How to Make Presentation by Beamer
- An Introduction

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Outline

Why Beamer

Pros:

- Both dvips/ps2pdf and pdflatex supports
- Rich overlay and transition effects
- Navigational bars and symbols
- Outputs: screen, transparency, handouts, and notes
- Emulation of other PDF presetation tools such as Prosper
- Easy to type math
- WYSIWYM (What You See Is What You Mean)

Cons:

- Not WYSIWYG (What You See Is What You Get)
- Steep learning curve
- Difficult to design a template

My First Slide

```
\documentclass{beamer}
\begin{document}
  \begin{frame}
    Hello World!
  \end{frame}
\end{document}
```

Frame Titles
...and Subtitles

Two ways to create titles and subtitles for a frame:

- `\begin{frame}{`*Frame Title*`}{`*Frame Subtitle*`}`
- `\frametitle{`*Frame Title*`}\framesubtitle{`*Frame Subtitle*`}`

Sectioning

Notice the sections and subsections at the top of each slide.

- `\section[`*Short Section Name*`]{`*Long Section Name*`}`
- `\subsection[`*Short Subsection Name*`]{`*Long Subsection Name*`}`

Sectioning

Notice the sections and subsections at the top of each slide.

- `\section[`*Short Section Name*`]{`*Long Section Name*`}`
- `\subsection[`*Short Subsection Name*`]{`*Long Subsection Name*`}`

"Short names" go into slide headers;
"Long names" go into outlines.

Sectioning

Notice the sections and subsections at the top of each slide.

- \section[*Short Section Name*]{*Long Section Name*}
- \subsection[*Short Subsection Name*]{*Long Subsection Name*}

"Short names" go into slide headers;
"Long names" go into outlines.

All sections and subsections automatically added to slideshow outline!

Looooooong Slides

BEAMER does not automatically put what doesn't fit from one slide onto another slide.

- You must keep track of slide lengths yourself; or
- you can use the frame option `\begin{frame}[allowframebreaks]`

This automatically breaks up the long slide and puts the extra content onto new slides.

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Why Beamer **Creating a Slideshow** Graphics Splitting a Frame into Multiple Columns Tables Creating Overlays Hyperlinks and Buttons Anim

ooooooooo ooooooooo oooooooooooo

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+ You don't have to worry about the length of your slides.
+ Slide title is continued on each subsequent slide.
− Most overlay options are not usable.

Verbatim

```
int main (void) {
std::vector<bool> is_prime (100, true);
 for (int i = 2; i < 100; i++)



    return 0;
}
```

Verbatim

```
int main (void) {
std::vector<bool> is_prime (100, true);
 for (int i = 2; i < 100; i++)
 if (is_prime[i])
{


 }   return 0;
}
```

Verbatim

```
int main (void) {
std::vector<bool> is_prime (100, true);
 for (int i = 2; i < 100; i++)
 if (is_prime[i])
{   std::cout « i « " ";
 for (int j = i; j < 100;
 is_prime [j] = false, j+=i);
 }   return 0;
}
```

Verbatim

```
int main (void) {
std::vector<bool> is_prime (100, true);
 for (int i = 2; i < 100; i++)
 if (is_prime[i])
{  std::cout « i « " ";
 for (int j = i; j < 100;
 is_prime [j] = false, j+=i);
 } return 0;
}
```

Using Verbatim

To use any sort of verbatim text, you must declare the frame as *fragile*:
\begin{frame}[fragile]
Use \path{content}, \verb|content| or verbatim environment.

Enumerate

A This is the first item.
B This is the second item.
C Yes, this is the third one!

```
\begin{enumerate}[minitemplate]
  \item ...
\end{enumerate}
where minitemplate can be empty or 'A','a', 'i', 'I', '(A)', ...
```

Framed Text

Theorem
You can read this.

Warning
You are warned!

Beamer supports predefined framed texts:

```
theorem, corollary, definition in structure color frame
examples in green color frame
block in structure color frame with your own title
alertblock in alert color frame with your own title
```

User-defined Framed Text

Theorem

$A = B$.

Source code:

```
{
\setbeamercolor{uppercol}{fg=white,bg=green!80}%
\setbeamercolor{lowercol}{fg=black,bg=green!10}%
\begin{beamerboxesrounded}%
[upper=uppercol,lower=lowercol,shadow=true]{Theorem}
  $A = B$.
\end{beamerboxesrounded}
}
```

\includegraphics{}

```
\begin{columns}
\begin{column}{.5\textwidth}
  \centering
  \includegraphics[width=\textwidth]{Zooey1}
\end{column}
\begin{column}{.5\textwidth}
  \centering
  \includegraphics[width=\textwidth]{Zooey2}
\end{column}
\end{columns}
```
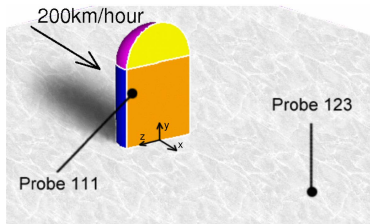
# Zooming Figure

Grammar:

- Figures can be zoomed using
- `\framezoom<buttonoverlay>`
  `<zoomedoverlay>[options](x,y)(w,h)`
- options: border.
- (x,y): Upper left coordinate point.
  They are measures relative to the place where
  the first normal text of a frame would go. Thus,
  the location $(0pt, 0pt)$ is at the beginning of the
  normal text (which excludes the headline and also
  the frame title).
- (w,h): Width and height for zooming.

