

A Whistle-Stop Tour of \LaTeX (Part 1)

Computing Science and Mathematics Skill Sharing

Alexander E. I. Brownlee
Nadarajen Veerapen

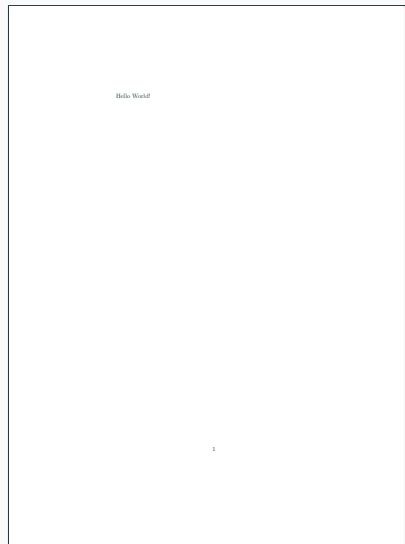
UNIVERSITY *of*
STIRLING 

1. Basics
2. The \LaTeX pipeline
3. Software and Services
4. Typesetting
5. Floats
6. Figures
7. Tables

Basics

A basic \LaTeX document

```
1 \documentclass{article}
2
3 \begin{document}
4 Hello World!
5 \end{document}
```



A basic \LaTeX document

```
1 \documentclass{article}
2
3 \begin{document}
4 Hello World!
5 \end{document}
```



Hello World!

A basic \LaTeX document

```
1 \documentclass[a4paper]{article}
2 \usepackage{xcolor}
3
4 \begin{document}
5 \textbf{\Huge \color{red} Hello World!}
6 \end{document}
```



Hello World!

```
1 \documentclass[a4paper]{article}
2 \usepackage{xcolor}
3
4 \begin{document}
5 \textbf{\Huge \color{red} Hello World!}
6 \end{document}
```

Hello World!

```
1 \documentclass[a4paper]{article}
2
3 \title{Lorem Ipsum}
4 \author{Loremy McLoremface}
5
6 \begin{document}
7 \maketitle
8
9 \section{First Section}
10 Lorem ipsum dolor sit amet, [...]
11
12 \[ G(n^2; x) = \sum_{n=0}^{\infty} n^2 x^n = \frac{x(x+1)}{(1-x)^3} \]
13
14 \subsection{Subsection}
15 Donec ullamcorper, felis non [...]
16
17 \begin{itemize}
18 \item Vivamus nunc nunc, molestie ut, ultricies vel,
19     semper in, velit.
20 \item Ut porttitor. Praesent in sapien.
21 \end{itemize}
22 \end{document}
```

Lorem Ipsum

Loremy McLoremface

December 5, 2016

1 First Section

Lorem ipsum dolor sit amet, consectetur adipiscing elit. Etiam lobortis facilisis sem. Nullam nec mi et neque pharetra sollicitudin. Praesent imperdiet mi nec ante.

$$G(n^2; x) = \sum_{n=0}^{\infty} n^2 x^n = \frac{x(x+1)}{(1-x)^3}$$

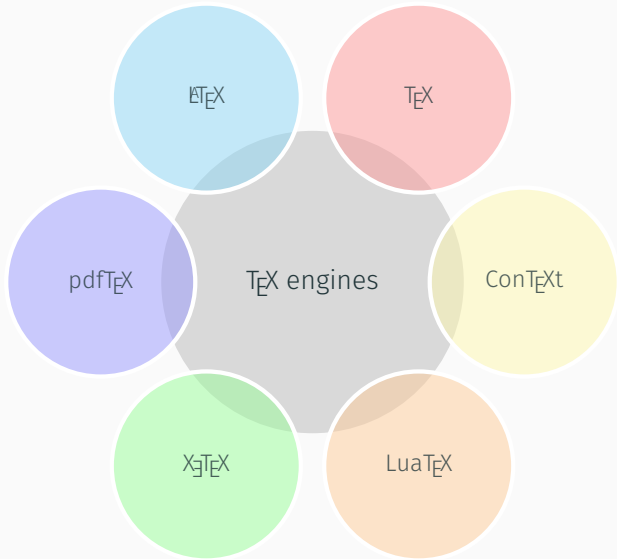
1.1 Subsection

Donec ullamcorper, felis non sodales commodo, lectus velit ultrices augue, a dignissim nibh lectus placerat pede.

