

# Labels and Cross References\*

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*The Basics*

*Multiple Runs*

*Missing Labels*

*Multiple Labels*



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## 1. The Basics

Automatic references are one of the greatest things about L<sup>A</sup>T<sub>E</sub>X.

Suppose you wrote

In Section 3 we show that alligators are not crocodiles.

The referee asked to add new section before Section 3. All numbers changed.  
What should you do?

And with equations it is even more difficult. . .

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## 1. The Basics

Automatic references are one of the greatest things about L<sup>A</sup>T<sub>E</sub>X.

Suppose you wrote

In Section 3 we show that alligators are not crocodiles.

The referee asked to add new section before Section 3. All numbers changed.  
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And with equations it is even more difficult. . .

L<sup>A</sup>T<sub>E</sub>X solution: let computer do this work for us!

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This slide starts with the following:

```
\section{The Basics}  
\label{sec:basics}
```

The command `\label{sec:basics}` creates a new label `sec:basics`. It can be used by commands `\ref` and `\pageref`:

```
We discuss the basics in Section~\ref{sec:basics} on  
page~\pageref{sec:basics}.
```

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This slide starts with the following:

```
\section{The Basics}  
\label{sec:basics}
```

The command `\label{sec:basics}` creates a new label `sec:basics`. It can be used by commands `\ref` and `\pageref`:

```
We discuss the basics in Section~\ref{sec:basics} on  
page~\pageref{sec:basics}.
```

This gives (colors and clickability are added by the `hyperref` package):

We discuss the basics in Section [1](#) on page [2](#).



It works with equations too!

```
\begin{equation}
  \label{eq:simple}
  2 \times 2 = 4
\end{equation}
Equation~(\ref{eq:simple}) is very simple.
```

$$2 \times 2 = 4 \qquad (1)$$

Equation (1) is very simple.

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It works with equations too!

```
\begin{equation}
  \label{eq:simple}
  2 \times 2 = 4
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Equation~(\ref{eq:simple}) is very simple.
```

$$2 \times 2 = 4 \qquad (1)$$

Equation (1) is very simple.

The package `amsmath` adds another useful command:

```
See equation~\eqref{eq:simple}.
```

See equation (1).



## 2. Multiple Runs

L<sup>A</sup>T<sub>E</sub>X writes the information about labels into *auxiliary file* file.aux. Example:

labels.tex

```
\documentclass{article}

\begin{document}

We start with the equation
\begin{equation}
  \label{eq:diff}
  \frac{dy}{dx} = y
\end{equation}
Equation~(\ref{eq:diff}) has the solution
\begin{equation}
  \label{eq:solution}
  y = \exp (x)
\end{equation}

\end{document}
```

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## 2. Multiple Runs

$\text{\LaTeX}$  writes the information about labels into *auxiliary file* `file.aux`. Example:

labels.tex

```

\documentclass{article}

\begin{document}

We start with the equation
\begin{equation}
  \label{eq:diff}
  \frac{dy}{dx} = y
\end{equation}
Equation~(\ref{eq:diff}) has the solution
\begin{equation}
  \label{eq:solution}
  y = \exp (x)
\end{equation}

\end{document}
  
```

**Exercise 1.** Which labels does this file define?

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If we run latex, we get:

\_\_\_\_\_ labels.aux \_\_\_\_\_

```
\relax  
\newlabel{eq:diff}{{1}{1}}  
\newlabel{eq:solution}{{2}{1}}
```

**Exercise 2.** Can you guess what is said there?

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If we run latex, we get:

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```
\relax
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\newlabel{eq:solution}{{2}{1}}
```

**Exercise 2.** Can you guess what is said there?

**A Problem:** L<sup>A</sup>T<sub>E</sub>X creates auxiliary files when typesetting. But it cannot use it if it is not created! What can we do?



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If we run `latex`, we get:

\_\_\_\_\_ `labels.aux` \_\_\_\_\_

```
\relax
\newlabel{eq:diff}{{1}{1}}
\newlabel{eq:solution}{{2}{1}}
```

**Exercise 2.** Can you guess what is said there?

**A Problem:** L<sup>A</sup>T<sub>E</sub>X creates auxiliary files when typesetting. But it cannot use it if it is not created! What can we do?

**Solution:** Multiple runs.

1. `latex file` creates the auxiliary file. The labels are not defined yet.
2. Another run `latex file` reads the labels from the auxiliary file (and creates it again).



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**Exercise 3.** Can you imagine a situation when you will need *three* latex runs?

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**Exercise 3.** Can you imagine a situation when you will need *three* latex runs?

**Solution:** You need this if the labels change between the first and second runs. Example: long table of contents in the beginning of the text.

If you take a look in the log file, you will see the warnings:

```
LaTeX Warning: There were undefined references.
```

```
LaTeX Warning: Label(s) may have changed. Rerun to  
get cross-references right.
```



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### 3. Missing Labels

What happens if a label is missing?

**Exercise 4.** Consider the file:

```

_____ labels1.tex _____
\documentclass{article}

\begin{document}

We start with the equation
\begin{equation}
  \label{eq:diff}
  \frac{dy}{dx} = y
\end{equation}
Equation~(\ref{eq:Diff}) has the solution
\begin{equation}
  \label{eq:solution}
  y = \exp (x)
\end{equation}

\end{document}
  
```

Find the error in the file. Check the result of typesetting.

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Answer:

```
...  
LaTeX Warning: Reference 'eq:Diff' on page 1 undefined on input line 10.  
...  
LaTeX Warning: There were undefined references.  
...
```

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## 4. Multiple Labels

What happens if we have coinciding labels?

**Exercise 5.** Upload the file:

labels2.tex

```

\documentclass{article}

\begin{document}

We start with the equation
\begin{equation}
  \label{eq:diff}
  \frac{dy}{dx} = y
\end{equation}
Equation~(\ref{eq:diff}) has the solution
\begin{equation}
  \label{eq:diff}
  y = \exp(x)
\end{equation}

\end{document}
  
```

Find the error in the file. Check the result of typesetting.

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Answer:

```
...  
LaTeX Warning: Label 'eq:diff' multiply defined.  
...  
LaTeX Warning: There were multiply-defined labels.  
...
```

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