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Graphics in LaTeX

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Enable Graphics Support

- LaTeXdoes not have graphics capabilities by default.
- Enable graphics with the "graphics" or "graphicx" package
  - `\usepackage[driver]{graphics}`
    - Uses traditional LaTeXsyntax (arguments are positional)
    - Less convenient (i.e. don't use this one)
  - `\usepackage[driver]{graphicx}`
    - Uses a keyword syntax (i.e. width=5cm)
    - Has all the capabilities of the graphics package with a more convenient syntax (i.e. use this one)
  - The driver argument is optional and it is best to leave it blank unless you have a specific reason to use a non standard driver.

Enable graphics with

```
\usepackage{graphicx}
```

LaTeX vs. pdfLaTeX

DVI vs. PDF

LaTeX

- Outputs DVI
- Supports encapsulated postscript (EPS) only
- Supports PSTricks

pdfLaTeX

- Outputs PDF
- Supports PDF, PNG, and JPG
- Does not support EPS or PSTricks

Formats

pdf vs. png vs. jpg

Which format should be used depends on the situation.

- Portable Document Format (PDF)
  - Vector graphic
  - Scalable without pixelation
  - Smaller file size (if a true vector graphic)
  - Use for graphs and plots if your math software supports it
  - Bitmaps can be converted into pdf, but the file size will usually be very large
- Portable Network Graphic (PNG)
  - Bitmap graphic
  - Lossless
  - Crisper edges
  - Larger file size (than jpg)
  - Use for screen shot, diagrams (if a vector version is no available), and any image with sharp edges (like a diagram with black lines)
- Joint Photographics Expert Group (JPEG or JPG)
  - Bitmap graphic
  - Lossy
  - Gradual color changes
  - Smaller file sizes
  - Use for photographs

The includegraphics Command

Graphics can be included with the command

```
\includegraphics[key=value]{filename}
```

where the options for `key` are

width	resize image to the width given
height	resize image to the height given
totalheight	resize image to totalheight
keepaspectratio	if both width and height are defined, then scale the image to fit the smaller of the two
scale	scale image to a percentage of its original size
angle	rotate the image counterclockwise (degrees)
origin	the point about which the image should be rotated
viewport	view only the region within the given coordinates
trim	crop the image by the given dimensions
clip	turn on the effects of trim
draft	display a figure even in draft mode

Specifying the Filename

Specifying the Extension

```
\includegraphics{filename}
```

- The `filename` can be given as `filename.ext` (i.e. `filename.pdf`)
- If an extension for `filename` is not given then LaTeX or pdfLaTeX will try to add the appropriate extension for you.
  - .eps for LaTeX
  - .png, .pdf, .jpg, or .mps for pdfLaTeX

  The order and type of the extensions can be customized with the `\DeclareGraphicsExtension` command. The defaults are
  - `\DeclareGraphicsExtension{.eps,.ps,eps.gz,.ps.gz,eps.Z}`
  - `\DeclareGraphicsExtension{.png,.pdf,.jpg,.mps}`

Specifying the Filename

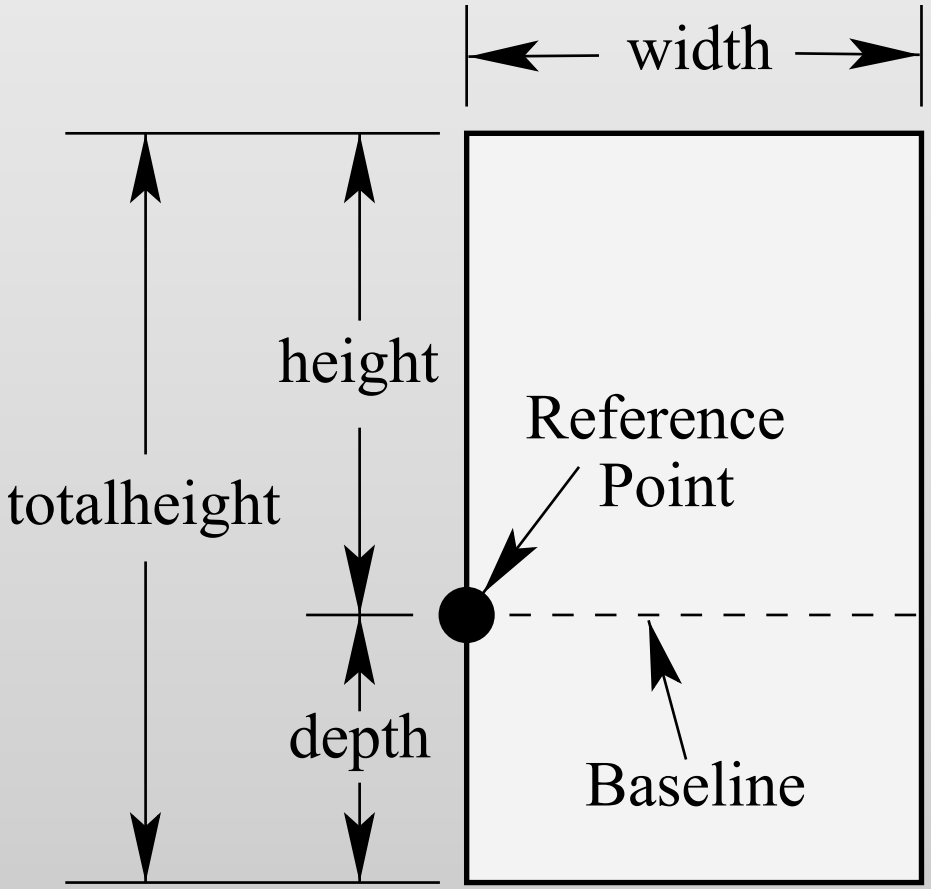
Path

Graphics that are not in the same directory as the `.tex` file can be included in one of three ways.