Zooming Figure

Comments:

* Agreement is favorable across the spectrum

* overestimate the sound pressure at probe 2
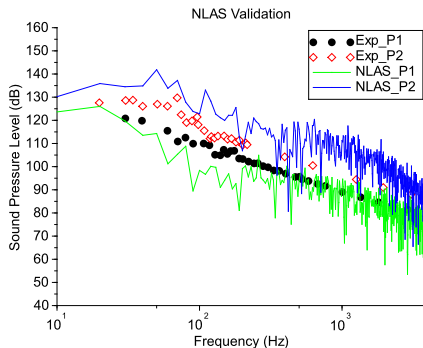
Splitting a slide into Columns

The line you are reading goes all the way across the slide. From the left margin to the right margin. Now we are going to split the slide into two columns.

Here is the first column. We put an itemized list in it.

- This is an item
- This is another item
- Yet another item

Here is the second column. We will put a picture in it.
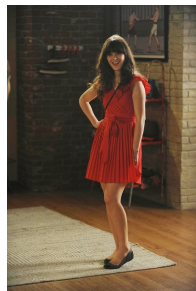
The line you are reading goes all the way across the slide.

More More More Columns

Left column
blah blah blah blah

Middle column
blah blah blah blah

Right column
blah blah blah blah

Bottom Left column
blah blah blah blah

Bottom Right column
blah blah blah blah

Columns with Graphics I

Two
lines.

```
\begin{columns}[T]
\column{5cm}
  Two\\lines.
\column[c]{5cm}
  \includegraphics[width=4cm]{Zooey}
\end{columns}
```

Columns with Graphics II

Two
lines.

```
\begin{columns}[c]
\column{5cm}
  Two\\lines.
\column[c]{5cm}
  \includegraphics[width=4cm]{Zooey}
\end{columns}
```

Columns with Graphics IV

- *Important text*

Columns with Graphics IV

- *Important text*
- Very important process

Columns with Graphics IV

- *Important text*
- Very important process
  - Steps one and two

Columns with Graphics IV

- *Important text*
- Very important process
  - Steps one and two

Columns with Graphics IV

- *Important text*
- Very important process
  - Steps one and two
  - Step with no image

Test Minipage I

- Item 1
- Item 2

Test Minipage II

- Another item 1

Test Minipage II

- Another item 1
- Another item 2

Test Minipage II

- Another item 1
- Another item 2
- This list is longer

Test Minipage II

- Another item 1
- Another item 2
- This list is longer
- Than the previous one.

A Simple One

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    1 & 2 & 3 \\
    \hline
    4 & 5 & 6 \\
    7 & 8 & 9 \\
    \hline
  \end{tabular}
\end{center}
```

1	2	3
4	5	6
7	8	9

More Complicated

```
\begin{center}
  \begin{tabular}{|r|l|}
    \hline
    7C0 & hexadecimal \\
    3700 & octal \\ \cline{2-2}
    11111000000 & binary \\
    \hline \hline
    1984 & decimal \\
    \hline
  \end{tabular}
\end{center}
```

7C0	hexadecimal
3700	octal
11111000000	binary

1984	decimal

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

1		

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

1	2	

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

1	2	hello

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

1	2	hello
4	5	6

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

1	2	hello
4	5	6
7	8	9

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

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```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

1		
	5	
		9

Even More Complicated

```
\begin{center}
  \begin{tabular}{ l | c || r | }
    \hline
    \onslide<2-6,8>{1} & \onslide<3-6>{2} & \onslide<4-6,9>{hello} \\
    \hline
    \onslide<5-6>{4} & \onslide<5-6,8,9>{5} & \onslide<5-6>{6} \\
    \onslide<6,9>{7} & \onslide<6>{8} & \onslide<6,8>{9} \\
    \hline
  \end{tabular}
\end{center}
```

			hello
	5		
7			

Pause for Stepwise Viewing

```
\begin{itemize}
\item
  Shown from first slide on.
\pause
\item
  Shown from second slide on.
  \begin{itemize}
  \item
    Shown from second slide on.
  \pause
  \item
    Shown from third slide on.
  \end{itemize}
\item
  Shown from third slide on.
\pause
\item
  Shown from fourth slide on.
\end{itemize}
Shown from fourth slide on.
\begin{itemize}
\onslide
\item
  Shown from first slide on.
\pause
\item
  Shown from fifth slide on.
\end{itemize}
```

- Shown from first slide on.

- Shown from first slide on.

Pause for Stepwise Viewing