- Vivamus nunc nunc, molestie ut, ultricies vel, semper in, velit.
- Ut porttitor. Praesent in sapien.


```
1 @book{garey_computers_1979,
2   title = {Computers and {Intractability}: {A} {Guide} to the {Theory} of {NP}-{Completeness}
3     },
4   isbn = {0-7167-1045-5},
5   publisher = {W. H. Freeman},
6   author = {Garey, Michael R. and Johnson, David S.},
7   year = {1979}
8 }
9 @Article{Knuth1968,
10  author="Knuth, Donald E.",
11  title="Semantics of context-free languages",
12  journal="Mathematical Systems Theory",
13  year="1968",
14  volume="2",
15  number="2",
16  pages="127--145"
17  issn="1433-0490",
18  doi="10.1007/BF01692511"
19 }
20 @misc{knuthwebsite,
21  author = "Donald Knuth",
22  title = "Fantasia Apocalyptica: A multimedia work for pipe organ",
23  url = "http://www-cs-faculty.stanford.edu/~{uno}/fant.html"
```

The \LaTeX pipeline



T_EX released in 1978 by Donald Knuth

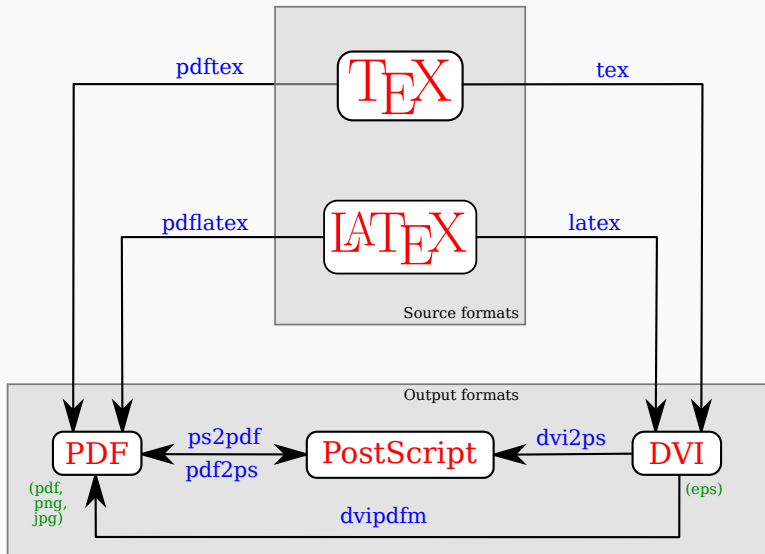
L^AT_EX (The macro package for T_EX) released in early 1980s by Leslie Lamport. Current version is L^AT_EX 2_ε

pdfT_EX provides pdf support

X_YT_EX provides default UTF-8 and better font support

LuaT_EX provides scripting with Lua

ConT_EXt not actually an engine, newer macro package with enhanced typesetting



"LaTeX diagram" by Alessio Damato is licensed under the GNU Free Documentation License
https://commons.wikimedia.org/wiki/File:LaTeX_diagram.svg

Document compilation pipeline

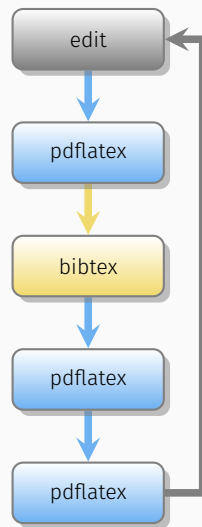
Usually, 4 steps are required to obtain the final output when a new citation is added.

Step 1 `pdflatex` reads `.tex` file and writes citation keys and label information to `.aux` file

Step 2 `bibtex` reads `.aux` file, looks up citations in `.bib` file and writes formatted references as `.bbl` file

Step 3 `pdflatex` reads `.aux` and `.tex` files to resolve cross-references, reads `.bbl` to insert references and set up information for citations

Step 4 `pdflatex` finalises citation references, page formatting and page numbers, writes `.pdf`



Document compilation pipeline

Usually, 4 steps are required to obtain the final output when a new citation is added.

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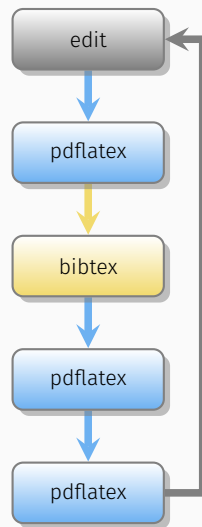
Step 3 `pdflatex` reads `.aux` and `.tex` files to resolve cross-references, reads `.bbl` to insert references and set up information for citations

Step 4 `pdflatex` finalises citation references, page formatting and page numbers, writes `.pdf`

Did you know?