1. `\includegraphics{path/to/file}`
   - Requires same relative path on all computers
   - Can lead to pool space problems
2. `\graphicspath{path/to/}`
   `\includegraphics{file}`
   - Requires same relative path on all computers
   - Can lead to pool space problems
3. `setenv TEXINPUTS /dir1:/dir2:`
   - Needs to be run from a shell (sh, bash, etc.)
   - Recommended because it conserves pool space

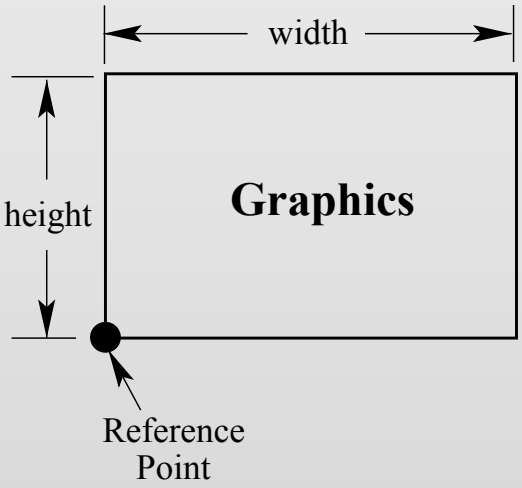
Size & Rotation

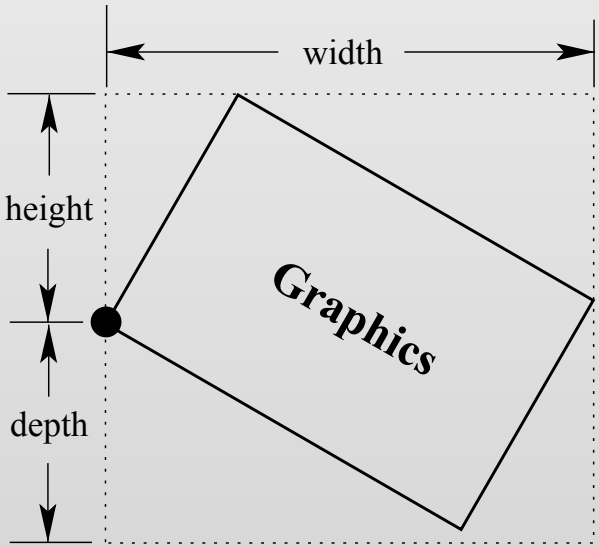
width, height, depth, totalheight

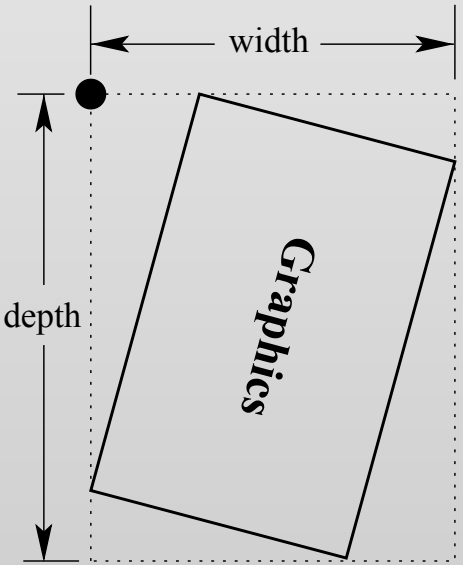


Size & Rotation

width, height, depth, totalheight







Size & Rotation

Resizing Images

```
\includegraphics[]{aulogo.pdf}
```

(a) [width=2cm]

(b) [height=2cm]

(c) [totalheight=2cm]

(d) [scale=0.15]

(e) [width=1cm, height=2cm]

(f) [width=1cm, height=2cm, keepaspectratio]

Figure: Size options for `\includegraphics`

Size & Rotation

Rotating Images

```
\includegraphics[]{aulogo.pdf}
```

(a) [height=2cm, angle=0]

(b) [height=2cm, angle=30]

(c) [angle=30, height=2cm]

(d) [height=2cm, angle=-30]

(e) [angle=-30, height=2cm]

(f) [angle=-30, totalheight=2cm]

Figure: Rotation options and order of operations for `\includegraphics`

Size & Rotation

Scalable Lengths

Dimensions can be defined as scalable lengths

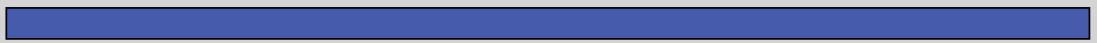
- `\includegraphics[width=1\textwidth]{box.pdf}`

- `\includegraphics[width=1\linewidth]{box.pdf}`

- `\includegraphics[width=\textwidth-\linewidth]{box.pdf}`

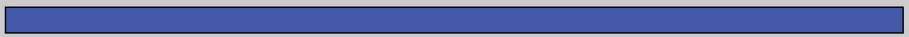
Column 1

- `\includegraphics [width=1\columnwidth]{box.pdf}`



Column 2

- `\includegraphics[height=0.025\textheight]{box.pdf}`



Positioning

Centering

```
\begin{center}
  \includegraphics[width=2cm]{aulogo.pdf}
\end{center}
```

Positioning

Multiple Images

```
\begin{center}
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}
\end{center}
```

Positioning

Avoiding Inter-Word Space Between Images

```
\begin{center}
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}%
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}
\end{center}
```

Positioning

Spacing Multiple Images

```
\begin{center}
  \hfill
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}
  \hfill
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}
  \hspace*{\fill}
\end{center}
```

What is a Float?