```
\begin{itemize}
\item
  Shown from first slide on.
\pause
\item
  Shown from second slide on.
  \begin{itemize}
  \item
    Shown from second slide on.
  \pause
  \item
    Shown from third slide on.
  \end{itemize}
\item
  Shown from third slide on.
\pause
\item
  Shown from fourth slide on.
\end{itemize}
Shown from fourth slide on.
\begin{itemize}
\onslide
\item
  Shown from first slide on.
\pause
\item
  Shown from fifth slide on.
\end{itemize}
```

- Shown from first slide on.
- Shown from second slide on.
  - Shown from second slide on.

- Shown from first slide on.

Pause for Stepwise Viewing

```
\begin{itemize}
\item
  Shown from first slide on.
\pause
\item
  Shown from second slide on.
  \begin{itemize}
  \item
    Shown from second slide on.
  \pause
  \item
    Shown from third slide on.
  \end{itemize}
\item
  Shown from third slide on.
\pause
\item
  Shown from fourth slide on.
\end{itemize}
Shown from fourth slide on.
\begin{itemize}
\onslide
\item
  Shown from first slide on.
\pause
\item
  Shown from fifth slide on.
\end{itemize}
```

- Shown from first slide on.
- Shown from second slide on.
    - Shown from second slide on.
    - Shown from third slide on.
- Shown from third slide on.

- Shown from first slide on.

Pause for Stepwise Viewing

```
\begin{itemize}
\item
  Shown from first slide on.
\pause
\item
  Shown from second slide on.
  \begin{itemize}
  \item
    Shown from second slide on.
  \pause
  \item
    Shown from third slide on.
  \end{itemize}
\item
  Shown from third slide on.
\pause
\item
  Shown from fourth slide on.
\end{itemize}
Shown from fourth slide on.
\begin{itemize}
\onslide
\item
  Shown from first slide on.
\pause
\item
  Shown from fifth slide on.
\end{itemize}
```

- Shown from first slide on.
- Shown from second slide on.
    - Shown from second slide on.
    - Shown from third slide on.
- Shown from third slide on.
- Shown from fourth slide on.

Shown from fourth slide on.

- Shown from first slide on.

Pause for Stepwise Viewing

```
\begin{itemize}
\item
  Shown from first slide on.
\pause
\item
  Shown from second slide on.
  \begin{itemize}
  \item
    Shown from second slide on.
  \pause
  \item
    Shown from third slide on.
  \end{itemize}
\item
  Shown from third slide on.
\pause
\item
  Shown from fourth slide on.
\end{itemize}
Shown from fourth slide on.
\begin{itemize}
\onslide
\item
  Shown from first slide on.
\pause
\item
  Shown from fifth slide on.
\end{itemize}
```

- Shown from first slide on.
- Shown from second slide on.
  - Shown from second slide on.
  - Shown from third slide on.
- Shown from third slide on.
- Shown from fourth slide on.

Shown from fourth slide on.

- Shown from first slide on.
- Shown from fifth slide on.

Pause for Stepwise Viewing

```
\begin{itemize}
\item
  Shown from first slide on.
\pause
\item
  Shown from second slide on.
  \begin{itemize}
  \item
    Shown from second slide on.
  \pause
  \item
    Shown from third slide on.
  \end{itemize}
\item
  Shown from third slide on.
\pause
\item
  Shown from fourth slide on.
\end{itemize}
Shown from fourth slide on.
\begin{itemize}
\onslide
\item
  Shown from first slide on.
\pause
\item
  Shown from fifth slide on.
\end{itemize}
```

- Shown from first slide on.
- Shown from second slide on.
    - Shown from second slide on.
    - Shown from third slide on.
- Shown from third slide on.
- Shown from fourth slide on.

Shown from fourth slide on.

- Shown from first slide on.
- Shown from fifth slide on.

Note that pause does not know overlay counters.

Pause: Table Example

- Row increment in a table:

Pause: Table Example

- Row increment in a table:

Class	A	B	C	D
X	1	2	3	4

Pause: Table Example

- Row increment in a table:

Class	A	B	C	D
X	1	2	3	4
Y	3	4	5	6

Pause: Table Example

- Row increment in a table:

Class	A	B	C	D
X	1	2	3	4
Y	3	4	5	6
Z	5	6	7	8

- Source code:

```
\rowcolors[]{1}{blue!20}{blue!10}
\begin{tabular}{l!{\vrule}cccc}
  Class & A & B & C & D \\\hline
  X & 1 & 2 & 3 & 4 \pause \\
  Y & 3 & 4 & 5 & 6 \pause \\
  Z & 5 & 6 & 7 & 8
\end{tabular}
```

Onslide for Stepwise Viewing

- `\onslide<n->stuff` shows stuff on the given slides.
- Example: Column increment in a table:

Class	A
X	1
Y	3
Z	5

- Source code:

```
\rowcolors[]{1}{blue!20}{blue!10}
\begin{tabular}{l!{\vrule}c<{\onslide<2->}c<{\onslide<3->}%
    c<{\onslide<4->}c<{\onslide}c}
    Class & A & B & C & D \\
    X & 1 & 2 & 3 & 4 \\
    Y & 3 & 4 & 5 & 6 \\
    Z & 5 & 6 & 7 & 8
\end{tabular}
```

Onslide for Stepwise Viewing

- \onslide<n->stuff shows stuff on the given slides.
- Example: Column increment in a table:

Class	A	B
X	1	2
Y	3	4
Z	5	6

- Source code:

```
\rowcolors[]{1}{blue!20}{blue!10}
\begin{tabular}{l!{\vrule}c<{\onslide<2->}c<{\onslide<3->}%
    c<{\onslide<4->}c<{\onslide}c}
    Class & A & B & C & D \\
    X & 1 & 2 & 3 & 4 \\
    Y & 3 & 4 & 5 & 6 \\
    Z & 5 & 6 & 7 & 8
\end{tabular}
```

Onslide for Stepwise Viewing

- `\onslide<n->stuff` shows stuff on the given slides.
- Example: Column increment in a table:

Class	A	B	C
X	1	2	3
Y	3	4	5
Z	5	6	7

- Source code:

```
\rowcolors[]{1}{blue!20}{blue!10}
\begin{tabular}{l!{\vrule}c<{\onslide<2->}c<{\onslide<3->}%
    c<{\onslide<4->}c<{\onslide}c}
    Class & A & B & C & D \\
    X & 1 & 2 & 3 & 4 \\
    Y & 3 & 4 & 5 & 6 \\
    Z & 5 & 6 & 7 & 8
\end{tabular}
```

Onslide for Stepwise Viewing

- `\onslide<n->stuff` shows stuff on the given slides.
- Example: Column increment in a table:

Class	A	B	C	D
X	1	2	3	4
Y	3	4	5	6
Z	5	6	7	8

- Source code:

```
\rowcolors[]{1}{blue!20}{blue!10}
\begin{tabular}{l!{\vrule}c<{\onslide<2->}c<{\onslide<3->}%
    c<{\onslide<4->}c<{\onslide}c}
    Class & A & B & C & D \\
    X & 1 & 2 & 3 & 4 \\
    Y & 3 & 4 & 5 & 6 \\
    Z & 5 & 6 & 7 & 8
\end{tabular}
```

Item for Step Viewing I

item<n-> for incremental overlays with overlay counters.

```
\begin{itemize}
  \item<2-> Every thing
  \item<3-> that has
  \item<4-> beginning
  \item<5-> and end.
\end{itemize}
```

Item for Step Viewing I

item<n-> for incremental overlays with overlay counters.

```
\begin{itemize}
  \item<2-> Every thing
  \item<3-> that has
  \item<4-> beginning
  \item<5-> and end.
\end{itemize}
```

- Every thing

Item for Step Viewing I

item<n-> for incremental overlays with overlay counters.

```
\begin{itemize}
  \item<2-> Every thing
  \item<3-> that has
  \item<4-> beginning
  \item<5-> and end.
\end{itemize}
```

- Every thing
- that has

Item for Step Viewing I

item<n-> for incremental overlays with overlay counters.

```
\begin{itemize}
  \item<2-> Every thing
  \item<3-> that has
  \item<4-> beginning
  \item<5-> and end.
\end{itemize}
```

- Every thing
- that has
- beginning

Item for Step Viewing I

`item<n->` for incremental overlays with overlay counters.

```
\begin{itemize}
  \item<2-> Every thing
  \item<3-> that has
  \item<4-> beginning
  \item<5-> and end.
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

Item for Step Viewing I

`item<n->` for incremental overlays with overlay counters.

```
\begin{itemize}
  \item<2-> Every thing
  \item<3-> that has
  \item<4-> beginning
  \item<5-> and end.
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

`\item<n1-n2>` for fine control of overlays.

Item for Step Viewing II

$<+->$ for incremental overlays automaticlly.

```
\begin{itemize}[<+->]
  \item Every thing
  \item that has
  \item beginning
  \item and end.
\end{itemize}
```

- Every thing

Item for Step Viewing II

$<+->$ for incremental overlays automaticlly.

```
\begin{itemize}[<+->]
  \item Every thing
  \item that has
  \item beginning
  \item and end.
\end{itemize}
```

- Every thing
- that has

Item for Step Viewing II

`<+->` for incremental overlays automaticlly.

```
\begin{itemize}[<+->]
  \item Every thing
  \item that has
  \item beginning
  \item and end.
\end{itemize}
```

- Every thing
- that has
- beginning

Item for Step Viewing II

$<+->$ for incremental overlays automaticlly.

```
\begin{itemize}[<+->]
  \item Every thing
  \item that has
  \item beginning
  \item and end.
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

Replace

- Successive `\only<n>{...}`.
  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒ Only1

- `\uncover<n>{...}` shows at given n.
  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.
  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.
  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.
  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide1

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒ Only2

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide2

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒ Only3

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide3

Replace

- Successive `\only<n>{...}`.

  (Ex)`\only<1>{Only1}\only<2>{Only2}\only<3>{Only3}` ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)`\uncover<5>{Iam5}` ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)`\invisible<8>{Invisibleat8}` ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)`\alt<11>{Iam11}{Iamnot11}` ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)`\temporal<14>{Iam13}{Iam14}{Iam15}` ⇒ I am 13

Slide4

Replace

- Successive `\only<n>{...}`.