It is possible to create documents that fail to converge to a state where cross-references do not change.

tex.stackexchange.com/questions/30674/document-requiring-infinitely-many-compiler-passes



Software and Services



Distributions: do the work of compiling documents and contain most of the commonly-used packages. These are the most popular ones, all in active development.

TeX Live Multi-platform: available in most Linux package managers, Windows installers available

MiKTeX Targeted specifically at Windows (wizard driven). Has a LaTeX package manager built in

MacTeX TeXLive, with some tweaks to make it more Mac-friendly

Editors: where you actually do the editing.

TeXMaker Multi-platform

TeXnicCenter Windows only

JabRef: desktop BibTeX manager (online ref managers also available e.g. Mendeley)



ShareLaTeX



There are multiple online collaborative editors. The one you choose is probably going to be influenced by what your collaborators already use.

- It seems quite a few people in CSM use Overleaf.
- When we compared Overleaf to ShareLaTeX some time ago, simultaneous collaborative editing seemed to work better in Overleaf.
- ShareLaTeX is open-source and can thus be hosted privately.
- ShareLaTeX accepts `knitr` (R) input.
- Authorea and Papeeria accept Markdown input so are easier to use for non-LaTeX collaborators.
- Authorea shows an HTML rendering of the output (not WYSIWYG).
- Papeeria accepts `gnuplot` input.

Typesetting

```

1 \usepackage{amsmath}
2
3 ...
4
5 We can reference \eqref{eqn:step1} and \eqref
   {eqn:step2} in the document.
6 \begin{align}
7 y_1 &= x + 1 \label{eqn:step1} \\
8 y_2 &= 3x^2 + 2x - 5 \label{eqn:step2} \\
9 (g + h) &= x^{2a + 3b} \nonumber \\
10 e &= mc^2 \text{(mass-energy eq.)} \\
11 a, b &\in \mathbb{N} \nonumber
12 \end{align}

```

We can reference (1) and (2) in the document.

$$y_1 = x + 1 \quad (1)$$

$$y_2 = 3x^2 + 2x - 5 \quad (2)$$

$$(g + h) = x^{2a+3b}$$

$$e = mc^2 \text{(mass-energy eq.)} \quad (3)$$

$$a, b \in \mathbb{N}$$

Use `\begin{split}...\end{split}` within the `align` environment to have one number for all equations. `\begin{align*}` is equivalent to `\nonumber` on every line.

```

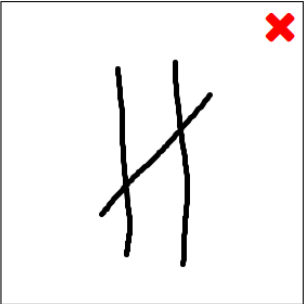
1 \begin{equation}\label{equation:checkerboard}
2 f(x)=4(s-2)^{2} - \sum_{i=2}^{s-1} \sum_{j=2}^{s-1} \left\{
3 \begin{array}{r c}
4 \delta \left(x_{i,j} , x_{i-1, j} \right) \backslash\backslash
5 + \delta \left(x_{i,j} , x_{i+1, j} \right) \backslash\backslash
6 + \delta \left(x_{i,j} , x_{i, j-1} \right) \backslash\backslash
7 + \delta \left(x_{i,j} , x_{i, j+1} \right) \backslash\backslash
8 \end{array}
9 \right\}
10 \end{equation}




```

$$f(x) = 4(s-2)^2 - \sum_{i=2}^{s-1} \sum_{j=2}^{s-1} \left\{ \begin{array}{l} \delta(x_{i,j}, x_{i-1,j}) \\ + \delta(x_{i,j}, x_{i+1,j}) \\ + \delta(x_{i,j}, x_{i,j-1}) \\ + \delta(x_{i,j}, x_{i,j+1}) \end{array} \right\} \quad (4)$$

Symbols: finding the right one

Detexify



	Score: 0.05069389346196656 <code>\usepackage{ amssymb }</code> <code>\nparallel</code> mathmode
	Score: 0.13945649620217834 <code>\usepackage{ textcomp }</code> <code>\textuparrow</code> textmode
	Score: 0.15527327725545362 <code>\usepackage{ amssymb }</code> <code>\shortparallel</code> mathmode

