikzscale}{Regenerate \tikzscale@externalizationName \MessageBreak because
238 }%
239 }{}%
240 \ifdef{\requestedAxisRatio}{%
241 \ifdef{\tikzscale@oldAxisRatio}{%
242 \tikzscale@ifSizeDifference{\requestedAxisRatio - \tikzscale@oldAxisRatio}{%
243 \tikzset{external/remake next}%
244 % \PackageWarning{tikzscale}{Regenerate \tikzscale@externalizationName \MessageBreak because
245 }{}%
246 \undef{\tikzscale@oldAxisRatio}%
247 }{%
248 \tikzset{external/remake next}%
249 % \PackageWarning{tikzscale}{Regenerate \tikzscale@externalizationName \MessageBreak because
250 }%
251 }{}%
252 }

```

`\tikzscale@preparePlot`

```

253 \NewDocumentCommand{\tikzscale@preparePlot}{}{%

```

Set a scaling factor or a width and height for the plot, which will be loaded. The `\tikzset` and `\pgfplotsset` commands have local scope. The internal redefinition of the style is correct, because if one `tikzpicture` includes another one, the scaling factor is reset so that it does not get **squared** in the inner one. Note that if a user-defined style thus is ignored in this special case. The styles are defined here, so that files which are inputted without the `\includegraphics` command are

not affected.

```

254 \pgfplotsset{every axis/.append style={width=\tikzscale@width,height=\tikzscale@height,every a
255 }
256 \NewDocumentCommand{\tikzscale@prepareTikzpicture}{m}{%
257 \tikzset{every picture/.style={scale=\tikzscale@scale,every picture/.style={}}}%
258 }

```

```

\tikzscale@includeNormalTikzpicture \tikzscale@includeNormalTikzpicture{\file name}
259 \NewDocumentCommand{\tikzscale@includeNormalTikzpicture}{m}{%
260 \tikzscale@prepareTikzpicture
261 \elseif{test {\ifdef{\requestedWidth}} and test {\ifundef{\requestedHeight}}}{%
262 \def\requestedSize{\requestedWidth}%
263 \tikzscale@scaleTikzpictureTo{\wd}{\input{#1}}{#1}%
264 }{test {\ifundef{\requestedWidth}} and test {\ifdef{\requestedHeight}}}{%
265 \def\requestedSize{\requestedHeight}%
266 \tikzscale@scaleTikzpictureTo{\ht}{\input{#1}}{#1}%
267 }{%
268 \tikzscale@invalidKeyError{#1}%
269 }%
270 }

```

\tikzscale@invalidKeyError

```

271 \NewDocumentCommand{\tikzscale@invalidKeyError}{m}{%
272 \PackageError{tikzscale}{Invalid key for TikZ graphic}{Change key #1 into a valid key.}%
273 }

```

\tikzscale@includeAxisRatio \tikzscale@includeAxisRatio{\file name}

```

274 \NewDocumentCommand{\tikzscale@includeAxisRatio}{m}{%
Try to set initial sizes close to the requested sizes, to improve the optimization's
speed.
275 \pgfplotsset{every axis/.append style={scale only axis,every axis/.style={}}}%
276 \elseif{test {\ifdef{\requestedWidth}} and test {\ifundef{\requestedHeight}}}{%
277 \let\requestedSize\requestedWidth
278 \def\tikzscale@width{\requestedWidth}%
279 \pgfmathsetmacro{\tikzscale@height}{\requestedWidth / \requestedAxisRatio}%
280 \tikzscale@resizePlotWithAxesRatioTo{\wd}{\tikzscale@width}{\input{#1}}{#1}%
281 }{test {\ifundef{\requestedWidth}} and test {\ifdef{\requestedHeight}}}{%
282 \let\requestedSize\requestedHeight
283 \def\tikzscale@height{\requestedHeight}%
284 \pgfmathsetmacro{\tikzscale@width}{\requestedHeight * \requestedAxisRatio}%
285 \tikzscale@resizePlotWithAxesRatioTo{\ht}{\tikzscale@height}{\input{#1}}{#1}%
286 }{%
287 \tikzscale@invalidKeyError{#1}%
288 }%
289 }

```

\tikzscale@scaleTikzpictureTo \scaleToTo{\wd or \ht}{\to-be-scaled content}{\file name} The first argument determines if a specific width or a specific height should be achieved by scaling.