Figures, Tables, Margin Notes, .etc

- In LaTeX, floats are objects which automatically move to esthetically pleasing locations, i.e. figures and tables.
- A float may not appear on the page where it was defined or first referenced.
- Don't use the phrase "In the following figure," instead use "In Figure 14."

Float Placement

Float Placement

- When declaring a float, the following options can be used for placement

  h place the float here
  t place the float at the top of a page
  b place the float at the bottom of a page
  p place the float on a special "floats only" page
  ! try really hard to apply the option given, i.e. [h!] will try to place the float "here" even if it looks bad

- In general, it is better if you give LaTeX as many options as possible, i.e. [htbp]
- The option [h] is a really bad idea and most distributions will automatically replace it with [ht]

Overriding Float Settings

Clearing the Float Queue

Floats must appear in the order in which they are defined, i.e. Figure 7 can't appear before Figure 6. Therefore, if Figure 6 doesn't fit into the body of the text well, then it can be pushed to the end of a chapter, section, subsection, etc.; and it will take all of the following figures with it. Three ways to clear the float queue are:

- `\clearpage`
- `\afterpage{\clearpage}` ⇒ Requires the `afterpage` package
- `\FloatBarrier` ⇒ Requires the `placeins` package.

Overriding Float Settings

Postponing Floats

There are also ways to postpone the appearance of floats

- `\usepackage{flafter}` stops a float from appearing before it is referenced in the text
- `\usepackage{endfloats}` moves all floats to the end of the document (required by some journals)
- `\suppressfloats` prevents floats from appearing on the current page
- `\suppressfloats[t]` prevents floats from appearing at the top of the current page
- `\suppressfloats[b]` prevents floats from appearing at the bottom of the current page
- `\usepackage{morefloats}` increases the size of the float queue from 18 to 36

Overriding Float Settings

Adjusting the Float Settings

The float settings (consider by some to be too restrictive) can be customized with the following.

```
\setcounter{topnumber}{4}
\setcounter{bottomnumber}{4}
\setcounter{totalnumber}{10}
\renewcommand{\textfraction}{0.15}
\renewcommand{\topfraction}{0.85}
\renewcommand{\bottomfraction}{0.70}
\renewcommand{\floatpagefraction}{0.66}
```

The figure Environment

An image can be included as a figure with the following command.

```
\begin{figure}[htbp]
  \centering
  \includegraphics[key=value]{filename}
  \caption{Caption text}
  \label{fig:DescriptiveName}
\end{figure}
```

Note: it is better to used \centering than \begin{center}...\end{center} in a figure environment because both environments insert an empty line above and below their contents

Warning

The label must be after the caption, or it will reference the previous item

The figure Environment

Multiple Images in a Figure

The same commands that were used earlier for including graphics can be used within an figure environment

```
\begin{figure}[htbp]
  \centering
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}
  \fbox{\includegraphics[width=2cm]{aulogo.pdf}}
  \caption{Caption text}
  \label{fig:DescriptiveName}
\end{figure}
```

Figure: Caption text

Referencing Figures

Figures can be referenced in text with the command `\ref{fig:name}`, where `fig:name` corresponds to the name given in the `\label{}` command when the figure was defined.

The figure number can be referenced with
"`Figure~\ref{fig:aulogo}`"
which produces "Figure 1"

Figure 1: The Auburn Logo

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Referencing Figures

Referencing Page Numbers

The page number on which a figure appears can be referenced with the command `\pageref{fig:name}`, where `fig:name` corresponds to the name given in the `\label{}` command when the figure was defined.

The figure number and page number can be referenced with
"`Figure~\ref{fig:aulogo}`
`on page \pageref{fig:aulogo}`"
which produces "Figure 1 on page 1"

Figure 1: The Auburn Logo

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Referencing Figures

Conditional Referencing

A command can be defined to conditionally display only the figure number if the figure is on the same page as the reference or the figure number and page number if the figure is on a different page.

```
\newcommand\FigDiff[1]{Figure~\ref*{#1} on page~\pageref*{#1}}
\newcommand\FigSame[1]{Figure~\ref*{#1}}
\newcommand\Figref[1]{\ifthenelse{\value{page}=\pageref{#1}}
                     {\FigSame{#1}}{\FigDiff{#1}}}
```

The `varioref` package defines the `\vref{}` command which accomplishes the same thing as well as replacing the page number with “on the facing page”, “on the following page”, or “on the previous page” if the figure and reference are only one page apart.

Referencing Figures

Hyperlinking Figure References

When using the package **hyperref**, the figure numbers will be links to the captions of the figures. If the caption is below the figure, the image may need to be scrolled after clicking the link. To fix this put the following line in the preamble (after loading the **hyperref** package)

```
\usepackage[all]{hypcap}
```

List of Figures

List of Figures

A list of figures can be automatically built by including the line `\listofigures` after `\begin{document}`. The entry in the list of figures will be created from the caption of each of the figures.

List of Figures

The list of figures is automatically built by including the line `\listoffigures` after `\begin{document}`

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Figure 1: A really really really really really really long caption.

