Chapter 3

Graphics and Tables in LaTeX

3.1 Graphics

3.1.1 Introduction

- Use package `graphicx` to enable graphics support
- Create graphic files in vector format (scalable)
- Use external programs to create graphics

  - Adobe Illustrator
  - CorelDRAW
  - FreeHand
  - TikZ/PGF
  - Xfig
  - Ipe
  - Inkscape
  - Dia
  - Adobe Photoshop
  - GIMP
  - ImageMagick (convert, mogrify)
  - Gnuplot
  - R
  - Generic Mapping Tools (GMT)
  - Gnumeric
  - Matplotlib

- DVI output with `latex` → include graphic files in EPS format
- PDF output with `pdflatex` → include graphic files in PDF, JPG, PNG
- Include graphics with the `\includegraphics[opts]{file_name}` command
- Common options include `width`, `height`, `scale`, `angle`, e.g.

  ```
  width=0.5\textwidth, height=0.25\textheight, scale=0.75, angle=90
  ```

- Command `\graphicspath{}` to direct LaTeX in search for graphic files

  ```
  \graphicspath{ {pic/}{plot/}{diag/} }
  ```

- Alternatively: `\includegraphics{path/file_name}`
- No need to specify the file extension: LaTeX will automatically select the right file (EPS or PDF)

3.1.2 Measurement Units

pt	≈ 0.3515 mm
mm	mm
cm	cm
in	inch
ex	height of “x”
em	width of “M”

3.1.3 Length Specifiers

```
\linewidth
\columnwidth
\textwidth
\textheight
\paperwidth
\paperheigth
\parindent
\parskip
```

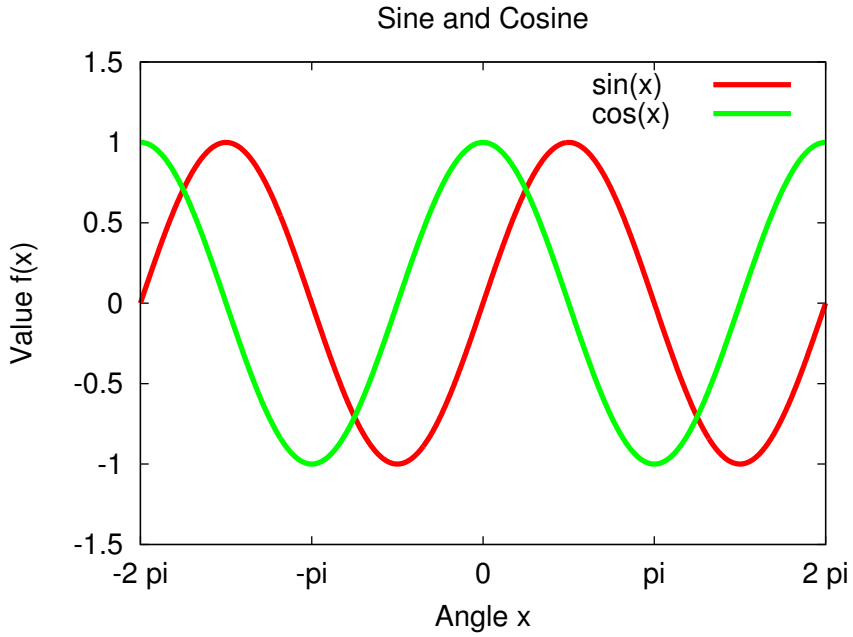
3.1.4 Custom Length Commands

- Define a new length parameter: `\newlength{parameter}`
- Set length of a new parameter: `\setlength{parameter}{length}`
- Change length of a parameter: `\addtolength{parameter}{length}`

