
The DuckBoat — Beginners’ Pond: Crazy Little Thing Called Glue

Herr Professor Paulinho van Duck

Abstract

In this installment, Prof. van Duck will explain what glue is and will suggest some tips and tricks to avoid bad spacing in your document.

1 Covid is mean!

Hi, \LaTeX friends,

As you well know, 2020 was a painful year. The virus has brought too much sadness worldwide, and the economic consequences of the pandemic are serious.

It is not easy to talk to you in the usual joyful mood, but *The Show Must Go On*, so let us try to find some not-so-negative aspects of the situation.

Firstly, while you (humans) were confined to your houses, we (animals) could visit places before unreachable for us. My fellow ducks of Sempione Park in Milan, for example, took a walk into Cadorna Station, a commuter station usually very crowded (if you are wondering if they named the station after the general who lost the battle of Caporetto: yes, it is; strange things happen in Italy, quack!).

Secondly, people had time for reading. During the first lockdown, all shops but pharmacies and grocery stores were closed. After it, the first commercial activities people wanted to be reopened were children’s clothing stores, hairdressers, and *bookshops*! I hope this habit will remain in the future.

Lastly, many events happened online. Needless to say, it is not the same as being at them live, but it gave you the possibility to attend them even if they were far away. I was happy to follow the 2020 \TeX Users Group meeting. It would not have been possible if it had not been online.



This time, I will show you how to avoid awful spacing between your documents’ words, lines, or elements.

Barbara Beeton suggested this topic to me, inspired by the \TeX .SE question *How can I visualize glue?*¹ and its brilliant answer by Donald Arseneau.

The subject is vast and complex, I will be neither rigorous nor exhaustive, but I would like to give some little tips & tricks to newbies.

I also take this opportunity to thank Barbara for her advice and corrections. Of course, all remaining errors are my own.

¹ <https://tex.stackexchange.com/questions/552527/how-can-i-visualize-glue>

2 Quack Guide No. 6: The glue

The basic elements of a \LaTeX document are *boxes* and *glue*. Every character or image is a box, but also a line of text, a table, or a minipage are boxes (which contain other boxes). The glue is the empty space between them: between words, between lines, between the text and an image or a table, and so on.

This spacing is not fixed; it may vary, according to the situation, to form a line or a page more pleasing to the eye.

Indeed, every glue is defined by three dimensions: a natural size; a stretchability, the basis for how much the natural size can be enlarged; and a shrinkability, how much it can be compressed.

For this reason, Prof. Knuth [2] said it would be more accurate to use the term “spring” instead of “glue”, but the latter is a long-established tradition, and he did not change it.

\TeX does not treat stretchability and shrinkability in the same way. While shrinkability represents a limit, that is, \TeX will not shrink more than what is specified, this is not true for stretchability.

For instance, in the case of a vertical glue, if `\flushbottom` is in effect (see below), and if applying the maximum specified stretchability a page ends up being too short, then the places where stretch is allowed will be stretched in proportion to what is specified.

Let us see a practical example. Imagine you are writing your text on straight lines, like children at primary school do. The vertical distance between two of these lines within a paragraph is set by:

```
\baselineskip = <size> plus <stretchability>
               minus <shrinkability>
```

The previous is plain \TeX syntax. You can also use it in \LaTeX directly or through the command:

```
\setlength{\baselineskip}{<size>
plus <stretchability>
minus <shrinkability>}
```

In both cases, the plus and minus parts are optional. If you do:

```
\setlength{\baselineskip}{20pt
plus 6pt minus 4pt}
```

the distance between your lines will normally be 20pt. If necessary, \TeX will reduce the spacing to a minimum of 16pt. Stretching the spacing is similar, but there is no limit to how far the glue will be stretched. Both stretching and shrinking are calculated taking into account other glue on the page. For instance, if there is one glue item with `plus 6pt` and another with `plus 2pt`, the former will expand three times as fast as the latter.

The stretching and shrinking does not normally apply to the last page of an article or chapter, which (in practice) is always ended with `\vfill` (which adds a vertical filling space till the end of the page).

If you are interested in the subject, check the T_EX.SE post *What is glue stretching?*² for more.

For a list of the L^AT_EX default lengths, see the L^AT_EX/Lengths page of Wikibooks,³ and the T_EX.SE post *Lengths and when to use them.*⁴

However, you do not usually need to set these lengths; your documentclass already does it for you.