List of Figures

Short Name in List of Figures

A shorter version of the caption can be given for use in the list of figures by defining the caption as

```
\caption[Short
Description]{A really
really really really
really really really
really long caption}
```

List of Figures

The list of figures is automatically built by including the line `\listoffigures` after `\begin{document}`

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Figure 1: A really really really really really really long caption.

The caption Package

Declaring Options

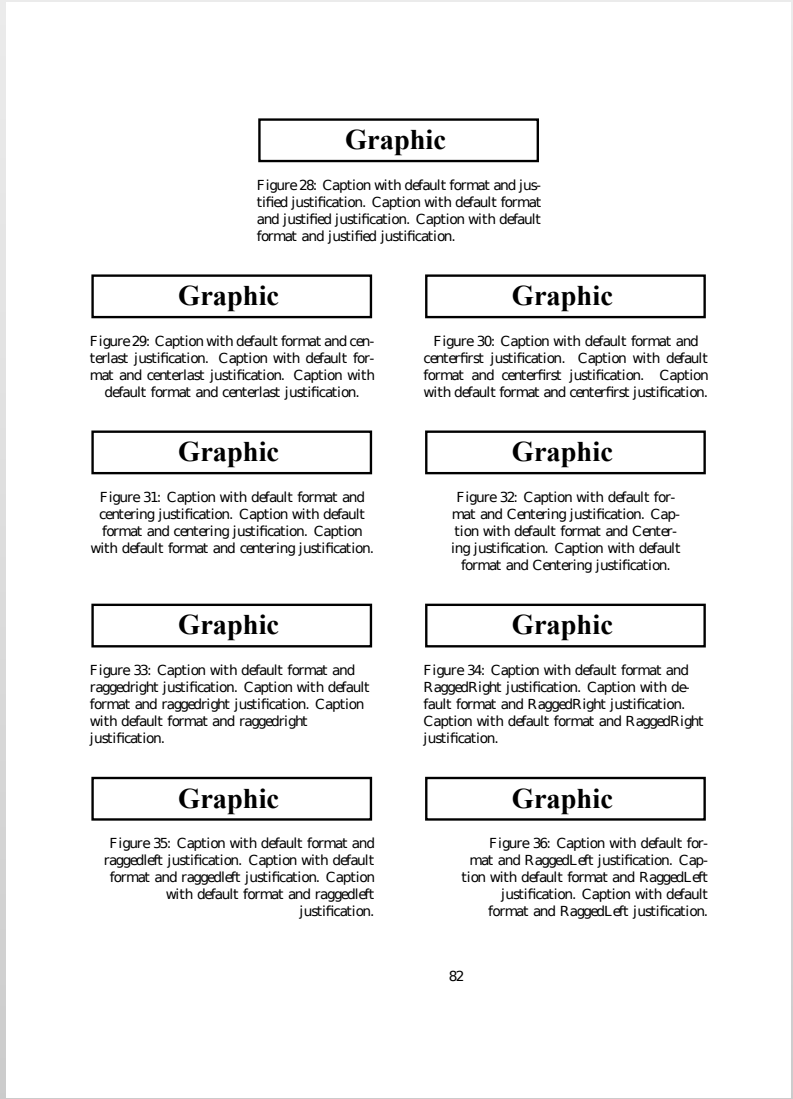
Captions can be customized with the `caption` package.
Options can be given in two ways

- `\usepackage[options]caption`
  - i.e. `\usepackage[labelfont=bf]{caption}`
- `\captionsetup{options}`
  - i.e. `\captionsetup{labelfont=bf}`

The caption Package

Examples of Customizing the Caption

The caption accepts values for the following options: font, labelfont, textfont, aboveskip, belowskip, position, parskip, labelformat, labelsep, format, justification, indentation, hangindent, margin, width, singlecheck.



Graphic

Figure 28: Caption with default format and justified justification. Caption with default format and justified justification. Caption with default format and justified justification.

Graphic

Figure 29: Caption with default format and centerlast justification. Caption with default format and centerlast justification. Caption with default format and centerlast justification.

Graphic

Figure 30: Caption with default format and centerfirst justification. Caption with default format and centerfirst justification. Caption with default format and centerfirst justification.

Graphic

Figure 31: Caption with default format and centering justification. Caption with default format and centering justification. Caption with default format and centering justification.

Graphic

Figure 32: Caption with default format and Centering justification. Caption with default format and Centering justification. Caption with default format and Centering justification.

Graphic

Figure 33: Caption with default format and raggedright justification. Caption with default format and raggedright justification. Caption with default format and raggedright justification.

Graphic

Figure 34: Caption with default format and RaggedRight justification. Caption with default format and RaggedRight justification. Caption with default format and RaggedRight justification.

Graphic

Figure 35: Caption with default format and raggedleft justification. Caption with default format and raggedleft justification. Caption with default format and raggedleft justification.

Graphic

Figure 36: Caption with default format and RaggedLeft justification. Caption with default format and RaggedLeft justification. Caption with default format and RaggedLeft justification.

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The caption Package

The \captionof Command

The caption package also defines the \captionof command, which allows for the creation of figure captions outside of the figure environment.

- i.e. \captionof{figure}{Caption text}
- i.e. \captionof{table}{Caption text}

Wide Figures

Two Column Figures

When writing a two-column document, a figure that will span both columns can be included with the `figure*` environment.

```
\begin{figure*}[htbp]
  \includegraphics[width=\textwidth]{box.pdf}
  \caption{A wide figure}
\end{figure*}
```

Note: the `figure*` environment will can the image to be placed at the top page after the place where it was defined. This may cause the figures to be out of order if another figure appears on the same page.