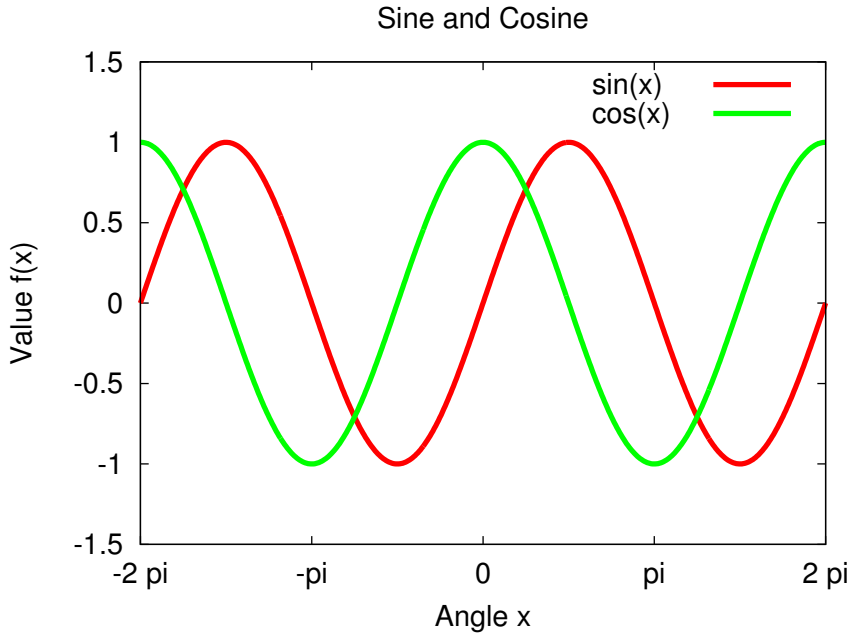
```
\newlength{lh}    % line height
\setlength{12pt}  % set length to 12pt
...
\vspace{2\lh}     % vertical spacing of 2 line heights (main text)
...
\\[2\lh]          % vertical spacing of 2 line heights (math mode, tables)
```

3.1.5 Examples of Graphics Inclusion

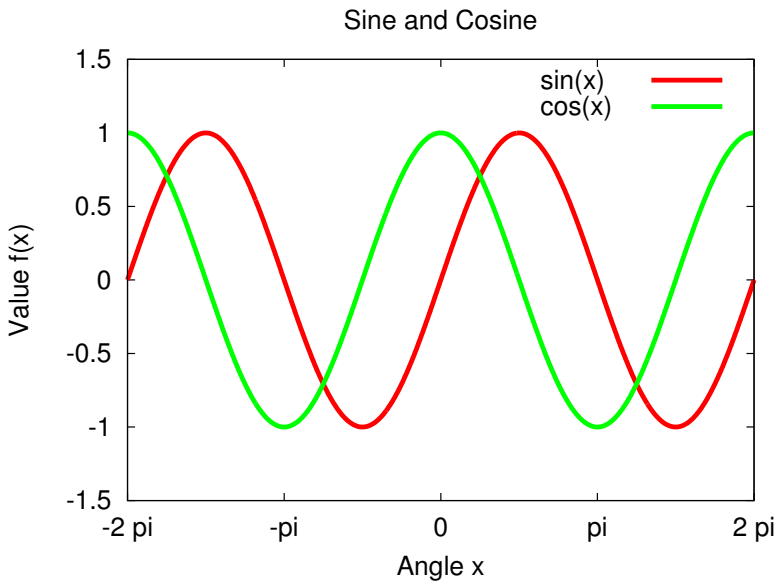
```
\includegraphics[width=12.5cm]{plot/sin-cos}
```



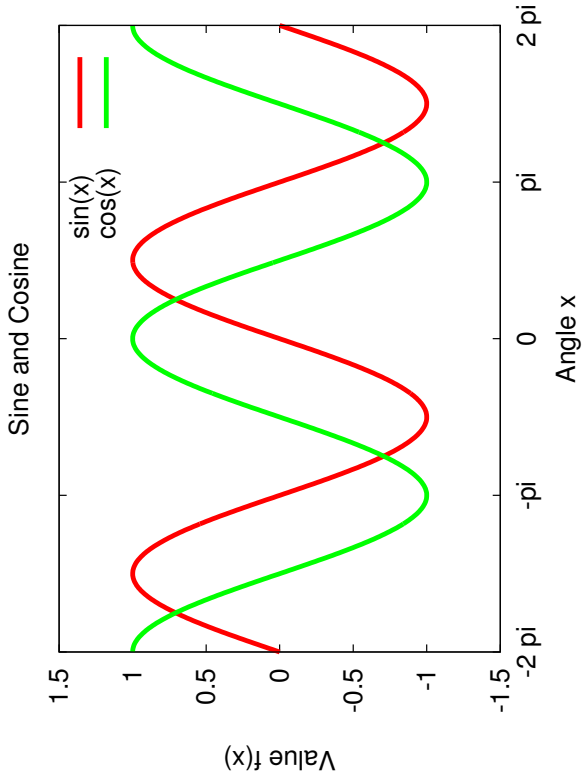

```
\includegraphics[height=8.75cm]{plot/sin-cos}
```



```
\includegraphics[scale=0.9]{plot/sin-cos}
```




```
\includegraphics[scale=0.9,angle=90]{plot/sin-cos}
```



3.1.6 Figures

- Float: container, encloses content, holds it on one page
- Floats: Figures, Tables, Algorithms, Listings, ...
- Use `figure` environment

```
\begin{figure}[htbp]
  \centering
  \includegraphics[scale=0.9]{plot/sin-cos}
  \caption{Plots of $\sin{(x)}$ and $\cos{(x)}$}
  \label{F:sin-cos}
\end{figure}
```