Draw what you are looking for on detexify.kirelabs.org

Look through *The Comprehensive L^AT_EX Symbol List*
`symbols-a4.pdf` via www.ctan.org or `texdoc symbols`
(+14 000 symbols)

The Comprehensive L^AT_EX Symbol List

Scott Pakin <scott+clal@pakin.org>
30 November 2015

Abstract

This document lists 14002 symbols and the corresponding L^AT_EX commands that produce them. Some of these symbols are guaranteed to be available in every L^AT_EX 2_ε system; others require fonts and packages that may not accompany a given distribution and that therefore need to be installed. All of the fonts and packages used to prepare this document – as well as this document itself – are freely available from the Comprehensive T_EX Archive Network (<http://www.ctan.org/>).

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**The original version of this document was written by David Carlisle, with several additional tables provided by Alexander Hahn. See Section 10.4 on page 225 for more information about who did what.

1

Input	Description
<code> </code>	A space
<code> </code>	Still one space
<code>\ </code>	A space
<code>\ \ \</code>	3 spaces
<code>\,</code>	A thin space, e.g., a thousands separator
<code>~</code>	An unbreakable space
<code>\hspace{1cm}</code>	A 1 cm horizontal space
<code>\hfill</code>	Take up the remaining horizontal space
<code>\vspace{1cm}</code>	A 1 cm vertical space
<code>\vfill</code>	Take up the remaining vertical space

Input	Output
<code>ellipsis\ldots</code>	ellipsis...
<code>three full stops...</code>	three full stops...
<code>`single quotation marks'</code>	‘single quotation marks’
<code>``double quotation marks''</code>	“double quotation marks”
<code>``double quotation marks"</code>	“double quotation marks”
<code>'wrong quotation marks'</code>	’wrong quotation marks’
<code>"wrong quotation marks"</code>	”wrong quotation marks”

Name	Input	Output	Purpose
Hyphen	-	-	inter-word
En-dash	--	–	page range, e.g., 1–10
Em-dash	---	—	punctuation dash
Minus	-	−	minus sign in <i>maths mode</i>

```
1 \begin{itemize}
2 \item Thing A
3 \item Thing B
4 \end{itemize}
5
6 \begin{enumerate}
7 \item Thing 1
8 \item Thing 2
9 \end{enumerate}
10
11 \begin{itemize}
12 \item Thing A
13 \item Thing B
14   \begin{enumerate}
15     \item Nested Thing 1
16     \item Nested Thing 2
17   \end{enumerate}
18 \end{itemize}
```

- Thing A
 - Thing B
1. Thing 1
 2. Thing 2
- Thing A
 - Thing B
 - 1. Nested Thing 1
 - 2. Nested Thing 2

```
1 \begin{description}
2 \item[Apple] A kind of fruit. Usually red or
   green.
3 \item[Orange] Another kind of fruit, not to be
   compared with Apples.
4 \end{description}
```

Apple A kind of fruit. Usually red or
green.

Orange Another kind of fruit, not to
be compared with Apples.

Floats

Floats are wrappers for objects like tables and figures that allow objects to be positioned separately to the flow of text

A float usually has:

- a caption, added with `\caption{Description here}`
- a label, added with `\label{someLabel}`

Labels must appear after or inside captions, otherwise they can label the wrong thing (e.g. the current section rather than your table).

Internally, \TeX will make a separate counter for each float type, so tables, figures, algorithms etc. are all separately numbered.

You can cite these numbers in the text by referencing a label, like this: `Table~\ref{someLabel}` (the ~ is a non-breaking space). You can also use `\pageref{someLabel}` to show the page that a float appears on.

It's conventional to prefix labels with the type of float to make things more readable (some packages also use this for formatting), e.g. `\label{tab:results}`. Common prefixes are:

ch:	chapter	sec:	section
subsec:	subsection	fig:	figure
tab:	table	eq:	equation
lst:	code listing	itm:	enumerated list item
alg:	algorithm	app:	appendix subsection

LaTeX tries to place a float on the current page. If there's not enough room, the float is moved to the top of the next page.

We can change placement by moving the float in the source, or we can tweak placement with modifiers, e.g. `\begin{figure}[htb]`:

- h** 'here', roughly at the same point it occurs in the source text.

- t** top of the page.

- b** bottom of the page.

- p** place on a special page for floats only.

- !** override LaTeX internal's parameters for deciding 'good' positions.

- H** precisely the same location as in the LaTeX code. Requires `\usepackage{float}`. Roughly equivalent to `!ht`.