T_EX is one of the best programs—if not *the* best—to manage the glue. But sometimes the automatic result may not be what you would like. Let us see how to remedy this.⁵

As general advice, I recommend making your refinements when you have completely finished your writing. Otherwise, you may have to redo them. It can be an excellent way to procrastinate, quack!

2.1 Horizontal glue

The classical situations where you need to adjust the horizontal spacing are when you get the warnings `Underfull \hbox` or `Overfull \hbox`.

Newbies often consider these messages a sort of mystery and ignore them.

On the contrary, their meaning is evident if you look at a line as a box: an underfull horizontal box is a line that is too empty; an overfull horizontal box warns you that your text goes beyond the margin (of your page, or your column table, you name it).

The `Underfull \hbox` usually appears when your paragraph is too narrow and T_EX cannot correctly distribute the words in one or more lines in the paragraph.

To improve this, it is usually best to use either `\raggedright` or (from the `ragged2e` package) `\RaggedRight`.

For example, compare the columns of the following table. The first one is an ordinary `p` column; since it is too narrow, there is too much space between the words, and an `Underfull \hbox` appears. The second and the third are ragged right; note

that `\RaggedRight` allows for hyphenation whereas `\raggedright` does not.

Choose the one your text fits better with.

Ordinary <code>p</code> column	With <code>\raggedright</code>	With <code>\RaggedRight</code>
Most Italians do not like pineapple pizza	Most Italians do not like pineapple pizza	Most Ital- ians do not like pineapple pizza
...

```

...
\usepackage{ragged2e}
...
\begin{tabular}{p{2.2cm}}
>{\raggedright\arraybackslash}p{2.2cm}
>{\RaggedRight\arraybackslash}p{2.2cm}}
\toprule
Ordinary \verb|p|~column &
With \cs{raggedright} &
With \cs{RaggedRight} \\
\midrule
Most Italians do not like pineapple pizza&
Most Italians do not like pineapple pizza&
Most Italians do not like pineapple pizza\\
\bottomrule
\end{tabular}

```

To cope with overfull horizontal boxes, firstly, you have to identify where they are. With the draft option, they are highlighted by black rectangles.

The fixing depends on the kind of bad box. Let us examine some common cases.

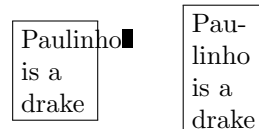
It may happen your text contains a word L^AT_EX is not able to hyphenate. If so, you can specify how to divide it with the command `\-`.

In the following example, the minipage width is too narrow to contain “Paulinho”, and since L^AT_EX does not know how to hyphenate it, the first case gives an `Overfull \hbox`. If you indicate how to do it, the warning disappears.

```

\fbx{\begin{minipage}{9mm}\RaggedRight
Paulinho is a drake
\end{minipage}}\hspace{1cm}
\fbx{\begin{minipage}{9mm}\RaggedRight
Pau\ -li\ -nho is a drake
\end{minipage}}

```



Other common examples of unbreakable elements are urls. If you would like to divide them, you could use the package `xurl` (or `url` or `hyperref`), see also the T_EX.SE post *Forcing linebreaks in \url.*⁶

⁶ <https://tex.stackexchange.com/questions/3033/forcing-linebreaks-in-url>

² <https://tex.stackexchange.com/questions/64756/what-is-glue-stretching>

³ <https://en.wikibooks.org/wiki/LaTeX/Lengths> or also other sites: <http://www-h.eng.cam.ac.uk/help/tpl/textprocessing/squeeze.html>.

⁴ <https://tex.stackexchange.com/questions/41476/lengths-and-when-to-use-them>

⁵ I found some of the following explanations and suggestions on <https://latexref.xyz/> and <https://www.guitex.org/home/it/forum/5-tex-e-latex/102632-spazi-verticali-in-eccesso>.

Also inline math or verbatim expression may cause overfull horizontal boxes.

In general, you may try to adjust your spacing using `\sloppy`, which practically allows the space within words to be infinitely stretched. However, since that command may likely ruin the word spacing in the already well-distributed paragraphs, it is not advisable to use it for all your document. You may use the environment `sloppypar`, which acts only on the text within it.

A more convenient parameter, added in $\text{T}_{\text{E}}\text{X}3$, to modify the stretching is

```
\emergencystretch = <dimen>
```

which is similar to `\sloppy` but does not ruin good paragraphs.

You may try setting `\looseness=1` to distribute the words of a paragraph more loosely (it may expand the paragraph one line) or `\looseness=-1` to squeeze them.