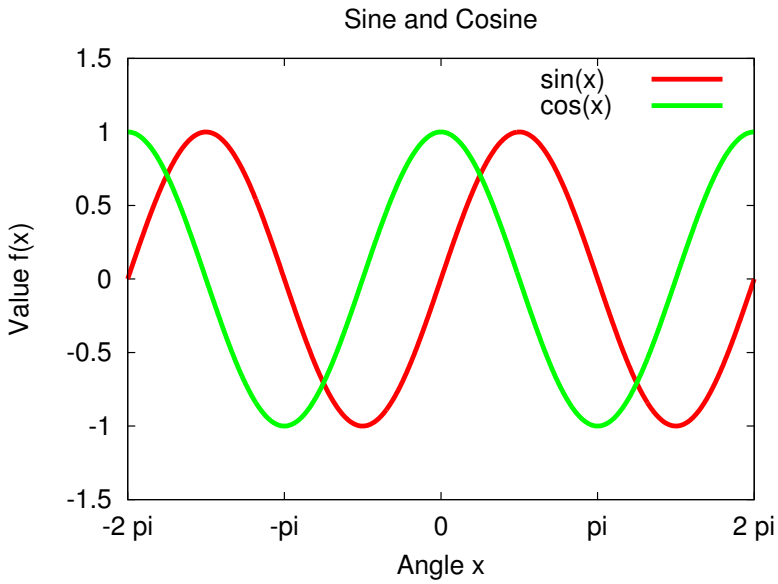


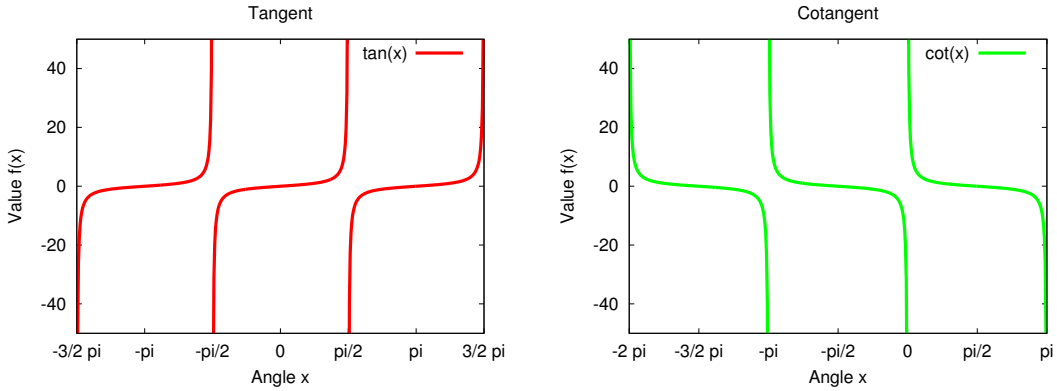
Figure 3.1: Plots of $\sin(x)$ and $\cos(x)$

- Supply an image with a caption and label for future reference
- Positioning commands: h—here, t—top, b—bottom, p—page
- Enforce float position with `h!` if necessary
- Use `\listoffigures` command to show the list of figures

3.1.7 Subfigures

- Use `subfigure` environment for multiple figures as part of one float
- Enable packages: `graphicx`, `caption`, `subcaption`

```
\begin{figure}[h]
  \begin{subfigure}[b]{0.5\textwidth}
    \centering
    \includegraphics[scale=0.6]{plot/tan}
    \caption{Plot of $\tan{(x)}$}
    \label{F:tan}
  \end{subfigure}
  %
  \begin{subfigure}[b]{0.5\textwidth}
    \centering
    \includegraphics[scale=0.6]{plot/cot}
    \caption{Plot of $\cot{(x)}$}
    \label{F:cot}
  \end{subfigure}
  %
  \caption{Plots of $\tan{(x)}$ and $\cot{(x)}$}
  \label{F:tan-cot}
\end{figure}
```



(a) Plot of $\tan(x)$

(b) Plot of $\cot(x)$

Figure 3.2: Plots of $\tan(x)$ and $\cot(x)$ [2]

3.2 Tables

3.2.1 Basic Tables

- Basic `tabular` environment

```
\begin{tabular}{ccc}
1   &   2   &   3   \\
4   &   5   &   6   \\
7   &   8   &   9   \\
*   &   0   &   \#  \\
\end{tabular}
```

