Scale Invariant Semantic Segmentation with RGB-D Fusion

Master thesis
University of Kaiserslautern

Alwi Husada

February 9, 2018

Kurzfassung

<insert your name>

<insert title>

Schlagwörter: <insert key words>

Abstract

Alwi Husada

Scale Invariant Semantic Segmentation with RGB-D Fusion

Key words: <insert key words>

Declaration

I hereby declare that this thesis is my own work and effort and that it has not been submitted anywhere for any award. Where other sources of information have been used, they have been acknowledged.

Kaiserslautern, February 9, 2018 Alwi Husada

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CHAPTER 1

Introduction

This LaTeX template is designed for the creation of thesis documents (bachelor, master, phd) and targets both beginner and experienced users of LaTeX. It supports all basic functionality and requirements of a technical document such as the inclusion of graphics, math, tables, references, bibliography and much more. In contrast to a standard LaTeX document this template not only loads all state of the art packages (`preamble/packages.tex`) to provide the best functions for each task, but also includes a separate document for the style/layout of the document (`preamble/style.tex`). It therefore tries to separate functionallity and layout as much as possible. And the best, everything is documented in the code and furthermore in a separate documentation file (`TemplateDocumentation.pdf`)

This document shows in section 3.1 a general tutorial for LaTeX with links to the documentation for further tasks. You can view the underlying code in file `content/demo/latextutorial.tex` or in this document in section 3.1.11.

The code of the template itself is documented in `TemplateDocumentation.pdf`.

CHAPTER 2

Theory

Duis porta orci. Integer eu arcu at enim tempus facilisis. Pellentesque dignissim orci sed est. Etiam elementum laoreet mi. Donec nunc sapien, dictum in, tristique sed, aliquam vitae, massa. Morbi magna magna, vestibulum tempor, lobortis non, convallis nec, nibh. In sed nibh. Suspendisse adipiscing dictum pede. Suspendisse non augue. Lorem ipsum dolor sit amet, consectetuer adipiscing elit. Pellentesque lacinia, velit sed commodo convallis, diam dolor consequat ligula, a scelerisque quam neque et purus. Praesent vel augue. Sed lectus leo, dignissim eget, vulputate eu, auctor ut, nulla. Vivamus a quam. Nulla tellus. Pellentesque tempor pulvinar nunc.

2.1 Semantic Segmentation

$$J_f(a) := \frac{\partial f}{\partial x}(a) := \frac{\partial(f_1, \ldots, f_m)}{\partial(x_1, \ldots, x_n)}(a) := \left(\frac{\partial f_i(a)}{\partial x_j}\right)_{i=1,\ldots,m;\ j=1,\ldots,n} \tag{2.1}$$

2.1.1 Pixel-based Semantic Segmentation

Subsubsection heading

2.1.2 Instance-based Semantic Segmentation

2.2 Deep Convolution Neural Network (DCNN)

2.2.1 Convolution Neural Network (CNN)

2.2.2 Dilated Convolution Neural Network

CHAPTER 3

Experiments

3.1 LaTeX Typesetting By Example

This section demonstrates a basic set of LaTeX formatting commands and shows how they look like in this template. For comparison of the typeset output with the input document refer to the code listing starting on page 11.

The content presented here is based on similar text by Phil Farrell[1] and Harvey Gould[2]. For further reading on the possibilities of this template please refer to the documentation: `TemplateDocumentation.pdf`.

3.1.1 Plain Text

Type your text in free-format; lines can be as long or as short as you wish. You can indent or space out your input text in any way you like to highlight the structure of your manuscript and make it easier to edit. LaTeX fills lines and adjusts spacing between words to produce an aesthetically pleasing result.

Completely blank lines in the input file break your text into paragraphs. Several command exist to change the font for a single character, word, or set of words. Simply enclose the word and within braces of the formating command, *like this*. A font changing command not enclosed in braces, like the change to **bold here, keeps that change in effect until the end of the document or until countermanded by another font switch, like this change back to** the default font.