You can also force a line break manually with the command `\newline`. The following example shows how it differs from `\linebreak`:

```
This line is broken\newline with
\verb|\newline|. \par
This line is broken\linebreak with
\verb|\linebreak|.
```

<p style="text-align: center;">This line is broken with <code>\newline</code>.</p> <p style="text-align: center;">This line is broken with <code>\linebreak</code>.</p>
--

Remember never to use `\\` to break a line. You should use `\\` only in `tabular`, `array`, or similar environments to end the rows or in some math environments with alignments.

In the previous code, I also used `\par` to create a new paragraph, but the usual way is to leave a blank line.

If your problem is a too-large image, you can resize it with the appropriate options of the macro `\includegraphics` from the `graphicx` package.

You can use `width=<wdim>` and `height=<hdim>` (if only one of them is set, the other is scaled to keep the aspect ratio) or you can scale your image by a given factor, using `scale=<factor>`.

If you are creating your image yourself, using `TikZ` or another graphics package, the best practice should be to draw it directly with the correct dimensions.

The `graphicx` package provides `\resizebox` (resize to a width) and `\scalebox` (resize to a scaling factor). You can use them if you have a too-large

table, but it is not advisable. In this case, it's usually better to choose a smaller font, starting with `\small`.

Sometimes, you may think to redesign your table. The following, for example, is too large for the `minipage` where it is placed:

```
\fbox{\begin{minipage}{6cm}\centering
\begin{tabular}{cc}
A very long title & Another very long title\\
\midrule
d & u\\
c & k\\
\end{tabular}
\end{minipage}}
```

A very long title	Another very long title
d	u
c	k

but, instead of resizing it, you can change the column definition to allow for a manual line break:

```
\newcolumntype{M}[1]{%
>{\centering\arraybackslash}m{#1}}
...
\fbox{\begin{minipage}{6cm}\centering
\begin{tabular}{*2{M{2.5cm}}}}
A very long title & Another very long title\\
\midrule
d & u\\
c & k\\
\end{tabular}
\end{minipage}}
```

A very long title	Another very long title
d	u
c	k



There are also situations where there are no errors or warnings but the spacing is not correct anyway.

For instance, compare

```
Prof. van Duck with\par
Prof.\ van Duck.
```

<p>Prof. van Duck with Prof. van Duck.</p>
--

In the first line the spacing between “Prof.” and “van” is too much because $\text{T}_{\text{E}}\text{X}$ interprets the dot at the end of a sentence, not as an abbreviation. To correct it, just put a `\.` (a backslash and a space) after the dot.

By the way, the space after the period is set according to the US typesetting rule. If you do not

like it or there is a different rule in your country, you could use `\frenchspacing`. Look at the following example:

```
Note the space after the dot. Here\par
{\frenchspacing
Note the space after the dot. Here}
```

Note the space after the dot. Here
Note the space after the dot. Here

In addition to `_`, there are many commands for explicitly setting horizontal spacing. For a detailed list, see the T_EX.SE post *What commands are there for horizontal spacing?*⁷



Last but not least, I would like to talk about spurious spaces. They are unwanted spaces that appear when you least expect them, but it usually is your fault, quack!

Even the most expert T_EXnicians may fall into the trap. There is an instructive article by prof. Enrico Gregorio on this topic [1].⁸

Suppose you are writing a thesis about queen Elizabeth I, and you would like to create a macro for her name, with the symbol `~` between “Elizabeth” and “I”, to avoid them being separated onto different lines. In the following simple example, the macro `\eliwrong` creates a spurious space, clearly visible if you compare it with `\eligood`.

Someone says the greatest kings of England were queens, Elizabeth I and Victoria.
Someone says the greatest kings of England were queens, Elizabeth I and Victoria.

```
\newcommand\eliwrong{
  Elizabeth~I}
\newcommand\eligood{% <-- note the %
  Elizabeth~I}
Someone says the greatest kings of England
were queens, \eliwrong\ and Victoria.\par
Someone says the greatest kings of England
were queens, \eligood\ and Victoria.
```

Note also the `_` after the macros (for example, `\eligood_`), which is needed to add a space if no punctuation mark is following. But if `\eligood` ends a sentence (e.g., if we had written “Victoria and `\eligood`.”), the capital “I” would cause the space to be only a normal interword space instead of recognized as ending a sentence. To fix it, add `\@` before the period: “`\eligood\@`.”.