Wide Figures

Two Column Figures – Example

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This is where Figure 1 was defined

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This is where Figure 2 was defined

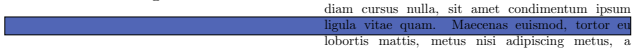

Figure 2: A wide figure included in the `figure` environment

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Figure 1: A wide figure included in the `figure*` environment

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Wide Figures

Expanding Figures and Tables Into the Margin

Wide figures (wider than the text) can be included by wrapping them in a `\makebox`

```
\noindent\makebox[\textwidth]{
\includegraphics[width=1.2\textwidth]
{box.pdf}}
\captionof{figure}{Caption text}}
```

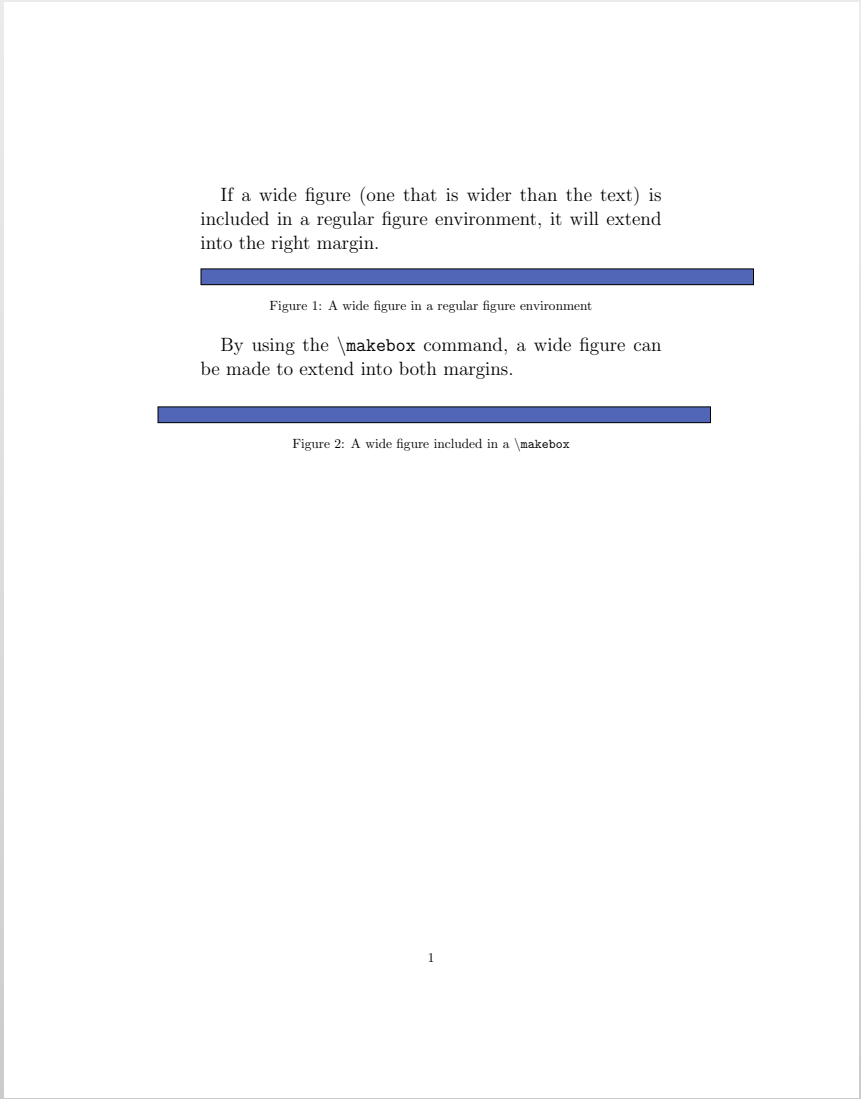
If a wide figure (one that is wider than the text) is included in a regular figure environment, it will extend into the right margin.

Figure 1: A wide figure in a regular figure environment

By using the \makebox command, a wide figure can be made to extend into both margins.

Figure 2: A wide figure included in a \makebox

1

Landscape Figures

Three options for landscape images are

- The `lscape` package: creates a `landscape` environment
  - Can include figure or table environments
  - Works with the `longtable` environment to produce muti-page landscape tables
  - The image will be on a separate floats page
  - Treat the left side as the top of the page
- The `rotating` package: creates a `sidewaysfigure` environment
  - Also creates a `sidewaystable` environment
  - Can customize right or left rotation for one and two sided documents
  - The image will be on a separate floats page
- The `rotating` package: creates a `\rotcaption` command which is used like the `\caption` command
  - Does not require the figure to be place on a separate floats page
  - Requires the use of two `minipage` environments: one for the figure and one for the caption

Landscape Figures

Two Column Figures – Example

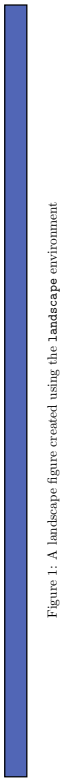

Figure 1: A landscape figure created using the `landscape` environment

1

Figure 1: A landscape figure created using the `sidewaysfigure` environment

1

Subfigures

Subfigures with the subcaption Package

The subcaption package (loaded after the caption) package defines the subfigure environment.

```
\begin{figure}[]
\begin{subfigure}[b]{0.5\linewidth}
  \centering
  \includegraphics[width=2cm]{aulogo.pdf}
  \caption{Subfigure 1}
  \label{fig:subfig1}
\end{subfigure}
\begin{subfigure}[b]{0.5\linewidth}
  \centering
  \includegraphics[width=2cm]{aulogo.pdf}
  \caption{Subfigure 2}
  \label{fig:subfig2}
\end{subfigure}
\caption{Subfigure example}
\label{fig:subfigexample}
\end{figure}
```

(a) Subfigure 1

(b) Subfigure 2

Figure: Subfigure example

Subfigures

Referencing Subfigures

Referencing subfigures is similar to referencing regular figures. Consider the subfigures on the previous slide.