```
290 \NewDocumentCommand{\tikzscale@scaleTikzpictureTo}{mmm}{%
```

Deactivate the externalization, as the measurements to determine the correct size should not be externalized.

```
291 \tikzscale@conditionalDisableExternalization
```

When scaling a tikzpicture, only the drawings are scaled, but nodes are not scaled. So in general, there are horizontal or vertical areas, where the picture contains only unscaled nodes, and areas where the picture contains scalable drawings. Mathematically all scaled and all unscaled areas can be combined, so that there is one area of fixed size and one variable sized area. Thus scaling only by multiplication of a factor is incorrect in general. To do the correct scaling, the fixed area size must be known. As there are two unknown parameters, i.e. fixed area size and variable area size, the fixed area size can be calculated by measuring the tikzpicture with two different scalings. A special scaling factor is used, to get the size close to the final size minimizing numerical and logical errors.

```
292 \def\tikzscale@scale{1}%
```

```
293 \tikzscale@measureSize{\measuredFirst}{#1}{#2}%
```

```
294 \pgfmathsetmacro{\tikzscale@scale}{\requestedSize/\measuredFirst}%
```

```
295 \tikzscale@measureSize{\measuredSecond}{#1}{#2}%
```

It can happen, that there are no variable areas. Furthermore, the original size could already fit. Avoid numerical problems in both cases by directly drawing the picture. Do not compare the float values directly, as TeX's precision is quite limited.

```
296 \tikzscale@ifSizeDifference{\measuredSecond - \requestedSize}{%
```

If a plot is not scalable (e.g. consisting of a node only), but is not correctly scaled, exit with an error.

```
297 \tikzscale@ifSizeDifference{\measuredFirst - \measuredSecond}{%
```

```
298 }{%
```

```
299 \PackageError{tikzscale}{Requested to scale unscalable graphic}{Do not set width or height for  
300 }%
```

We know, that the variable sized area scales with the scaling factor, thus it holds $\text{\scale} * \text{\variableFirst} = \text{\variableSecond}$, with $\text{\variableFirst} = \text{\measuredFirst} - \text{\fixedSize}$ and $\text{\variableSecond} = \text{\measuredSecond} - \text{\fixedSize}$, which can be solved by substitution and results in

```
301 \pgfmathsetmacro{\fixedSize}{(\tikzscale@scale*\measuredFirst - \measuredSecond) / (\tikzscale@scale - 1)}
```

Now, to get the correct scaling factor, only take the variable areas into account, as it holds $\text{\scaleFinal} = \text{\variableSizeFinal} / \text{\variableSizeOriginal}$ with $\text{\variableSizeFinal} = \text{\requestedSize} - \text{\fixedSize}$ and $\text{\variableSizeOriginal} = \text{\measuredFirst} - \text{\fixedSize}$, which results in

```
302 \pgfmathsetmacro{\tikzscale@scale}{(\requestedSize - \fixedSize) / (\measuredFirst - \fixedSize)}
```

Additionally or alternatively the brute force approach to iteratively improve the solution can be used.

```
303 \foreach \l in {1,...,\maxTestIterations}{%
```

```
304 \tikzscale@measureSize{\measuredIntermediate}{#1}{#2}%
```

Optimize until the absolute difference is small enough, although the (relative) size ratios are used to calculate a new scaling factor.

```

305 \tikzscale@ifSizeDifference{\measuredIntermediate-\requestedSize}{%
First divide before multiply to avoid overflowing (at 16384).
306 \pgfmathsetmacro{\errorRatio}{\measuredIntermediate/\requestedSize}%
307 % \PackageWarning{tikzscale}{errorRatio \errorRatio\MessageBreak for #3}%
308 \pgfmathsetglobalmacro{\tikzscale@scale}{\tikzscale@scale/\errorRatio}%
309 }{%
310 \breakforeach%
311 }%
312 }%

```

Externalize the graphic with the final size.

```

313 \tikzscale@conditionalEnableExternalization{#3}%

```

Finally, include the picture. Do it via a new measurement to be able to warn if it does not fit good enough.