  `(Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3}` $\Rightarrow$

- `\uncover<n>{...}` shows at given n.

  `(Ex)\uncover<5>{Iam5}` $\Rightarrow$ I am 5

- `\invisible<n>{...}` hides at given n.

  `(Ex)\invisible<8>{Invisibleat8}` $\Rightarrow$ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  `(Ex)\alt<11>{Iam11}{Iamnot11}` $\Rightarrow$ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  `(Ex)\temporal<14>{Iam13}{Iam14}{Iam15}` $\Rightarrow$ I am 13

Slide5

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide6

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide7

Replace

- Successive `\only<n>{...}`.

  (Ex)`\only<1>{Only1}\only<2>{Only2}\only<3>{Only3}` ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)`\uncover<5>{Iam5}` ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)`\invisible<8>{Invisibleat8}` ⇒

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)`\alt<11>{Iam11}{Iamnot11}` ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)`\temporal<14>{Iam13}{Iam14}{Iam15}` ⇒ I am 13

Slide8

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide9

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide10

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide11

Replace

- Successive `\only<n>{...}`.

  (Ex)`\only<1>{Only1}\only<2>{Only2}\only<3>{Only3}` ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)`\uncover<5>{Iam5}` ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)`\invisible<8>{Invisibleat8}` ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)`\alt<11>{Iam11}{Iamnot11}` ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)`\temporal<14>{Iam13}{Iam14}{Iam15}` ⇒ I am 13

Slide12

Replace

- Successive `\only<n>{...}`.
  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒

- `\uncover<n>{...}` shows at given n.
  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.
  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.
  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.
  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 13

Slide13

Replace

- Successive `\only<n>{...}`.

  (Ex)`\only<1>{Only1}\only<2>{Only2}\only<3>{Only3}` ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)`\uncover<5>{Iam5}` ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)`\invisible<8>{Invisibleat8}` ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)`\alt<11>{Iam11}{Iamnot11}` ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)`\temporal<14>{Iam13}{Iam14}{Iam15}` ⇒ I am 14

Slide14

Replace

- Successive `\only<n>{...}`.

  (Ex)\only<1>{Only1}\only<2>{Only2}\only<3>{Only3} ⇒

- `\uncover<n>{...}` shows at given n.

  (Ex)\uncover<5>{Iam5} ⇒

- `\invisible<n>{...}` hides at given n.

  (Ex)\invisible<8>{Invisibleat8} ⇒ Invisible at 8

- `\alt<n>{atn}{notatn}` for two alternatives.

  (Ex)\alt<11>{Iam11}{Iamnot11} ⇒ I am not 11

- `\temporal<n>{before}{atn}{after}` for three alternatives.

  (Ex)\temporal<14>{Iam13}{Iam14}{Iam15} ⇒ I am 15

Slide15

More Replaces

In case if subtle differences in the heights of replacements, it may lead to slight, but annoying differences in the heights of the lines, which may cause the whole frame to "wobble" from slide to slide. To solve this problem, overlayarea and overprint environment can be used.

Example:

Some text for the first slide.
Possibly several lines long.

```
\begin{overlayarea}{\textwidth}{3cm}
  \only<1>{Some text for the first slide.\\
          Possibly several lines long.}
  \only<2>{Replacement on the second slide.}
\end{overlayarea}
```

More Replaces

In case if subtle differences in the heights of replacements, it may lead to slight, but annoying differences in the heights of the lines, which may cause the whole frame to "wobble" from slide to slide. To solve this problem, overlayarea and overprint environment can be used.

Example:

Replacement on the second slide.

```
\begin{overlayarea}{\textwidth}{3cm}
  \only<1>{Some text for the first slide.\\
          Possibly several lines long.}
  \only<2>{Replacement on the second slide.}
\end{overlayarea}
```

Environments with Overlay Specifications

Theorem

Exists infinite set.

```
\begin{theorem}<1->
  Exists infinite set.
\end{theorem}
\begin{proof}<3->
  Axiom of infinity.
\end{proof}
\begin{example}<2->
  Natural numbers.
\end{example}
```

Environments with Overlay Specifications

Theorem

Exists infinite set.

```
\begin{theorem}<1->
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\end{theorem}
\begin{proof}<3->
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\end{proof}
\begin{example}<2->
  Natural numbers.
\end{example}
```

Example

Natural numbers.

Environments with Overlay Specifications

Theorem

Exists infinite set.

Proof.

Axiom of infinity. □

Example

Natural numbers.

```
\begin{theorem}<1->
  Exists infinite set.
\end{theorem}
\begin{proof}<3->
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\end{proof}
\begin{example}<2->
  Natural numbers.
\end{example}
```

Environments with Overlay Specifications

Theorem
Exists infinite set.