1 2 3
4 5 6
7 8 9
* 0 #

- Cell alignment c—centre, l—left, r—right
- Number of alignment commands = number of columns `{ccc}`
- Column separator `&`
- Row separator `\\`

3.2.2 Tables with Vertical Bars

- Specify vertical bars with the "|" symbols in the alignment, e.g. `{|r|l|r|l|l|}`

```
\begin{tabular}{|r|l|r|r|}
World Rank & Institution                                & Total Score & Score on Alumni \\
         1 & Harvard University                       & 100.0       & 100.0           \\
         2 & Stanford University                      &  72.6       &  41.2           \\
         3 & Massachusetts Institute of Technology (MIT) &  72.0       &  72.8           \\
         4 & University of California, Berkeley       &  71.9       &  68.3           \\
         5 & University of Cambridge                  &  70.0       &  87.1           \\
         6 & California Institute of Technology       &  64.7       &  52.6           \\
         7 & Princeton University                     &  61.2       &  56.7           \\
         8 & Columbia University                      &  60.4       &  69.6           \\
         9 & University of Chicago                    &  57.5       &  65.0           \\
        10 & University of Oxford                     &  56.4       &  55.5           \\
  $\vdots$ & $\vdots$                                 & $\vdots$    & $\vdots$        \\
        38 & The University of Manchester             &  34.8       &  21.2           \\
\end{tabular}
```

World Rank	Institution	Total Score	Score on Alumni
1	Harvard University	100.0	100.0
2	Stanford University	72.6	41.2
3	Massachusetts Institute of Technology (MIT)	72.0	72.8
4	University of California, Berkeley	71.9	68.3
5	University of Cambridge	70.0	87.1
6	California Institute of Technology	64.7	52.6
7	Princeton University	61.2	56.7
8	Columbia University	60.4	69.6
9	University of Chicago	57.5	65.0
10	University of Oxford	56.4	55.5
⋮	⋮	⋮	⋮
38	The University of Manchester	34.8	21.2

3.2.3 Tables with Horizontal Bars

- Specify horizontal bars with the `\hline` commands

```
\begin{tabular}{|l|r|r|r|}
  \hline
  UK Census 2001    & Manchester  & Greater Manchester  & England \\
  \hline
  Total population  & 398,819     & 2,547,700           & 49,138,831 \\
  Foreign born      & 15.0\%      &  7.2\%              &  9.2\% \\
  White             & 81.0\%      & 91.0\%              & 91.0\% \\
  Asian             &  9.1\%      &  5.7\%              &  4.6\% \\
  Black             &  4.5\%      &  1.2\%              &  2.3\% \\
  Over 75 years old &  6.4\%      &  7.0\%              &  7.5\% \\
  Christian         & 62.4\%      & 74.0\%              & 71.8\% \\
  Muslim            &  9.1\%      &  5.0\%              &  3.1\% \\
  \hline
\end{tabular}
```

UK Census 2001	Manchester	Greater Manchester	England
Total population	398,819	2,547,700	49,138,831
Foreign born	15.0%	7.2%	9.2%
White	81.0%	91.0%	91.0%
Asian	9.1%	5.7%	4.6%
Black	4.5%	1.2%	2.3%
Over 75 years old	6.4%	7.0%	7.5%
Christian	62.4%	74.0%	71.8%
Muslim	9.1%	5.0%	3.1%

3.2.4 Rows Spanning Multiple Columns

- Rows over multiple columns (headings, titles):

  `\multicolumn{span}{layout}{content}`, e.g. `\multicolumn{5}{c}{Heading}`

```
\begin{tabular}{|r|l|r|r|r|}
  \hline
  \multicolumn{5}{|c|}{World population (millions)} \\
  \hline
 Rank & Most populous countries &  1990 &  2008 &  2025 \\
  \hline
    1 & China                   & 1,141 & 1,333 & 1,458 \\
    2 & India                   &   849 & 1,140 & 1,398 \\
    3 & United States           &   250 &   304 &   352 \\
    4 & Indonesia               &   178 &   228 &   273 \\
    5 & Brazil                  &   150 &   192 &   223 \\
    6 & Pakistan                &   108 &   166 &   226 \\
    7 & Bangladesh              &   116 &   160 &   198 \\
    8 & Nigeria                 &    94 &   151 &   208 \\
    9 & Russia                  &   148 &   142 &   137 \\
   10 & Japan                   &   124 &   128 &   126 \\
  \hline
\end{tabular}
```

World population (millions)				
Rank	Most populous countries	1990	2008	2025
1	China	1,141	1,333	1,458
2	India	849	1,140	1,398
3	United States	250	304	352
4	Indonesia	178	228	273
5	Brazil	150	192	223
6	Pakistan	108	166	226
7	Bangladesh	116	160	198
8	Nigeria	94	151	208
9	Russia	148	142	137
10	Japan	124	128	126