⁷ <https://tex.stackexchange.com/questions/74353/what-commands-are-there-for-horizontal-spacing>

⁸ And a funny video: <https://youtu.be/jGAiF2LBUy>

Remember, when you go to a new line in a `.tex` file, you are putting a space in your final output document. People accustomed to ordinary word editors or programming languages usually find it strange and forget to add the `%` sign when needed.

T_EX ignores what is written after a percentage sign and also ignores the leading spaces of a line.

Therefore, pay attention when you put a comment at the end of a line; you may make a space disappear (of course, there are cases where this behavior is convenient, as above, in the definition of the macro `\eligood`).

```
Here:% This is a comment
  a space is missing\par
Here: % This is a comment
  a space is present
```

Here:a space is missing
Here: a space is present

2.2 Vertical glue

Having adjusted the horizontal glue, let us move on to the vertical.



Many L^AT_EX document classes use the declaration `\flushbottom` when the text is two-sided. Indeed, it makes all the pages of the same height, adding some vertical space if necessary. Usually, this is pleasant to the eye because the left page looks equal to the right one.

Nevertheless, if your pages have many math formulae, tables, figures, and not only plain text, `\flushbottom` may add too much vertical glue.

If this exceeds the allowed stretchability, you may get the warning `Underfull \vbox`.

Sometimes, you may have *widows* and *orphans*, typographical terms to indicate respectively a single ending line at the beginning of a page or a single opening line at the end of a page. There is an interesting article by Frank Mittelbach [4] on this topic.

Let us see how to solve the problem.

First of all, you can use `\raggedbottom`. It does not add extra vertical space to your page. Of course, the downside is that your pages will have different heights, and they could look bad if they are facing pages of a two-sided document.

You may use `\raggedbottom`, also temporarily, to see if any of your pages are too empty and then adjust them. There are many ways to do it.

You may modify some vertical glues, refining their stretchability or shrinkability. For instance, you can adjust the space between paragraphs with `\parskip`.

You may also increase (or decrease if the parameter is negative) the space after a specific paragraph with `\vspace{<length>}`. If you place this command in the middle of a paragraph, it is deferred until after the paragraph ends. The space is not added if it is at the beginning of the page, among other places. There is also a starred version of the command, `\vspace*{<length>}`, which adds the space also if it is at the top of the page, or would otherwise be ignored.

Of course, there are many more commands for vertical spacing; for a list, see <https://latexref.xyz/Spaces.html>.

If you are not constrained to some typesetting rules, you may try to (slightly) increase or decrease your `textheight`; `geometry` is the recommended package for this.

You can even change the height of a single page with `\enlargethispage{<size>}`. The size could also be negative, for example

```
\enlargethispage{-\baselineskip}
```

reduces the current page by a line. There is also a starred version of the command that shrinks the glue between your page elements, if possible, to make room for the indicated size.

Moreover, you can suggest to (L^A)T_EX where a page break should be encouraged or discouraged, respectively, with the macros `\pagebreak[<num>]` and `\nopagebreak[<num>]`.

The optional parameter `<num>` is the suggestion's strength. It may vary from 1 (weak) to 4 (mandatory, the default).

Note that these commands apply to the next new line with respect to the point where they are positioned.

For example, suppose this is a paragraph at the end of a page. If you put a `\verb|\pagebreak|` here: `\pagebreak` it will not break the page there but after the end of the line where it appears.

End of the current page:

For example, suppose this is a paragraph at the end of a page. If you put a `\pagebreak` here: it will not break the page there but after

Beginning of the next page:

the end of the line where it appears.

A more abrupt command is `\newpage`, which ends the current page immediately and does not vertically stretch it. Note that a new paragraph is

started on the new page. Hence, you should use the command at the end of a paragraph. If you would like to use it in the middle, as in the following example, you should add `\noindent`, if needed, to avoid the possible paragraph indentation.

If you put a `\verb|\newpage|` here: `\newpage` `\noindent` the page breaks at once.

If you put a `\newpage` here:

the page breaks at once.

Analogously to `\newpage`, also `\clearpage` and `\cleardoublepage` end the current page at once. The latter creates a blank page, if needed, to start the new page always as an odd page; it is used in two-sided documents. If your document has two columns per page, they eventually leave an empty column, whereas `\newpage` does not.

Another difference with `\newpage` is that they also typeset all the floating environments present in the float queue (see below). Hence, you can use these two commands to print all your floats before a certain point if you need this.



If we had to make a ranking of things that shock beginners, floating environments undoubtedly win the gold medal.

The standard ones are `table` and `figure`, but there are others, and you can also create your own floating environment, for example, with the package `float`.