Proof.
Axiom of infinity. □

Example
Natural numbers.

```
\begin{theorem}<1->
  Exists infinite set.
\end{theorem}
\begin{proof}<3->
  Axiom of infinity.
\end{proof}
\begin{example}<2->
  Natural numbers.
\end{example}
```

Note
Various overlay counters: 'n', 'n-', '-n', 'n1-n2', '+-'.

```
\textbf, \textit, \textsl,
\textrm, \textsf, and
\color also understand overlays.
```

Simple Highlighting

`\item<+-|alert@+>` for automatic highlighting.

```
\begin{itemize}
  \item <+-| alert@+> Every thing
  \item <+-| alert@+> that has
  \item <+-| alert@+> beginning
  \item <+-| alert@+> has end.
\end{itemize}
```

- Every thing

- You can also use `\begin{itemize}[<+-|alert@+>]` instead of individual '`\item<+-|alert@+>`'.
- You can use structure instead of alert.

Simple Highlighting

`\item<+-|alert@+>` for automatic highlighting.

```
\begin{itemize}
  \item <+-| alert@+> Every thing
  \item <+-| alert@+> that has
  \item <+-| alert@+> beginning
  \item <+-| alert@+> has end.
\end{itemize}
```

- Every thing
- that has

- You can also use `\begin{itemize}[<+-|alert@+>]` instead of individual '`\item<+-|alert@+>`'.
- You can use structure instead of alert.

Why Beamer | Creating a Slideshow | Graphics | Splitting a Frame into Multiple Columns | Tables | **Creating Overlays** | Hyperlinks and Buttons | Anir

○○○○○○○○○ | ○○○○○○○○ | | ○○○○○○○○ | | **○○○○○○○○○●○○**

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\end{itemize}
```

- Every thing
- that has
- beginning

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`\item<+-|alert@+>` for automatic highlighting.

```
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  \item <+-| alert@+> that has
  \item <+-| alert@+> beginning
  \item <+-| alert@+> has end.
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

- You can also use `\begin{itemize}[<+-|alert@+>]` instead of individual '`\item<+-|alert@+>`'.
- You can use structure instead of alert.

Alert for Highlighting

`\item<n->\alert<m>{stuff}` is better than the previous automatic one.

```
\begin{itemize}
  \item<1->\alert<2> {Every thing}
  \item<1->\alert<3> {that has}
  \item<1->\alert<4> {beginning}
  \item<1->\alert<5> {has end.}
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

Note that `\item<1->\alert<2>` is same to `\item<1-|alert@2>`.

Alert for Highlighting

`\item<n->\alert<m>{stuff}` is better than the previous automatic one.

```
\begin{itemize}
  \item<1->\alert<2> {Every thing}
  \item<1->\alert<3> {that has}
  \item<1->\alert<4> {beginning}
  \item<1->\alert<5> {has end.}
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

Note that `\item<1->\alert<2>` is same to `\item<1-|alert@2>`.

Alert for Highlighting

`\item<n->\alert<m>{stuff}` is better than the previous automatic one.

```
\begin{itemize}
  \item<1->\alert<2> {Every thing}
  \item<1->\alert<3> {that has}
  \item<1->\alert<4> {beginning}
  \item<1->\alert<5> {has end.}
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

Note that `\item<1->\alert<2>` is same to `\item<1-|alert@2>`.

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```
\begin{itemize}
  \item<1->\alert<2> {Every thing}
  \item<1->\alert<3> {that has}
  \item<1->\alert<4> {beginning}
  \item<1->\alert<5> {has end.}
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

Note that `\item<1->\alert<2>` is same to `\item<1-|alert@2>`.

Alert for Highlighting

`\item<n->\alert<m>{stuff}` is better than the previous automatic one.

```
\begin{itemize}
  \item<1->\alert<2> {Every thing}
  \item<1->\alert<3> {that has}
  \item<1->\alert<4> {beginning}
  \item<1->\alert<5> {has end.}
\end{itemize}
```

- Every thing
- that has
- beginning
- has end.

Note that `\item<1->\alert<2>` is same to `\item<1-|alert@2>`.

Temporal for Highlighting

- \temporal<n>{before}{on}{after} for highlighting

- Ready?
    - Everything
    - that has
    - beginning
    - has end.

- Source code:

```
\def\hilite<#1>{%
\temporal<#1>{\color{gray}}{\color{blue}}%
{\color{blue!25}}}
...
\begin{itemize}
  \hilite<3> \item Everything
  \hilite<4> \item that has
  \hilite<5> \item beginning
  \hilite<6> \item has end.
\end{itemize}
```

Temporal for Highlighting

- \temporal<n>{before}{on}{after} for highlighting
- Ready?
  - Everything
  - that has
  - beginning
  - has end.
- Source code:
```
\def\hilite<#1>{%
\temporal<#1>{\color{gray}}{\color{blue}}%
{\color{blue!25}}}
...
\begin{itemize}
  \hilite<3> \item Everything
  \hilite<4> \item that has
  \hilite<5> \item beginning
  \hilite<6> \item has end.
\end{itemize}
```

Temporal for Highlighting

- `\temporal<n>{before}{on}{after}` for highlighting
- Ready?
    - Everything
    - that has
    - beginning
    - has end.
- Source code:
```
\def\hilite<#1>{%
\temporal<#1>{\color{gray}}{\color{blue}}%
{\color{blue!25}}}
...
\begin{itemize}
  \hilite<3> \item Everything
  \hilite<4> \item that has
  \hilite<5> \item beginning
  \hilite<6> \item has end.
\end{itemize}
```

Temporal for Highlighting

- \temporal<n>{before}{on}{after} for highlighting
- Ready?
  - Everything
  - that has
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- Source code:

```
\def\hilite<#1>{%
\temporal<#1>{\color{gray}}{\color{blue}}%
{\color{blue!25}}}
...
\begin{itemize}
  \hilite<3> \item Everything
  \hilite<4> \item that has
  \hilite<5> \item beginning
  \hilite<6> \item has end.
\end{itemize}
```

Temporal for Highlighting

- `\temporal<n>{before}{on}{after}` for highlighting

- Ready?
  - Everything
  - that has
  - beginning
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- Source code:
  ```
  \def\hilite<#1>{%
  \temporal<#1>{\color{gray}}{\color{blue}}%
  {\color{blue!25}}}
  ...
  \begin{itemize}
    \hilite<3> \item Everything
    \hilite<4> \item that has
    \hilite<5> \item beginning
    \hilite<6> \item has end.
  \end{itemize}
  ```

Hyperlinks and Buttons

- Beamer provides additional options for hyperlinks and buttons.
- `\hyperlink{targetname}{\beamergotobutton{text}}` to create link.
- `\hypertarget{targetname}{text}` to create target.
- To make a button "clickable" you must place it in a command like `\hyperlink`.
- Some useful buttons are `\beamerbutton`, `\beamergotobutton`, `\beamerreturnbutton` and `\beamerskipbutton`.
- To go to the title page, click ▶ Title Page
- To go to the end of presentation, click ▶ End Page
- To go to the appendix, click ▶ Appendix

Beamer Skip Button

The symbol drawn for this button is usually a double right arrow. Use this button if pressing it will skip over a well-defined part of your talk.

Theorem

I got a theorem.

⟩⟩ Skip proof

Beamer Skip Button

The symbol drawn for this button is usually a double right arrow. Use this button if pressing it will skip over a well-defined part of your talk.

Theorem
I got a theorem.

Proof.
I am trying...   □

Beamer Goto and Return Button

Theorem

I got a theorem...

▸ Go to proof details

Animations Created by Showing Slides in Rapid Succession

- To facilitate the creation of animations using this feature, the following commands can be used: `\animate` and `\animatevalue`.
- `\animate<overlayspecification>`
  The slides specified by *overlay specification* will be shown as quickly as possible.
- `\animatevalue<startslide-endslide>{name}{startvalue}{endvalue}`
  The *name* must be the name of a *counter* or a *dimension*. It will be varied between two values. For the slides in the specified range, the counter or dimension is set to an interpolated value that depends on the current slide number. On slides before the *start slide* the counter or dimension is set to *start value*, on the slides after the *end slide* it is set to *end value*.
- Use with caution as animation needs lots of slides.
- For Acrobat Adobe Reader, this works only in full-screen mode.

A Five Slide Animation with \animate<n1-n2>

The first slide is shown normally. When the second slide is shown
(presumably after pressing a forward key), the second, third, and fourth slides
"flash by" At the end, the content of the fifth slide is shown.

• Everything

A Five Slide Animation with `\animate<n1-n2>`