3.2.5 Professional Tables

- Professional tables: `booktabs` package
- Horizontal bars only: commands `\toprule`, `\midrule`, `\bottomrule`
- Column headings in bold font face with the `{\bf ...}` command

```
\begin{tabular}{lrr}
  \toprule
  {\bf Continent} & {\bf Density} & {\bf Population} \\
  \midrule
    Asia          & 86.7          & 4,140,336,501    \\
    Africa        & 32.7          &   994,527,534    \\
    Europe        & 70            &   738,523,843    \\
    North America & 22.9          &   528,720,588    \\
    South America & 21.4          &   385,742,554    \\
    Oceania       &  4.25         &    36,102,071    \\
    Antarctica    &  0            &         4,490    \\
  \bottomrule
\end{tabular}
```

Continent	**Density**	**Population**
Asia	86.7	4,140,336,501
Africa	32.7	994,527,534
Europe	70	738,523,843
North America	22.9	528,720,588
South America	21.4	385,742,554
Oceania	4.25	36,102,071
Antarctica	0	4,490

3.2.6 Table Floating Environment

- Table with a floating environment `table`
- Basic structure

```
\begin{table}[htbp]
\centering
  \begin{tabular}{lll}
    ...
  \end{tabular}
\caption{...}
\label{T: ...}
\end{table}
```

```
\begin{table}[h]
  \centering
  \begin{tabular}{lrr}
  \toprule
  {\bf Continent} & {\bf Density} & {\bf Population} \\
  \midrule
    Asia          & 86.7          & 4,140,336,501    \\
    Africa        & 32.7          &   994,527,534    \\
    Europe        & 70            &   738,523,843    \\
    North America & 22.9          &   528,720,588    \\
    South America & 21.4          &   385,742,554    \\
    Oceania       &  4.25         &    36,102,071    \\
    Antarctica    &  0            &         4,490    \\
  \bottomrule
  \end{tabular}
  \caption{Population by continents~\cite{WorldBank08}}
  \label{T:populationData}
\end{table}
```

Continent	Density	Population
Asia	86.7	4,140,336,501
Africa	32.7	994,527,534
Europe	70	738,523,843
North America	22.9	528,720,588
South America	21.4	385,742,554
Oceania	4.25	36,102,071
Antarctica	0	4,490

Table 3.1: Population by continents [6]

3.3 Exercises

3.3.1 Graphics

1. Create an empty document.
2. Include the graphics file provided using a single `\includegraphics[]{}` command.
3. Set the graphics size by using the `width`, `height`, `scale` options.
4. Rotate graphics with an `angle` option.
5. Introduce a floating environment `figure`, set figure's caption and label.
6. Refer to a figure in the text.
7. Create a figure consisting of two horizontally placed subfigures.

3.3.2 Tables

8. Recreate one of the tables provided in the lecture, use the `tabular` environment.
9. Specify the column alignment.
10. Use horizontal and vertical bars.
11. Make one of the rows to span two or more columns of the table.
12. Redesign the table by using the `booktabs` package.
13. Convert the table into a float by using the `table` environment.
14. Specify table caption and label.
15. Refer to the table in the text.

Bibliography

[1] (2012, Apr. 16) LaTeX Wikibook. [Online]. Available: http://www.wikibooks.org

[2] I. N. Bronstein and K. A. Semendiaev, *Reference on Mathematics for Engineers and Students of Technical Universities*, 15th ed., A. Z. Ryvkin, S. N. Akhlamov, and O. A. Sigal, Eds. 117071 Moscow B-71, Lenin Prospect 15: "Physical–Mathematical Literature" RAN, Mar. 3, 1998, (in Russian).

[3] (2012, Jun. 10) Academic ranking of world universities 2011. Center for World-Class Universities of Shanghai Jiao Tong University (CWCU). [Online]. Available: http://www.shanghairanking.com/ARWU2011.html

[4] (2007, Jan. 17) Key Facts Sheets. United Kingdom Census 2001. Archived from the original on Jul. 21, 2006. Retrieved Jul. 10, 2007. [Online]. Available: http://www.manchester.gov.uk

[5] (2007, Jul. 10) United Kingdom Census 2001. Manchester (Local Authority). [Online]. Available: neighbourhood.statistics.gov.uk

[6] CO_2 Emissions from Fuel Combustion Population 1971–2008. IEA OECD World Bank. (original population ref. OECD/World Bank, e.g., in IEA Key World Energy Statistics 2010, page 57).