The adjective “floating” always reminds me of a delicious French dessert, poison for diabetics, named *île flottante*. It is an iceberg of meringue that sails on an ocean of custard.

The newbie-astonishing property of these environments is just that they wander about in your document as the meringue glides on the custard. With ordinary word processors, tables and figures usually remain where you put them.

Of course, this is a plus of (L^A)T_EX, because it places floating elements professionally. Look at any textbook of yours. You will see that figures and tables are generally not positioned where they are referenced, but at a specific place on the page. The text references them with a number (one of the reasons why I love (L^A)T_EX is exactly its efficient and straightforward way of referencing objects).

The positioning mechanism is quite complex and usually not immediately grasped by beginners. On

this topic, I recommend you to read a detailed and clarifying article by Frank Mittelbach [3].

In brief, the floating environments have an optional parameter that specifies where to place the float. It may contain the characters: **h** for *here*; **t** and **b** for *top* and *bottom* of the page; **p** for a float *page*; and a **!** that indicates some positioning restrictions should be ignored.

L^AT_EX tries to place the float where specified. If it does not succeed, the float is put in a queue which is disposed of on the next page, if possible, or at the end of the document, or when a `\clearpage` is encountered.

The first “strange” thing (to newbies) is that the position specifiers’ order is irrelevant. If you write **ht** or **th** it is the same. It does *not* mean that, in the first case, “here” is tried first and, in the second, “top” is the first option. It only means that L^AT_EX will not place the floats at the “bottom” or in a “page”, at least not at first.

The second is that **h** does *not* mean “absolutely here” but more or less “the float will be placed at the end of the paragraph where it is mentioned, if possible.”

After getting over the shock, newbies try with every means to make the floats not floating, for example, using the position specifier **H** from the `float` package. But if you do not want your figures or tables to float, simply do not use *floating* environments, quack!

The command

```
\captionof<float type> [<list entry>]{<heading>}
from package caption (or capt-of) allows you to
have consistent numbering and labeling without using
floats. The parameter <float type>, that is figure,
table, etc., is mandatory; <list entry> is optional
and represents what you want to put in the list of
figures, tables, etc.
```

In the following example, I use a `center` environment, which does not float. You may use a `minipage` with an appropriate alignment as well.

By the way, remember never to use a `center` environment *within* a floating environment, because it would add extra vertical space, use `\centering` instead.⁹

```
...
\usepackage{caption}
...
\listoffigures
See Figure \ref{fig:my}, for example:
\begin{center}
```

⁹ <https://tex.stackexchange.com/questions/23650/when-should-we-use-begincenter-instead-of-centering/23653>

```
\includegraphics[width=3cm]{example-image}
\captionof{figure}[An image]
  {An example image}\label{fig:my}
\end{center}
```

List of Figures

1 An image 39

See Figure 1, for example:

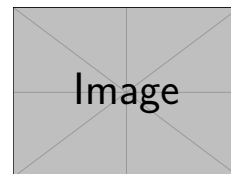


Figure 1: An example image

3 Conclusion

While I was writing this article (January 2021), other bad news reached me. With sadness in my heart, let me remember Gustavo Mezzetti, a brilliant T_EXnician and T_EX.SE friend, author of the gorgeous `halloweenmath` package. He generously helped many people also on the G_JT Forum, with the nickname of `letteracdp` (taken from a documentclass he wrote years ago).

🐧 *Ciao GuM, we will miss you!* 🐧

References

- [1] E. Gregorio. Recollections of a spurious space catcher. *TUGboat* 36(2):149–161, 2015. <https://tug.org/TUGboat/tb36-2/tb113gregorio.pdf>
- [2] D.E. Knuth. *The T_EXbook*, vol. A of *Computers and Typesetting*. Addison-Wesley, Reading, MA, USA, 1986.
- [3] F. Mittelbach. How to influence the position of float environments like figure and table in L^AT_EX? *TUGboat* 35(3):248–254, 2014. <https://tug.org/TUGboat/tb35-3/tb111mitt-float.pdf>
- [4] F. Mittelbach. Managing forlorn paragraph lines (a.k.a. widows and orphans) in L^AT_EX. *TUGboat* 39(3):246–251, 2018. <https://tug.org/TUGboat/tb39-3/tb123mitt-widows.pdf>

◇ Herr Professor Paulinho van Duck
Quack University Campus
Sempione Park Pond
Milano, Italy
paulinho dot vanduck (at)
gmail dot com