3.1.2 Font shapes

The default font in the template is Latin Modern (lmodern). It includes *italics*, **boldface**, *slanted*, SMALL CAPS and `monospaced` fonts as well as the corresponding sans serif variants of the same font family sans serif, *italics*, **boldface** and *slanted*. Note that for other fonts not all font shapes may be available.

3.1.3 Quotation and Citations

LaTeX provides the 'quote' and 'quotation' environments for typesetting quoted material or any other text that should be slightly indented and set off from the normal text.

However, if the text shall not just be indented but rather be a real quotation with a citation of the origin, then the commands 'enquote' for inline quotes and 'blockquote' for multi line quotes are more appropriate. The first is used to highlight the commands

1 https://pangea.stanford.edu/computing/unix/formatting/latexexample.php
2 http://sip.clarku.edu/tutorials/TeX/

in this section and the latter in the following text, which is a direct quotation from the documentation of the package *csquotes*:

> This command determines the length of the text. If the length exceeds a certain threshold, the text will be typeset in display mode, i. e., as a block quotation. If not, `\blockquote` will behave like `\textquote`. Depending on the threshold type option, the threshold may be based on the number of lines required to typeset the text or on the number of words in the text. (csquotes.pdf)

The standard command for citations is `\cite` which may have a prenote argument for adding a page number or something similar. To show how a citation is typeset we cite here a book about LaTeX [**companion**]. Further commands such as `\parencite` [**companion**] and `\textcite` **companion** allow a different typeset of the citation. The resulting bibliography is printed out on page 25. Refer to the biblatex manual for further details on citation commands and modifications on the printout and the section on biblatex in the template documentation.

3.1.4 References

So far, in this text chapter and section headings, paragraphs (section 3.1.1), font changes (section 3.1.2) and citations (section 3.1.3) were demonstrated ad in this section the use of references. Not that here the command `\cref` was used instead of the standard `\ref`.

The following sections show lists, tables and math.

3.1.5 Lists

LaTeX has three types of lists with the environment names *itemize*, *enumerate* and *description*. All lists have a separation between each item, to improve the reading of item texts spanning several lines. This item text can contain multiple paragraphs. These paragraphs are appropriately spaced and indented according to their position in the list.

- The 'itemize' sets off list items with *bullets*, like this.
- Of course, lists can be nested, each type up to at least four levels. One type of list can be nested within another type.
  - Nested lists of the same type will change style of numbering or *bullets* as needed.

1. The 'enumerate' environment numbers the list elements.

   This is a new paragraph in the item text, which is not intended as in the normal text but separated from the previous paragraph.

2. The enumeration scheme changes with each nesting level

   a) as shown in this nested enumerated list item.

Don't forget to close off all list environments with the appropriate `\end{...}` command. Indenting `\begin{...}`, `\item`, and `\end{...}` commands in the input document according to their nesting level can help clarify the structure.

3.1.6 Tables

Tables are a little more difficult. One can achieve even the most complex and fancy layout, even spanning over multiple pages, but the code to create these tables is not necessarily the best readable one.

Table 3.1 is a very simple table showing data lined up in columns, where each column width is automatically calculated by LaTeX. Notice that the tabular is centered with `\centering` and printed in a a smaller font to achieve a clear distinction to the normal text. The title is created above the tabular with `\captionabove`.

Table 3.1: Numbers of Computers in the department, By Type.

Mac (Apple)	2
Windows XP, 7	60
Linux (Server)	10

Table 3.2 on page 7 demonstrate the creation of a pleasant appearing table, which helps to read the table without attracting to much attention by the use of shaded colors. The caption uses the additional short caption in square brackets `[ ]`, which is used in the list of tables, see page 27.

Table 3.2: Comparison of the mean-field predictions for the critical temperature of the Ising model with exact results and the best known estimates for different spatial dimensions d and lattice symmetries.

lattice	d	q	T_{mf}/T_c
square	2	4	1.763
triangular	2	6	1.648
diamond	3	4	1.479
simple cubic	3	6	1.330
bcc	3	8	1.260
fcc	3	12	1.225

The design and creating of complex tables is shown in much greater detail in the documentation of this template.

