Robotics 2
LaTeX

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Motivation

- Introduction to the most relevant tools commonly used in scientific writing
  - **LaTeX** - a general typesetting system
  - Gnuplot - a plotting utility to visualize data

Why not Using Word?

- "I am happy with Word, why not use it?"

- Word might be fine for small and simple documents such as a letter with few pages
- Word is clearly suboptimal for scientific writing (reformatting texts takes ages, no proper math typesetting, no build-in citation system, problems when using lots of images, …)
- Most results produced by Word are look ugly compared to LaTeX documents

LaTeX

- Key idea: concentrate on writing texts not on design
- Purely text-based (no WYSIWYG)
- More a programming language than a word processor
- Pronunciation is “lei-tek” or “la-tek”, but never “lei-teks” – that is a rubber product [A. Tabet]
- You will need it for your future scientific activities such as writing papers, theses, reports
- It takes time to learn and get used to it, so do that as early as possible
- In this course, you will have to use LaTeX

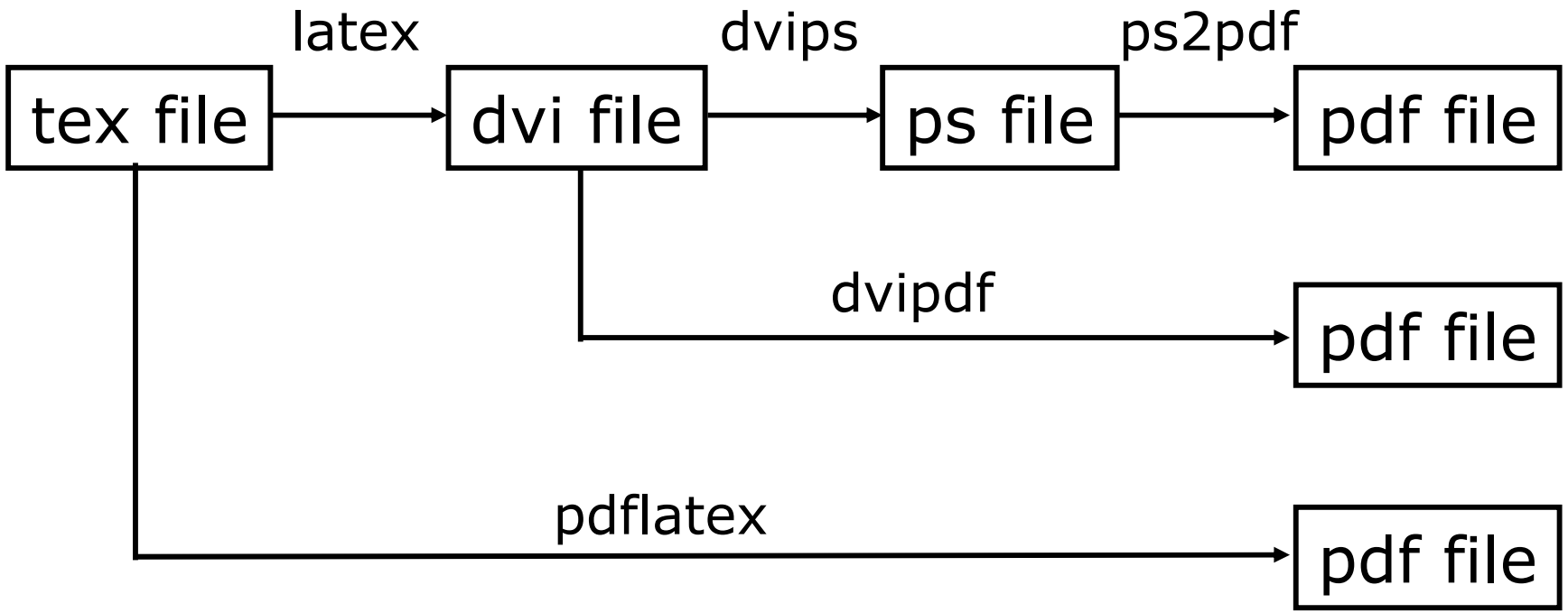
Advantages of LaTeX

- Concentrate on writing texts not on design
- Design is done by design templates
- It is only text based and thus excellent for collaborative working and synchronization (svn, cvs, diff, …)
- Automatic and consistent cross-referencing, bibliography, labels
- Nice-looking mathematic typesetting
- Results look the same on all machines
- It is available for more or less all platforms
- It is free
- De-facto standard for scientific documents

You Need

- TeX or LaTeX program
  - Linux: teTex comes with all mayor distributions
  - Windows: MikTeX
  - OS X: TeX (via fink) or MacTeX
- Text editor (Emacs, Vim, WinEdit, TextEdit, …)
- Ghostscript, ghostview, pdf viewer/dvi viewer
- Plotting/graphics utility (Gnuplot, Xfig/Inkscape)

How Does LaTeX Work?