- `\ref{fig:subfig1}`⇒ 4a
- `\ref{fig:subfig2}`⇒ 4b
- `\ref{fig:subfigexample}`⇒ 4
- `\subref{fig:subfig1}`⇒ a
- `\subref{fig:subfig2}`⇒ b

Subfigures

Customizing Subcaptions

The subcaptions can also be customized like the regular captions by either passing options when loading the `subcaption` command, or with the commands:

- `\captionsetup[sub]{...}` for all subcaptions
- `\captionsetup[subfigure]{...}` for only figure subcaptions
- `\captionsetup[subtable]{...}` for only table subcaptions

The wrapfig Package

Wrapping Text Around Figures

The wrapfig package enables a wrapfigure environment that will allow text to wrap around a figure.

```
\begin{wrapfigure}{r}{0.5\textwidth}
\centering
\includegraphics[width=0.4\textwidth]
  {aulogo.pdf}
\caption{A figure included in a
\texttt{wrapfigure} environment}
\end{wrapfigure}
```

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Figure 1: A figure included in a `wrapfigure` environment

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The overpic Package

The overpic package creates an overpic environment, which can be used in place of the \includegraphics command. This allows figures, text, tables, etc. to be placed of top of a figure. The objects can be placed at relative or absolute coordinates with respect to the image.

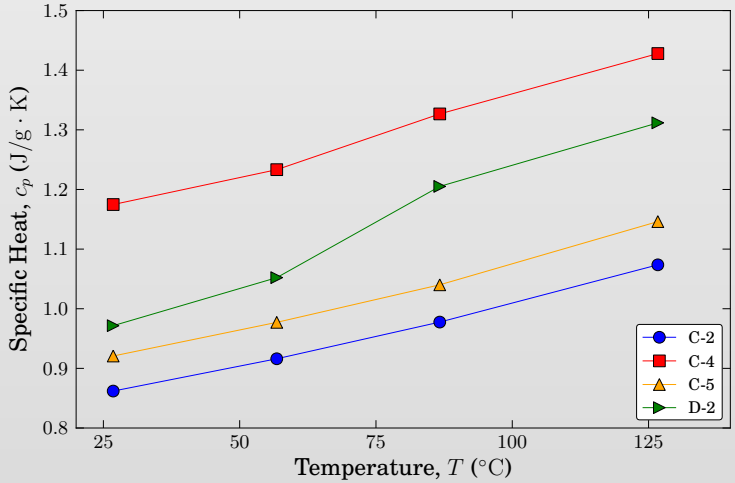
- \usepackage{overpic} for relative coordinates
- \usepackage[abs]{overpic} for absolute coordinates
- Place objects with the \put(x,y){} command
- The overpic environment accepts the same options as the \includegraphics command

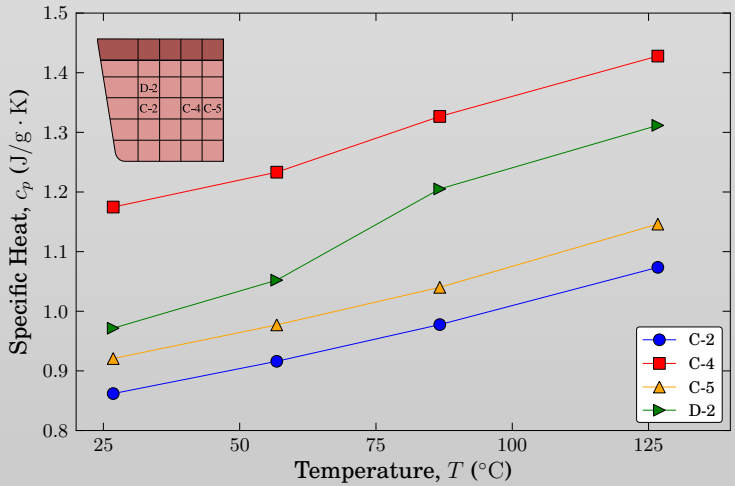
The overpic Package

Stacking Figures

```
\begin{figure}[htbp]
\centering
\includegraphics[width=\linewidth]
  {SpecificHeatSpatialChange.pdf}
\end{figure}

\begin{figure}[htbp]
\centering
\begin{overpic}[width=\linewidth]
  {SpecificHeatSpatialChange.pdf}
\put(15,38){\includegraphics%
[width=0.15\textwidth]%
{MapSpatialChange4.pdf}}
\end{overpic}
\end{figure}
```