3.1.7 Mathematical Equations

Simple equations, like x^y or $x_n = \sqrt{a+b}$ can be typeset right in the text line by enclosing them in a pair of single dollar sign symbols. Don't forget that if you want a real dollar sign in your text, like $2000, you have to use the `\$` command.

A more complicated equation should be typeset in *displayed math* mode using `\[ ... \]`, like this:

$$z\left(1 \;+\; \sqrt{\omega_{i+1} + \zeta - \frac{x+1}{\Theta+1}y + 1}\right) \quad = \quad 1$$

The `equation` environment displays your equations, and automatically numbers them consecutively within your document, like this: We can give an equation a label so that we can refer to it later.

$$E = -J \sum_{i=1}^{N} s_i s_{i+1}, \tag{3.1}$$

Equation (3.1) expresses the energy of a configuration of spins in the Ising model.[1]

For more complex formulas it may be necessary to do some fine tuning by adding small amounts of horizontal spacing,

```
\, small space        \! negative space
```

as is done in eq. (3.2).

$$\iiint_{\mathcal{G}} \left[u\nabla^2 v + (\nabla u, \nabla v)\right] \mathrm{d}^3 V = \oiint_{S} u \, \frac{\partial v}{\partial n} \, \mathrm{d}^2 A \tag{3.2}$$

We also can also align several equations

$$\dot{q}_i = \frac{\partial H}{\partial p_i} \tag{3.3}$$

$$\dot{p}_i = -\frac{\partial H}{\partial q_i} \tag{3.4}$$

number them as subequations

$$\dot{q}_i = \frac{\partial H}{\partial p_i} \tag{3.5a}$$

$$\dot{p}_i = -\frac{\partial H}{\partial q_i} \tag{3.5b}$$

or with only a single number

$$\begin{aligned} \dot{q}_i &= \frac{\partial H}{\partial p_i} \\ \dot{p}_i &= -\frac{\partial H}{\partial q_i} \end{aligned} \tag{3.6}$$

Many further possibilities of displaying equations exist.

1 It is necessary to process (typeset) a file twice to get the counters correct.

Common Greek letters

These commands may be used only in math mode. Only the most common letters are included here.

$$\alpha, \beta, \gamma, \Gamma, \delta, \Delta, \varepsilon, \zeta, \eta, \theta, \Theta, \kappa, \lambda, \Lambda, \mu, \nu, \xi, \Xi, \pi, \Pi, \rho, \sigma, \tau, \phi, \Phi, \chi, \psi, \Psi, \omega, \Omega$$

3.1.8 Literal text

It is desirable to print program code exactly as it is typed in a monospaced font. Use `\begin{lstlisting}` and `\end{lstlisting}` as in the following example:

```
1 double y0 = 10; // example of declaration and assignment statement
2 double v0 = 0;  // initial velocity
3 double t = 0;   // time
4 double dt = 0.01; // time step
5 double y = y0;
```

Two styles are defined in this template: `lstStyleCpp` and `lstStyleLaTeX`.

A complete file can be printed with listings using the command `\lstinputlisting`, see section 3.1.11 for an example.

3.1.9 Figures

Figures with captions are included in the `figure` environment in order to position the graphic inside the text. The size should be given in relation to natural text size. It is recommended to use a percentage value of the `\textwidth`. This size should not exceed 80 % of the text width.

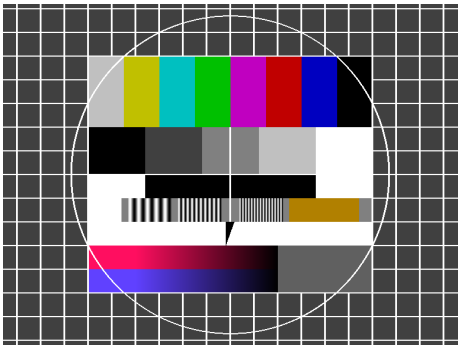


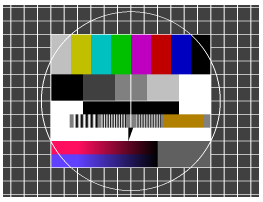
Figure 3.1: Test image for television (Origin of the image: http://de.wikipedia.org/wiki/Testbild).