TeX stores floats in a stack, placing them as it finds space to do so. If you have many, sometimes this means they will jam and push to the end of the document. (more detail on the procedure here: <http://tinyurl.com/hosk82o>)

Note: LaTeX has an internal limit of 18 floats in the stack (use `\morefloats` package to increase), so look for

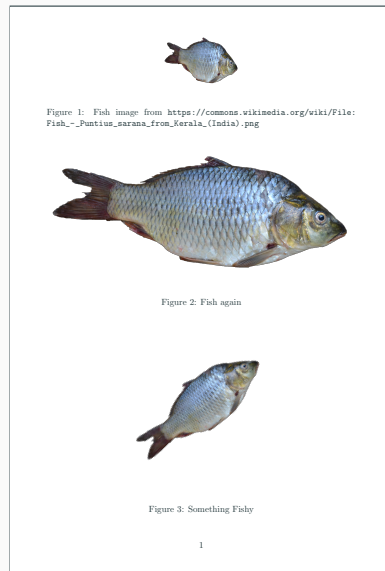
! LaTeX Error: Too many unprocessed floats.

in the output. If this happens, you can move the float around in the source so they have a chance to clear earlier.

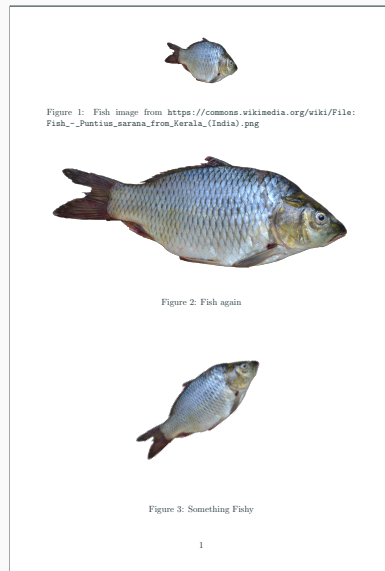
You can also use `\clearpage` to force a page break and clear the floats currently in the stack.

Figures

```
1 \documentclass{article}
2 \usepackage{hyperref}
3 \usepackage{graphicx}
4 \graphicspath{ {images/} }
5
6 \begin{document}
7
8 \begin{figure}
9 \begin{center}
10 \includegraphics[width=3cm, height=2cm]{
11     fish.png}
12 \end{center}
13 \caption{Fish image from \url{https://
14     commons.wikimedia.org/wiki/File:Fish_-_
15     Puntius_sarana_from_Kerala_(India).png
16     }}
17 \label{fig:fish1}
18 \end{figure}
```



```
15 \begin{figure}
16 \begin{center}
17 % could use \columnsep, \columnwidth, \
    linewidth, \paperwidth, \paperheight...
18 \includegraphics[width=\textwidth]{fish}
19 \end{center}
20 \caption{Fish again}
21 \label{fig:fish2}
22 \end{figure}
23
24 \begin{figure}
25 \begin{center}
26 \includegraphics[width=0.5\textwidth,
    angle=45]{fish}
27 \end{center}
28 \caption{Something Fishy}
29 \label{fig:fish2}
30 \end{figure}
31
32 \end{document}
```

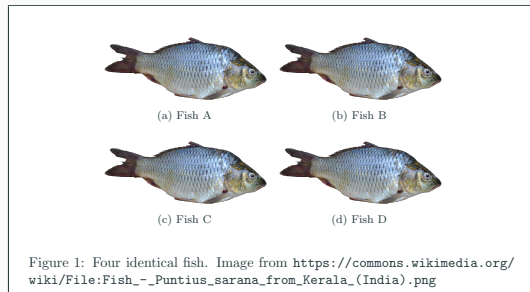


We can divide floats up into subfloats, laid out in a grid. `\\` marks the end of a line. Each subfloat can have its own caption and label.

Note: The `subfigure` and `subfig` packages are deprecated: the current recommended way to do this is via the `subcaption` package, but many templates we use frequently are not compatible with `subcaption`, e.g. Springer, IOP, IEEETran and ACM SIG.