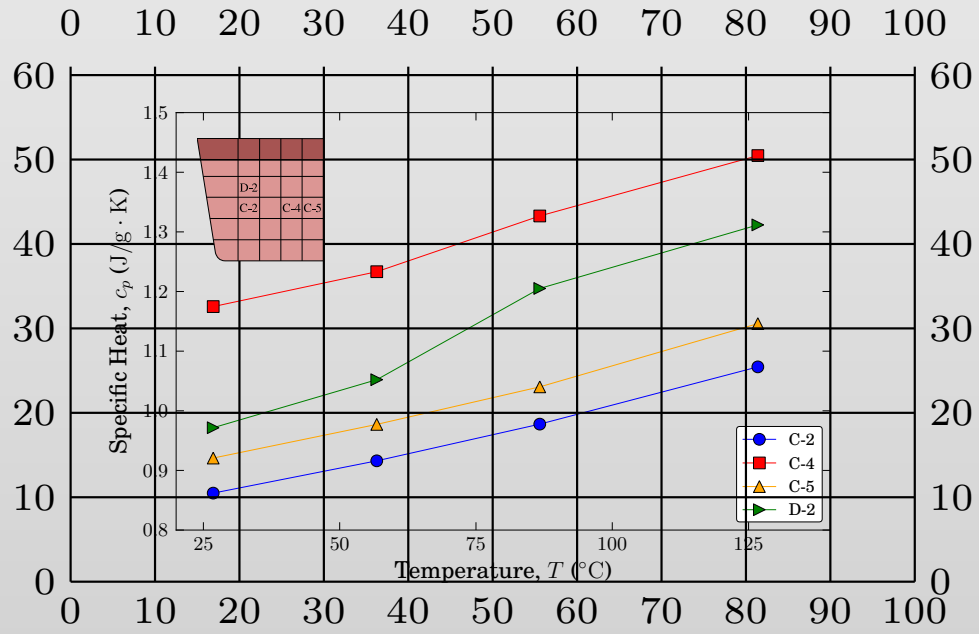


The overpic Package

Stacking Figures

The grid option can be given to the overpic environment to aid in placement.

```
\begin{figure}[htbp]
\centering
\begin{overpic}%
  [width=\linewidth,grid]
  {SpecificHeatSpatialChange.pdf}
\put(15,38){
  \includegraphics%
  [width=0.15\textwidth]%
  {MapSpatialChange4.pdf}}
\end{overpic}
\end{figure}
```



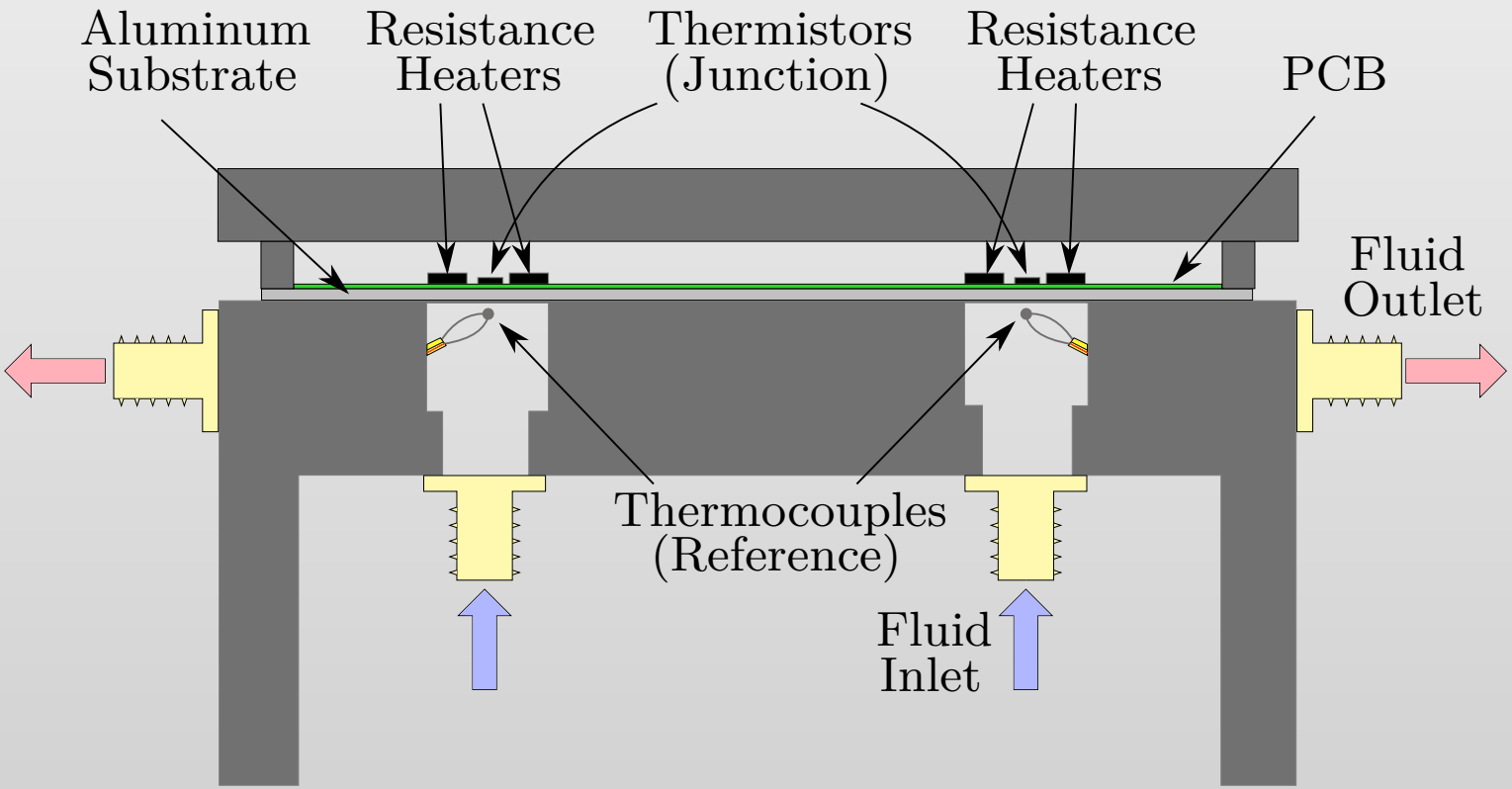
Fonts in Graphics

When images are labeled in an external program, the fonts of the labels will not match the rest of the LaTeX document. Two ways to remedy this are:

- Label the images with `overpic`
  - Use a `\put(x,y){}` for each word
  - Takes a long time
  - If the size of the font or image changes, then the position will have to be corrected
- Label the image in Inkscape and export to pgf
  - Create text labels in Inkscape
  - Export to pdf with the "PDF+LaTeX: Omit text in PDF, and create LaTeX file" option selected
  - Requires Inkscape ≥ 0.48 (currently still in development)

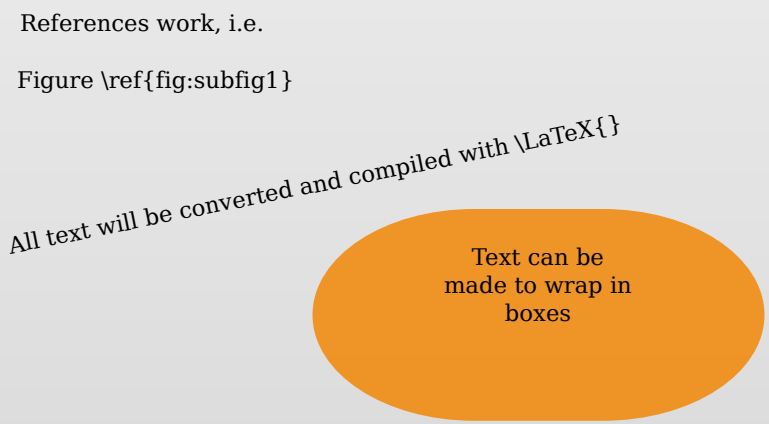
Fonts in Graphics

Labeling with `overpic`

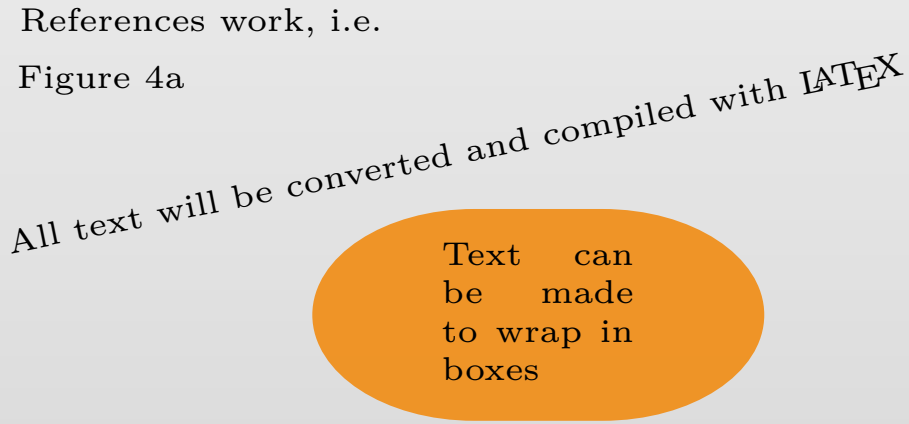


Fonts in Graphics

Labeling Images with Inkscape



(a) Prior to exporting with the LaTeX option



(b) After text has been recompiled with LaTeX

Figure: Example of using the export to LaTeX option in Inkscape.

Fonts in Graphics

Using the inkscapelatex Package

When using the Inkscape export to LaTeX option, two files will be created: `filename.pdf` and `filename.pdf_tex`. The `filename.pdf_tex` is a pgf file than will pull in `filename.pdf` and place the text over it. This can be included in a LaTeX document with the following

```
\begin{figure}[]
  \centering
  \def\svgwidth{\columnwidth}
  \input{filename.pdf_tex}
\end{figure}
```

where `\svgwidth` is used to control the width of the image

Fonts in Graphics

The `inkscapelatex` Package

The `inkscapelatex` package (included in the source directory of this file) can be used on Linux/Unix based system to automatically update the .pdf and .pdf_tex files when LaTeX is run if the .svg file has changed if the `-shell-escape` option is included in the `pdflatex` command. Loading the package will create a new command `\includesvg` command which can be used as

```
\begin{figure}[]
  \centering
  \def\svgwidth{\columnwidth}
  \includesvg{filename}
\end{figure}
```

where `filename` is given without the extension.

Further details can be found at the following links:

http://www.ctan.org/tex-archive/help/Catalogue/entries/epslatex.html

http://www.ctan.org/tex-archive/help/Catalogue/entries/overpic.html

http://www.ctan.org/tex-archive/help/Catalogue/entries/svg-inkscape.html

http://www.ctan.org/tex-archive/help/Catalogue/entries/caption.html

http://www.ctan.org/tex-archive/help/Catalogue/entries/lscape.html

http://www.ctan.org/tex-archive/help/Catalogue/entries/wrapfig.html