All possibilities of grouping pictures side by side, on top or in matrices can be realized. Each subfigure is created in the same way as a graphic inside a figure, just enclosed by a figure environment, as shown in fig. 3.2.

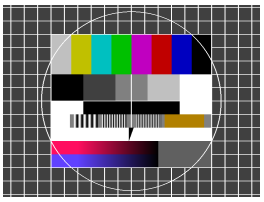
For complex subfigure constructs and correct alignment of the subcaption the `floatrow` provides powerful commands.

3.1.10 Index

An index is easy to create with LaTeX, but should only be done if the time is available to do it right, since it requires substantial work to create an index which is really useful for



(a) The first subfigure.



(b) The second subfigure.

Figure 3.2: Demonstration of the *subfigure* environment inside a figure environment

the reader.

A word is added to the index with the command `\index{word}` and these indexed words can be grouped with `\index{group!word}`. Within this document some index commands are inserted below the section headers of this tutorial for the purpose of demonstrating the indexing. The resulting index is displayed on page 37.

3.1.11 Code

```
% !TeX encoding=utf8
% !TeX program = pdflatex
% !TeX spellcheck = en-US

% LaTeX Tutorial for the latexthesistemplate
% based on
% - https://pangea.stanford.edu/computing/unix/formatting/latexexample.php
% - http://sip.clarku.edu/tutorials/TeX/
% and extended and modified by Matthias Pospiech

\ifcsdef{cs}{}{\newcommand{\cs}[1]{\texttt{\textbackslash{}#1}\relax}}%

% Define colors in case they are not available because style.tex was
% not loaded
% table colors
\colorlet{tablebodycolor}{white!100}
\colorlet{tablerowcolor}{gray!10}
\colorlet{tablesubheadcolor}{gray!30}
\colorlet{tableheadcolor}{gray!25}

\section{LaTeX Typesetting By Example}
\label{sec:example:tutorial}
This section demonstrates a basic set of LaTeX formatting commands and shows how
they look like in this template. For comparison of the typeset output with the
input document refer to the code listing starting on page \pageref{sec:example:
code}.

The content presented here is based on similar text by Phil Farrell\footnote{\url
{https://pangea.stanford.edu/computing/unix/formatting/latexexample.php}} and
Harvey Gould\footnote{\url{http://sip.clarku.edu/tutorials/TeX/}}.
For further reading on the possibilities of this template please refer to the
documentation: \path{TemplateDocumentation.pdf}.

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Plain Text}
\label{sec:example:PlainText}
\index{example!text}

Type your text in free-format; lines can be as long
or as short as you wish.
        You can indent         or space out
        your input
            text in
                any way you like to highlight the structure
        of your manuscript and make it easier to edit.
LaTeX fills lines and adjusts spacing between words to produce an
aesthetically pleasing result.