```

314 \tikzscale@measureSize{\measuredFinal}{#1}{#2}%
315 \usebox{\tikzscale@measuredSize}%
316 \tikzscale@warnIfSizeDifference{\measuredFinal}{\requestedSize}{#3}%
317 }{%

```

Externalize the graphic with the final size.

```

318 \tikzscale@conditionalEnableExternalization{#3}%
319 #2%
320 }%
321 }

```

```

\tikzscale@resizePlotTo \tikzscale@resizePlotTo{(file name)}

```

```

322 \NewDocumentCommand{\tikzscale@resizePlotTo}{m}{%
323 \def\fileName{#1}%
324 \def\content{\input{#1}}%
325 \tikzscale@preparePlot
326 \def\tikzscale@width{\requestedWidth}%
327 \def\tikzscale@height{\requestedHeight}%

```

Deactivate the externalization, as the measurements to determine the correct size should not be externalized.

```

328 \tikzscale@conditionalDisableExternalization

```

Improve the solution iteratively until it is good enough.

```

329 \foreach \l in {1,...,\maxTestIterations}{%

```

Using the box allows measuring the width and height with one rendering run.

```

330 \sbox{\tikzscale@measuredSize}{\content}%

```

Determine the remaining error and check if it is larger than a threshold.

```

331 \pgfmathsetmacro{\widthDifference}{\wd\tikzscale@measuredSize - \requestedWidth}%
332 \pgfmathsetmacro{\heightDifference}{\ht\tikzscale@measuredSize - \requestedHeight}%

```

Output error in current iterion for debugging.

```

333 % widthDifference: \widthDifference, heightDifference: \heightDifference\\% Debugging

```

Check if the remaining error is larger than a threshold.

```
334 \ifbool{test {\tikzscale@ifSizeDifference{\widthDifference}} or test {\tikzscale@ifSizeDifference{\heightDifference}}}{%
Correct the dimension by the error. Use a global assignment, as each iteration in
the loop is put into a separate group.
```

```
335 \pgfmathsetglobalmacro{\tikzscale@width}{\tikzscale@width - \widthDifference}%
336 \pgfmathsetglobalmacro{\tikzscale@height}{\tikzscale@height - \heightDifference}%
337 }{%
338 \breakforeach
339 }%
340 }%
```

Externalize the graphic with the final size.

```
341 \tikzscale@conditionalEnableExternalization{\fileName}%
```

Finally, include the picture. Do it via a new measurement to be able to warn if it does not fit good enough.

```
342 \sbox{\tikzscale@measuredSize}{\content}%
343 \usebox{\tikzscale@measuredSize}%
344 \tikzscale@warnIfSizeDifference{\requestedWidth}{\wd\tikzscale@measuredSize}{\fileName's width}%
345 \tikzscale@warnIfSizeDifference{\requestedHeight}{\ht\tikzscale@measuredSize}{\fileName's height}%
346 }
```

`\tikzscale@resizePlotWithAxesRatioTo` `\tikzscale@resizePlotWithAxesRatioTo{<\wd or \ht>}{<\tikzscale@width or \tikzscale@height>}{<to-be-scaled content>}{<file name>}` The first argument determines if a specific width or a specific height should be achieved by resizing.

```
347 \NewDocumentCommand{\tikzscale@resizePlotWithAxesRatioTo}{mmm}{%
348 \def\dimension{#1}%
349 \def\variable{#2}%
350 \def\content{#3}%
351 \def\fileName{#4}%
352 \gdef\tikzscale@oldSizeDifference{0pt}%
353 \tikzscale@preparePlot
```

Deactivate the externalization, as the measurements to determine the correct size should not be externalized.

```
354 \tikzscale@conditionalDisableExternalization
```

Improve the solution iteratively until it is good enough.

```
355 \foreach \l in {1,...,\maxTestIterations}{%
356 \tikzscale@measureSize{\measuredSize}{\dimension}{\content}%
```

Determine the remaining error and check if it is larger than a threshold.

```
357 \pgfmathsetmacro{\sizeDifference}{\measuredSize - \requestedSize}%
```

Output error in current iteration for debugging.