Subfigures

```
1 \usepackage[caption=false]{subfig}
2
3 \begin{figure}
4 \begin{center}
5 \subfloat[Fish A]{\label{fig:fish-a} \
  includegraphics[width=0.35\textwidth] {
  fish.png}}
6 \subfloat[Fish B]{\label{fig:fish-b} \
  includegraphics[width=0.35\textwidth] {
  fish.png}}\\
7 \subfloat[Fish C]{\label{fig:fish-c} \
  includegraphics[width=0.35\textwidth] {
  fish.png}}
8 \subfloat[Fish D]{\label{fig:fish-d} \
  includegraphics[width=0.35\textwidth] {
  fish.png}}
9 \end{center}
10 \caption{Four identical fish. Image from \
  url{https://commons.wikimedia.org/wiki/
  File:Fish_-_Puntius_sarana_from_Kerala
  _(India).png}}
11 \label{fig:fish-all}
12 \end{figure}
```



If you're using a style with two columns, by default the floats will be one column wide. Use the starred versions to make them span two columns:

```
\begin{table*} ... \end{table*}
```

```
\begin{figure*} ... \end{figure*}
```

Tables

A basic table

```
1 \begin{tabular}{l c r}
2   Animal & Description & Price \\
3   Gnat & per gram & 13.65 \\
4       & each & 0.01 \\
5   Gnu & stuffed & 92.59 \\
6   Emu & stuffed & 33.33 \\
7   Armadillo & frozen & 8.99 \\
8 \end{tabular}
```

Animal	Description	Price
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.59
Emu	stuffed	33.33
Armadillo	frozen	8.99

A basic table with lots of lines

```
1 \begin{tabular}{|l|c|r|}
2   \hline \hline
3   Animal & Description & Price \\
4   \hline \hline
5   Gnat & per gram & 13.65 \\
6   \hline
7     & each & 0.01 \\
8   \hline
9   Gnu & stuffed & 92.59 \\
10  \hline
11  Emu & stuffed & 33.33 \\
12  \hline
13  Armadillo & frozen & 8.99 \\
14  \hline \hline
15 \end{tabular}
```

Animal	Description	Price
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.59
Emu	stuffed	33.33
Armadillo	frozen	8.99

Merging cells (horizontally with `multirow` package)

```

1 \begin{tabular}{|l|c|r|}
2   \hline \hline
3   \multicolumn{2}{|c|}{Item} & \multirow{2}{*}{Price} \\
4   \cline{1-2}
5   Animal & Description & \\
6   \hline \hline
7   Gnat & per gram & 13.65 \\
8   \cline{2-3}
9     & each & 0.01 \\
10  \hline
11  Gnu & stuffed & 92.59 \\
12  \hline
13  Emu & stuffed & 33.33 \\
14  \hline
15  Armadillo & frozen & 8.99 \\
16  \hline \hline
17 \end{tabular}

```

Item		Price
Animal	Description	
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.59
Emu	stuffed	33.33
Armadillo	frozen	8.99

Less is more, nice tables with the `booktabs` package

```

1 \begin{tabular}{l c r}
2 \toprule
3 \multicolumn{2}{c}{Item} & \multirow{2}{*}{Price} \\
4 \cmidrule{1-2}
5 Animal & Description & \\
6 \midrule
7 Gnat & per gram & 13.65 \\
8 & each & 0.01 \\
9 Gnu & stuffed & 92.59 \\
10 Emu & stuffed & 33.33 \\
11 Armadillo & frozen & 8.99 \\
12 \bottomrule
13 \end{tabular}

```

Item		Price
Animal	Description	
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.59
Emu	stuffed	33.33
Armadillo	frozen	8.99

Space matters

```

1 \newcommand{\ra}[1]{\renewcommand{\arraystretch}{#1}}
2
3 \ra{1.2}
4 \begin{tabular}{@{} l l r @{}}
5   \toprule
6   \multicolumn{2}{c}{Item} & \multirow{2}{*}{Price} \\
7   \cmidrule(r){1-2}
8   Animal & Description & \\
9   \midrule
10  Gnat & per gram & 13.65 \\
11      & each & 0.01 \\
12  Gnu & stuffed & 92.59 \\
13  Emu & stuffed & 33.33 \\
14  Armadillo & frozen & 8.99 \\
15   \bottomrule
16 \end{tabular}

```

Item		Price
Animal	Description	
Gnat	per gram	13.65
	each	0.01
Gnu	stuffed	92.59
Emu	stuffed	33.33
Armadillo	frozen	8.99

Small Guide to Making Nice Tables

www.inf.ethz.ch/personal/markusp/teaching/guides/guide-tables.pdf

- Avoid vertical lines
- Avoid “boxing up” cells, usually 3 horizontal lines are enough for a table (more if there are hierarchies)
- Avoid double horizontal lines
- Enough space between rows
- If in doubt, align left