```

```
Completely blank lines in the input file break your text into
paragraphs.
Several command exist to change the font for a single character, word, or set of
words. Simply enclose the word and within braces of the formating command,
\emph{like this}.
A font changing command not enclosed in braces, like the change to \bfseries
bold here, keeps that change in effect until the end of the document or
until countermanded by another font switch, like this change back to
\normalfont the default font.

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Font shapes}
\label{sec:example:FontShapes}
\index{example!font shapes}

The default font in the template is Latin Modern (lmodern). It includes \textit{
italics}, \textbf{boldface}, \textsl{slanted}, \textsc{small caps} and \texttt{
monospaced} fonts as well as the corresponding sans serif variants  of the same
font family \textsf{sans serif}, \textsf{\textit{italics}}, \textsf{\textbf{
boldface}} and \textsf{\textsl{slanted}}. Note that for other fonts not all font
shapes may be available.

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Quotation and Citations}
\label{sec:example:QuoteCite}
\index{example!quote}
\index{example!cite}
%
LaTeX provides the \enquote{quote} and \enquote{quotation} environments for
typesetting quoted material or any other text that should be slightly indented
and set off from the normal text.

However, if the text shall not just be indented but rather be a real quotation
with a citation of the origin, then the commands \enquote{enquote} for inline
quotes and \enquote{blockquote} for multi line quotes are more appropriate. The
first is used to highlight the commands in this section and the latter in the
following text, which is a direct quotation from the documentation of the package
 \emph{csquotes}:
%
\blockquote[(csquotes.pdf)]{This command determines the length of the text.
If the length exceeds a certain threshold, the text will be
typeset in display mode, i. e., as a block quotation.
If not, \cs{blockquote} will behave like \cs{textquote}.
Depending on the threshold type option, the threshold may be based on the number
of lines required to typeset the text or on the number of words in the text.}

The standard command for citations is \texttt{\textbackslash{}cite} which may
have a prenote argument for adding a page number or something similar. To show
how a citation is typeset we cite here a book about LaTeX \cite[59]{companion}.
```

```
Further commands such as \cs{parencite} \parencite{companion} and \cs{textcite} \
textcite{companion} allow a different typeset of the citation. The resulting
bibliography is printed out on \cpageref{sec:bibliography}. Refer to the biblatex
 manual for further details on citation commands and modifications on the
printout and the section on biblatex in the template documentation.
79
80 % ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
81 \subsection{References}
82 \label{sec:example:references}
83 \index{example!references}
84
85 So far, in this text chapter and section headings, paragraphs (\cref{sec:example:
PlainText}), font changes (\cref{sec:example:FontShapes}) and citations (\cref{
sec:example:QuoteCite}) were demonstrated ad in this section the use of
references. Not that here the command \texttt{\textbackslash{}cref} was used
instead of the standard \cs{ref}.
86
87 The following sections show lists, tables and math.
88
89 % ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
90 \subsection{Lists}
91 \label{sec:example:lists}
92 \index{example!lists}
93 %
94 LaTeX has three types of lists with the environment names \emph{itemize}, \emph{
enumerate} and \emph{description}. All lists have a separation between each item,
 to improve the reading of item texts spanning several lines.
95 This item text can contain multiple paragraphs. These paragraphs are
appropriately spaced and indented according to their position in the list.
96
97 \begin{itemize}
98 \item
99 The \enquote{itemize} sets off list items with \emph{bullets}, like this.
100 %
101 \item Of course, lists can be nested, each type up to at least four levels.
102 One type of list can be nested within another type.
103 %
104   \begin{itemize}
105   \item Nested lists of the same type will change style of numbering
106   or \emph{bullets} as needed.
107   \end{itemize}
108 \end{itemize}
109 %
110 \begin{enumerate}
111 \item The \enquote{enumerate} environment numbers the list elements.
112
113 This is a new paragraph in the item text, which is not intended as in the
114 normal text but separated from the previous paragraph.
115 %
```

```
\item The enumeration scheme changes with each nesting level
  \begin{enumerate}
  \item as shown in this nested enumerated list item.