Note on LaTeX for OS X

- A key difference to LaTeX under Linux/Windows compared Mac OS X is that OS X uses pdfLaTeX by default (probably since there is no non-X dvi viewer under OS X
- One can use xdvi (under X11) and standard LaTeX by (for fink systems)

  cd /sw/bin

  sudo mv latex latex-org

  sudo ln –s tex latex

LaTeX Example

```
\documentclass{article}
\title{Cartesian closed categories and the price of eggs}
\author{Jane Doe}
\date{September 1994}
\begin{document}
   \maketitle
   Hello world!
\end{document}
```

- This document is an article.
- Its title is Cartesian closed categories and the price of eggs.
- Its author is Jane Doe.
- It was written in September 1994.
- The document consists of a title followed by the text Hello world!

A LaTeX Document Contains

- Preamble: document class, packages to include, fonts, definitions, title, author, date
- Body: the text, typically broken down in chapters, sections, subsections, an abstract, …
- Bibliography
- Optionally lists such as table-of-content, list of figures, etc.

preamble

body

```
\documentclass{article}
\title{Cartesian closed categories}
\author{Jane Doe}
\date{September 1994}
\begin{document}
   \maketitle
   Hello world!
\end{document}
```

A More Complex Document

```
\documentclass{article}
\title{Cartesian closed
categories}
\author{Jane Doe}
\date{September 1994}
\begin{document}
  \maketitle
  \section{Introduction}

\subsection{Motivation}
     We need to fix
that.
  \section{Conclusion}
    Solved!
\end{document}
```

Cartesian closed categories

Jane Doe

September 1994

1 Introduction

1.1 Motivation

We need to fix that.

2 Conclusion

Solved!

Bibliography with BibTeX

- References to other publications is essential in scientific writing
- LaTeX uses the program BibTeX for generating these references

```
…
\begin{document}
   The work of Stachniss \emph{et al.}~\cite{stachniss09amai}
   …
\end{document}
```

```
@ARTICLE{stachniss09amai,
  TITLE =          {Efficient Exploration of Unknown
        Indoor Environments using a Team of Mobile Robots},
  AUTHOR =         {Stachniss, C. and Martinez Mozos, O. and Burgard, W.},
  JOURNAL =        {Annals of Mathematics and Artificial Intelligence},
  year =           2009,
  volume =         52,
  issue =          2,
  pages =          {205ff}
}
```

A Bibliography File

```
@ARTICLE{stachniss09amai,
  TITLE =   {Efficient Exploration of Unknown Indoor
                  Environments using a Team of Mobile Robots},
  AUTHOR =  {Stachniss, C. and Martinez Mozos, O. and Burgard, W.},
  JOURNAL = {Annals of Mathematics and Artificial Intelligence},
  year =     2009,
  volume =   52,
  issue =    2,
  pages =    {205ff}
}
```

```
@string{IJCAI = "Proc.~of the Int.~Conf.~on Artificial Intelligence
(IJCAI)"}

@InProceedings{sturm09ijcai,
  author =    {J. Sturm and V. Predeap and  Stachniss, C. and C.
               Plagemann and K. Konolige and  Burgard, W.},
  title =     {Learning  Kinematic Models for Articulated  Objects},
  booktitle = IJCAI,
  year =      2009,
  address =   {Pasadena, CA, USA},
  NOTE =     {To appear},
}
```

Bibliography in Action

In robotics, one of the core capabilities needed for the majority of applications is autonomous navigation. For truly autonomous navigation in initially unknown environments, the robot has to solve the so-called simultaneous localization and mapping (SLAM) problem [2, 12, 19]. Solving the SLAM problem, however, is computationally demanding

REFERENCES

[1] S. Arya and D.M. Mount. Algorithms for fast vector quantization. In *Proc. of the IEEE Data Compression Conference (DDC'93)*, pages 381–390, 1993.