```
358 % sizeDifference: \sizeDifference\\% Debugging
```

Optimize if the absolute difference is too large.

```
359 \tikzscale@ifSizeDifference{\sizeDifference}{%
360 \ifdefstring{\dimension}{\wd}{%
361 \pgfmathsetglobalmacro{\tikzscale@width}{\tikzscale@width - \sizeDifference}%
```

```

362 \pgfmathsetglobalmacro{\tikzscale@height}{\tikzscale@width / \requestedAxisRatio}%
363 }{%
364 \pgfmathsetglobalmacro{\tikzscale@height}{\tikzscale@height - \sizeDifference}%
365 \pgfmathsetglobalmacro{\tikzscale@width}{\tikzscale@height * \requestedAxisRatio}%
366 }%
367 \tikzscale@ifSizeDifference{\sizeDifference-\tikzscale@oldSizeDifference}{%
368 }{%
369 \tikzscale@includeNormalTikzpicture{#4}%
370 \gdef\tikzscale@alreadyIncluded{true}%
371 \breakforeach
372 }%
373 \pgfmathsetglobalmacro{\tikzscale@oldSizeDifference}{\sizeDifference}%
374 }{%
375 \breakforeach
376 }%
377 }%
378 \ifdef\tikzscale@alreadyIncluded{%
379 \global\undef\tikzscale@alreadyIncluded%
380 }{%

```

Externalize the graphic with the final size.

```

381 \tikzscale@conditionalEnableExternalization{\fileName}%

```

Finally, include the picture. Do it via a new measurement to be able to warn if it does not fit good enough.

```

382 \tikzscale@measureSize{\measuredFinal}{\dimension}{\content}%
383 \usebox{\tikzscale@measuredSize}%
384 \tikzscale@warnIfSizeDifference{\measuredFinal}{\requestedSize}{\fileName}%
385 }%
386 }

```

\tikzscale@measuredSize

```

387 \newsavebox{\tikzscale@measuredSize}
\measureSize{<result variable name>}{<\wd or \ht>}{<to-be-measured content>}
388 \def\tikzscale@measureSize#1#2#3{%
389 \sbox{\tikzscale@measuredSize}{#3}%
390 \pgfmathsetmacro{#1}{#2\tikzscale@measuredSize}%
391 }

```

\tikzscale@ifSizeDifference \tikzscale@ifSizeDifference{<size>}{<executed if true>}{<executed if false>}

```

392 \def\tikzscale@ifSizeDifference#1#2#3{%
393 \pgfmathparse{abs(#1)}%
394 \ifdimgreater{\pgfmathresult pt}{\tikzscale@accuracy}{%
395 #2%
396 }{%
397 #3%
398 }%
399 }%

```

```

\tikzscale@measuredSize \tikzscale@warnIfSizeDifference{<firstSize>}{<secondSize>}{<file name>}
400 \def\tikzscale@warnIfSizeDifference#1#2#3{%
401 \tikzscale@ifSizeDifference{#1-#2}{%
402 \PackageWarning{tikzscale}{Scaling of #3 was only\MessageBreak accurate to \pgfmathresult pt}%
403 }{}%
404 }

conditionalDisableExternalization
405 \NewDocumentCommand{\tikzscale@conditionalDisableExternalization}{}{%
406 \tikzexternaldisable
407 }

conditionalEnableExternalization Activate externalization of TikZ graphics iff it had been active before definitely
disabling it for measurement purposes. The argument contains the file name.
408 \NewDocumentCommand{\tikzscale@conditionalEnableExternalization}{m}{%
For the externalization, set correct file name and only externalize the graphic with
the final size. This produces a known bug
409 % \tikzsetnextfilename{#1}%
Get the current directory as a string and use it as an prefix, so that the graphic's
PDF is generated in a subdirectory if the tikz file is located in a subdirectory, too.
This is necessary, as the PDF file is searched for in the subdirectory in this case.
This might be unnecessary due to the newly created path lookup logic.
410 % \expandafter\tikzsetexternalprefix\expandafter{\tikzscale@pwd}%
411 % \expandnext{\tikzsetexternalprefix}{\tikzscale@pwd}%
412 \tikzexternalenable
413 }

```