  \end{enumerate}
\end{enumerate}
%
Don't forget to close off all list environments with the
appropriate \verb+\end{...}+ command.
Indenting \verb+\begin{...}+, \verb+\item+, and \verb+\end{...}+
commands in the input document according to their nesting level can help
clarify the structure.

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Tables}
\label{sec:example:tables}
\index{example!tables}
%
Tables are a little more difficult. One can achieve even the most complex and
fancy layout, even spanning over multiple pages, but the code to create these
tables is not necessarily the best readable one.

Table \ref{tab:Computers} is a very simple table showing data lined up in columns
, where each column width is automatically calculated by LaTeX.
Notice that the tabular is centered with \cs{centering} and printed in a a
smaller font to achieve a clear distinction to the normal text. The title is
created above the tabular with \cs{captionabove}.

\begin{table}[hb]
\centering
\small\renewcommand{\arraystretch}{1.4}
\captionabove{Numbers of Computers in the department, By Type.}
\label{tab:Computers}
\begin{tabular}{lr}
\hline
Mac (Apple)    & 2  \\
Windows XP, 7  & 60 \\
Linux (Server) & 10 \\
\hline
\end{tabular}
\end{table}

\Cref{tab:IsingModel} on \cpageref{tab:IsingModel} demonstrate the creation of a
pleasant appearing table, which helps to read the table without attracting to
much attention by the use of shaded colors. The caption uses the additional short
 caption in square brackets \texttt{[ ]}, which is used in the list of tables,
see \cpageref{sec:lot}.

\begin{table}[ht]
\centering
```

```
\small\renewcommand{\arraystretch}{1.4}
\rowcolors{1}{tablerowcolor}{tablebodycolor}
%
\captionabove[Mean-field predictions for the critical temperature of the Ising model]{Comparison of the mean-field predictions for the critical temperature of the Ising model with exact results and the best known estimates for different spatial dimensions $d$ and lattice symmetries.}
\label{tab:IsingModel}
%
\begin{tabularx}{0.5\textwidth}{lXXX}
\hline
\rowcolor{tableheadcolor}
lattice & $d$ & $q$ & $T_\text{mf}/T_c$ \\
\hline
square  & 2 & 4 & 1.763 \\
%
triangular & 2 & 6 & 1.648 \\
%
diamond & 3 & 4 & 1.479 \\
%
simple cubic & 3 & 6 & 1.330 \\
%
bcc & 3 & 8 & 1.260 \\
%
fcc & 3 & 12 & 1.225 \\
\hline
\end{tabularx}
\end{table}

The design and creating of complex tables is shown in much greater detail in the documentation of this template.

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Mathematical Equations}
\label{sec:example:math}
\index{example!math}

Simple equations, like $x^y$ or $x_n = \sqrt{a + b}$ can be typeset right
in the text line by enclosing them in a pair of single dollar sign symbols.
Don't forget that if you want a real dollar sign in your text, like \$2000,
you have to use the \verb+\$+ command.

A more complicated equation should be typeset in \emph{displayed math} mode using
 \texttt{\textbackslash{[} ... \textbackslash{]}}, like this:
%
\[
z \left( 1 \ +\  \sqrt{\omega_{i+1} + \zeta -\frac{x+1}{\Theta +1} y + 1}
\ \right)
\ \ \ =\ \ \  1
```

```
\]
%
The \texttt{equation} environment displays your equations, and automatically
numbers them consecutively within your document, like this:
%
We can give an equation a label so that we can refer to it later.
\begin{equation}
  \label{eqn:ising}
  E = -J \sum_{i=1}^N s_i s_{i+1} ,
\end{equation}
Equation~\eqref{eqn:ising} expresses the energy of a configuration
of spins in the Ising model.\footnote{It is necessary to process (typeset) a
file twice to get the counters correct.}

For more complex formulas it may be necessary to do some fine tuning by adding
small amounts of horizontal spacing,
\begin{verbatim}
 \, small space       \! negative space
\end{verbatim}
as is done in eq.~\eqref{eqn:GreenTheorem}.
\begin{equation}
  \underset{\mathcal{G}\quad}\iiint\!
  \left[u\nabla^{2}v+\left(\nabla  u,\nabla  v\right)\right]\mathrm{d}^{3}V
  =\underset{\mathcal{S}\quad}\oiint  u\,\frac{\partial v}{\partial n}
  \,\,\mathrm{d}^{2}A
  \label{eqn:GreenTheorem}
\end{equation}
We also can also align several equations
\begin{align}
  \dot{q}_i & = \frac{\partial H}{\partial p_i} \\
  \dot{p}_i & = -\frac{\partial H}{\partial q_i}
\end{align}
number them as subequations
\begin{subequations}
\begin{align}
  \dot{q}_i & = \frac{\partial H}{\partial p_i} \\
  \dot{p}_i & = -\frac{\partial H}{\partial q_i}
\end{align}
\end{subequations}
or with only a single number
\begin{equation}
\begin{aligned}
  \dot{q}_i & = \frac{\partial H}{\partial p_i} \\
  \dot{p}_i & = -\frac{\partial H}{\partial q_i}
\end{aligned}
\end{equation}
Many further possibilities of displaying equations exist.

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