[2] T. Bailey. *Mobile Robot Localisation and Mapping in Extensive Outdoor Environments*. PhD thesis, University of Sydney, 2002. pages 22–23.

[3] A. Barto and M. Duff. Monte Carlo matrix inversion and reinforcement learning. In *Advances in Neural Information Processing Systems*, pages 687–694, 1994.

BibTeX – What is Needed?

- latex, bibtex (comes with all LaTeX distributions)
- A LaTeX document (*.tex)
- A bibliography file (*.bib)
- Tell which bibliography style to use

Execute:

- latex mytext # which bibitems are used
- bibtex mytext # create corresponding references
- latex mytext # generate numbers
- latex mytext # integrate them into the output
  # document

Different Bibliography Styles

plain

In robotics, one of the core capabilities needed for the majority of applications is autonomous navigation. For truly autonomous navigation in initially unknown environments, the robot has to solve the so-called simultaneous localization and mapping (SLAM) problem [2, 12, 19]. Solving the SLAM problem, however, is computationally demanding

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named

Yan and Pollefeys [2006] present an approach for learning the structure of an articulated object from feature trajectories under affine projections. They first segment the feature trajectories by local sampling and spectral clustering and then build the kinematic chain as a minimum spanning tree of a graph constructed from the segmented motion subspaces.

[Yan and Pollefeys, 2006] J. Yan and M. Pollefeys. Automatic kinematic chain building from feature trajectories of articulated objects. In *CVPR*, 2006.

Bibliography

- The same conference/journal should be written in the same way, not
  - A. Abc “An approach to..”. In Proc. of ICRA”
  - C. Cba “A technique to..”. In Proc. of the Int. Conf. on Robotics and Automation (ICRA)”
- Some authors have abbreviated first names, other not
- A bibtex reference (the label in brackets) is never part of a sentence
  - NOT: [2] describes an approach …
  - The work of Abc [2] describes an approach …
  - As shown by Abc [2], the SLAM problem …

References and Labels

- Similar to citations, LaTeX provides means for referencing in documents
- Definition of labels
- Possibility to reference a label using the chapter, section, subsection, figure, table number
- Possibility to reference to the page number where a certain label is defined
- Possibility to define own references and counters
- All this is done consistently and automatically

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Itemizations and lists

- LaTeX has multiple ways of generating lists and itemizations
- LaTeX uses so-called environments
- Environments start with \begin and end with \end
- Each item starts with \item followed by text

```
\begin{itemize}
  \item bee
  \item crocodile
  \item mouse
\end{itemize}
```

```
\begin{descrition}
  \item [*] bee
  \item [*] crocodile
  \item [*] mouse
\end{descrition}
```

Itemizations

```
…
\begin{document}
An itemized list of animals:
\begin{itemize}
\item bee
\item crocodile
\item mouse
\end{itemize}
\end{document}
```

An itemized list of animals:

- bee
- crocodile
- mouse

Math (1)

```
…
\usepackage{amsmath}
\begin{document}
\begin{align}
 x &= \int_{-\infty}^{\infty} f(x)\,dx \nonumber
  \end{align}
\end{document}
```

$$x = \int_{-\infty}^{\infty} f(x)\,dx$$

Math (2)

```
…
\usepackage{amsmath}
\begin{document}
\begin{align}
    E &= mc^2                                          \\
    m &= \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}
  \end{align}
\end{document}
```

$$E = mc^2 \tag{1}$$

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2}$$

Math (3)

```
…
\usepackage{amsmath}
\begin{document}
Let us start with some math.

\begin{align}
    E &= mc^2                                    \\
    m &= \frac{m_0}{\sqrt{1-\frac{v^2}{c^2}}}
    \label{eq:m}
  \end{align}
As shown in \eqref{eq:m}, $m$ depends on $m_0$.
\end{document}
```

Let us start with some math.

$$E = mc^2 \tag{1}$$

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} \tag{2}$$

As shown in (2), m depends on m_0.