```
\subsubsection{Common Greek letters}
\label{sec:example:math:greekletters}
These commands may be used only in math mode. Only the most common
letters are included here.
%
\[\alpha, \beta, \gamma, \Gamma, \delta,\Delta,
\epsilon, \zeta, \eta, \theta, \Theta, \kappa,
\lambda, \Lambda, \mu, \nu, \xi, \Xi, \pi, \Pi,
\rho, \sigma, \tau, \phi, \Phi, \chi, \psi, \Psi,
\omega, \Omega\]

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Literal text}
\label{sec:example:verbatim}
\index{example!verbatim}
%
It is desirable to print program code exactly as it is typed in a
monospaced font. Use \cs{begin\{lstlisting\}} and
\cs{end\{lstlisting\}} as in the following example:

\begin{lstlisting}
double y0 = 10; // example of declaration and assignment statement
double v0 = 0;  // initial velocity
double t = 0;   // time
double dt = 0.01; // time step
double y = y0;
\end{lstlisting}
%
Two styles are defined in this template: \texttt{lstStyleCpp} and \texttt{
lstStyleLaTeX}.

A complete file can be printed with listings using the
command \cs{lstinputlisting}, see \cref{sec:example:code} for an example.
% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Figures}
\label{sec:example:figures}
\index{example!figures}
%
Figures with captions are included in the \texttt{figure} environment in order to
 position the graphic inside the text. The size should be given in relation to
natural text size. It is recommended to use a percentage value of the \cs{
textwidth}. This size should not exceed 80\,\%  of the text width.

\begin{figure}[htb]
  \centering
  \includegraphics[width=0.4\textwidth]{images/testimage.png}
  \caption[Test image for television]{Test image for television (Origin of the
image: \url{http://de.wikipedia.org/wiki/Testbild}).}
  \label{fig:example:figure}
```

```
\end{figure}

All possibilities of grouping pictures side by side, on top or in matrices can be
 realized. Each subfigure is created in the same way as a graphic inside a figure
, just enclosed by a figure environment, as shown in \cref{fig:example:subfigures
}.

\begin{figure}[htb]
  \begin{subfigure}[b]{.45\linewidth}
    \centering
    \includegraphics[width=0.5\linewidth]{images/testimage.png}
    \caption{The first subfigure.}
    \label{fig:example:subfigures:a}
  \end{subfigure}%
  \begin{subfigure}[b]{.45\linewidth}
    \centering
    \includegraphics[width=0.5\linewidth]{images/testimage.png}
    \caption{The second subfigure.}
    \label{fig:example:subfigures:b}
  \end{subfigure}
  \caption{Demonstration of the \emph{subfigure} environment inside a figure
environment}
  \label{fig:example:subfigures}
\end{figure}
%
For complex subfigure constructs and correct alignment of the subcaption the \
texttt{floatrow} provides powerful commands.

% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\subsection{Index}
\label{sec:example:index}
\index{example!index}
%
An index is easy to create with LaTeX, but should only be done if the time is
available to do it right, since it requires substantial work to create an index
which is really useful for the reader.

A word is added to the index with the command \cs{index\{word\}} and these
indexed words can be grouped with \cs{index\{group!word\}}. Within this document
some index commands are inserted below the section headers of this tutorial for
the purpose of demonstrating the indexing. The resulting index is displayed on
page~\pageref{sec:Index}.
% ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
\clearpage
\subsection{Code}
\label{sec:example:code}

\ifcsdef{lstStyleLaTeX}{%
  \lstinputlisting[style=lstStyleLaTeX,%nolol=true,%
```

```
330      caption={LaTeX Typesetting By Example}, label=lstLaTeXExample]
331   {content/template/latextutorial.tex}
332 }{}
```

Listing 3.1: LaTeX Typesetting By Example

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Results

CHAPTER 5

Summery and Outlook

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A First chapter of appendix

A.1 Parameters

Publications

Scientific publications
Submissions to international conferences
Submissions to national conferences

Curriculum Vitae

Delete these notes:
This is a modified version of a german CV. I have not translated it into English, because I am not familiar with English CV styles.

Remember that you do not write this CV to apply for a job. This is just a brief summary of your previous research career. A 'real' CV is much more complex!

Personalien

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Acknowledgments

I thank ?? and ?? for giving me the opportunity to write this bachelor/master/phd thesis at ??, and for their professional advise.

I thank in particular the ?? team who readily/willingly provided information at any time and ??.

I would also like to than all people who supported me in writing this thesis.