Figures

- LaTeX can also deal with figures and images
- A figure is an environment that is placed by LaTeX automatically
- Inside a figure, an image can be included with the command \inlcudegraphics[options]{filename}
- Every figure should have a caption describing it
- With \label, one can define a label for referencing the figure

```
\begin{figure}
  \includegraphics[width=0.5\columnwidth]{pics/tasks}
    \caption{My caption}
    \label{fig:myimage}
\end{figure}

Figure~\ref{fig:myimage} depicts the result of …
```

Figures

```
\begin{figure}
  \begin{center}
    \newcommand{\pscale}{0.5}
    \includegraphics[width=\pscale\columnwidth]{pics/activeloop/tasks}
    \caption{Tasks that need to be solved …}
    \label{fig:intro:tasks}
  \end{center}
\end{figure}
```

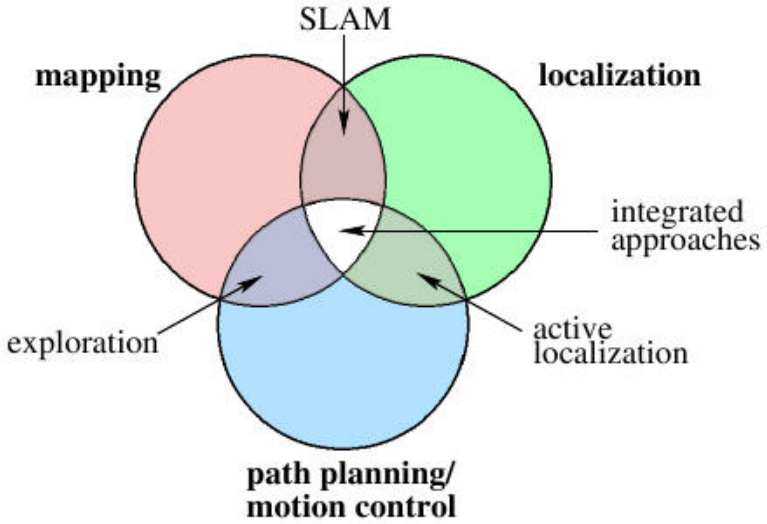

Fig. 1.1. Tasks that need to be solved by a robot in order to acquire accurate models of the environment. The overlapping areas represent combinations of the mapping, localization, and path planning tasks [94].

Figures

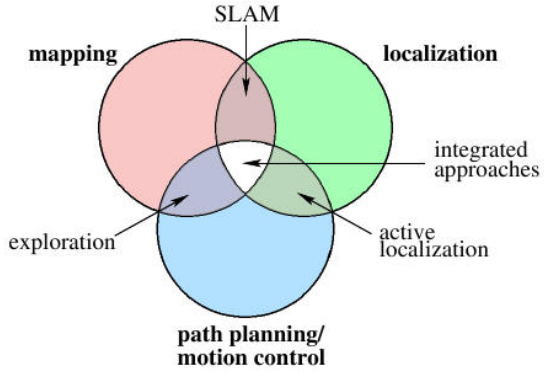

Fig. 1.1. Tasks that need to be solved by a robot in order to acquire accurate models of the environment. The overlapping areas represent combinations of the mapping, localization, and path planning tasks [94].

```
\begin{figure}
  \begin{center}
    \newcommand{\pscale}{0.5}
    \includegraphics[width=\pscale\columnwidth]{pics/activeloop/tasks}
    \caption{Tasks that need to be solved …}
    \label{fig:intro:tasks}
  \end{center}
\end{figure}

The diagram in Figure~\ref{fig:intro:tasks} depicts the mapping,
localization, and path planning tasks as well as the combined problems
in the overlapping areas
```

The diagram in Figure 1.1 depicts the mapping, localization, and path planning tasks as well as the combined problems in the overlapping areas.

Supported Images

- LaTeX (dvi output) reads eps and ps files
- PdfLaTeX (pdf output) reads pdf, png, jpg files
- In theory, one can place images for LaTeX and pdfLaTeX in a project
- This can lead to inconsistencies depending on the image converter
- Note: pdf, eps, and ps are typically vector images (which can also include raster images)
- Prefer vector images vs. raster images, especially when they contain text or drawings

Further Reading

- A lot of free LaTeX books are available online
- Thousands of LaTeX packages available for all sorts of modifications

- http://www.latex-project.org/
- Or use Google to search for a specific solution

Get used to LaTeX NOW!