The first slide is shown normally. When the second slide is shown
(presumably after pressing a forward key), the second, third, and fourth slides
"flash by" At the end, the content of the fifth slide is shown.

- Everything
- that has

A Five Slide Animation with \animate<n1-n2>

The first slide is shown normally. When the second slide is shown
(presumably after pressing a forward key), the second, third, and fourth slides
"flash by" At the end, the content of the fifth slide is shown.

- Everything
- that has
- beginning

A Five Slide Animation with `\animate<n1-n2>`

The first slide is shown normally. When the second slide is shown
(presumably after pressing a forward key), the second, third, and fourth slides
"flash by" At the end, the content of the fifth slide is shown.

- Everything
- that has
- beginning
- has end.

A Five Slide Animation with `\animate<n1-n2>`

The first slide is shown normally. When the second slide is shown
(presumably after pressing a forward key), the second, third, and fourth slides
"flash by" At the end, the content of the fifth slide is shown.

- Everything
- that has
- beginning
- has end.
- That's right!

Fadeout Frame by `\animate<n1-n2>+\animatevalue`

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This text (and all other frame content) will fade out when the second slide is shown. This even works with colored text.

Fadeout Frame by \animate<n1−n2>+\animatevalue

Flying Theorems (You Really Shouldn't!)

Theorem

This theorem flies out from right!.

Flying Theorems (You Really Shouldn't!)

Theorem

This theorem flies out from right!.

ft!.

Flying Theorems (You Really Shouldn't!)

heorem

his theorem flies out from right!.

left!.

Flying Theorems (You Really Shouldn't!)

orem

theorem flies out from right!.

m left!.

Flying Theorems (You Really Shouldn't!)

m

eorem flies out from right!.

from left!.

Flying Theorems (You Really Shouldn't!)

rem flies out from right!.

in from left!.

Flying Theorems (You Really Shouldn't!)

*m flies out from *right*!.*

*es in from *left*!.*

Flying Theorems (You Really Shouldn't!)

flies out from right!.

flies in from left!.

Flying Theorems (You Really Shouldn't!)

es out from right!.

m flies in from left!.

Flying Theorems (You Really Shouldn't!)

out from right!.

rem flies in from left!.

Flying Theorems (You Really Shouldn't!)

t from right!.

m

eorem flies in from left!.

Flying Theorems (You Really Shouldn't!)

rom right!.

rem

theorem flies in from left!.

Flying Theorems (You Really Shouldn't!)

m right!.

eorem

his theorem flies in from left!.

Flying Theorems (You Really Shouldn't!)

right!.

Theorem

This theorem flies in from left!.

Flying Theorems (You Really Shouldn't!)

Theorem

This theorem flies in from left!.

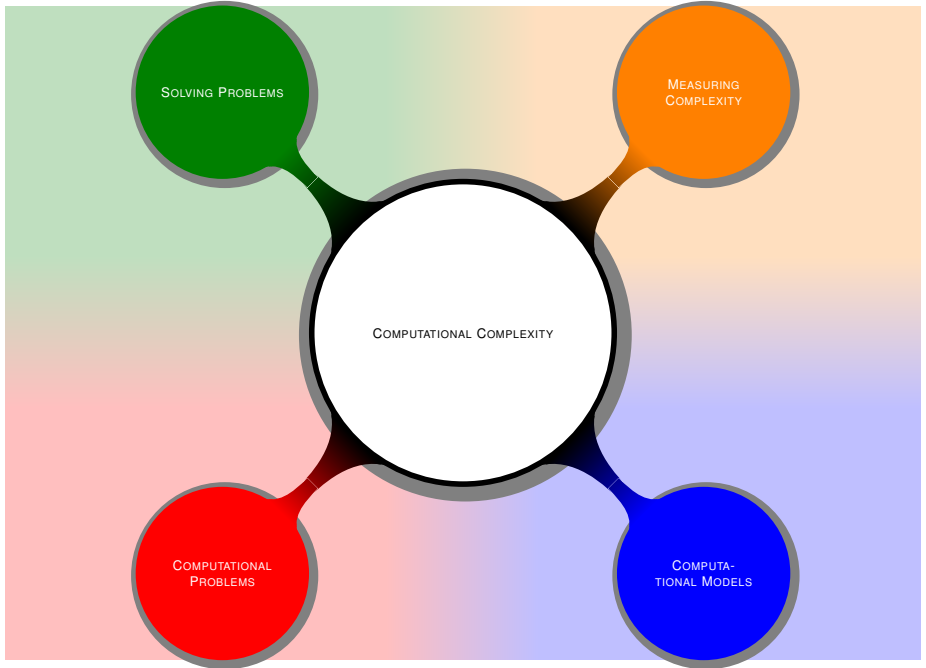## Moive with multimedia by pdflatex

`\usepackage{multimedia}`, command: `\movie`
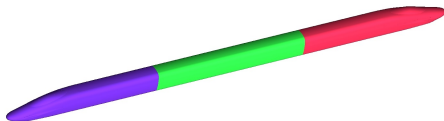
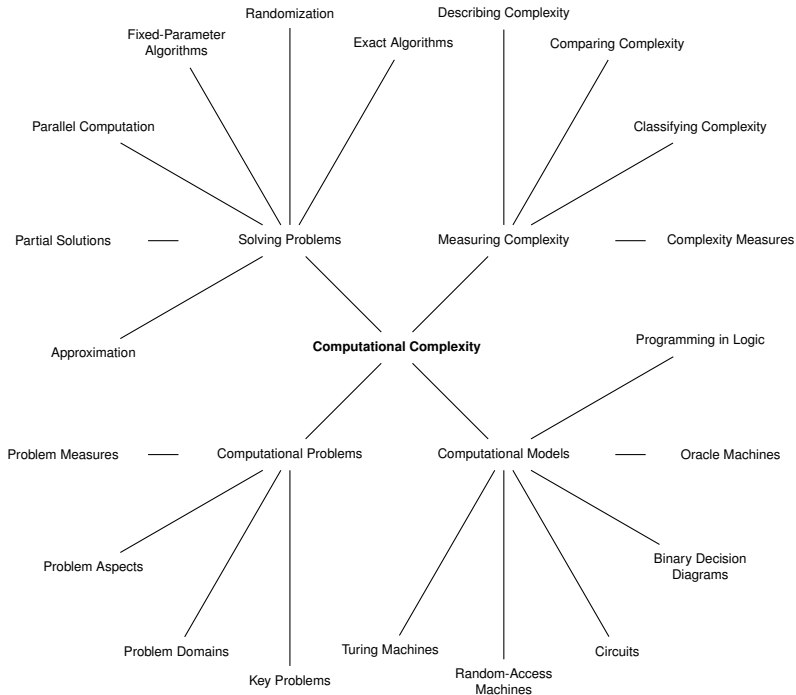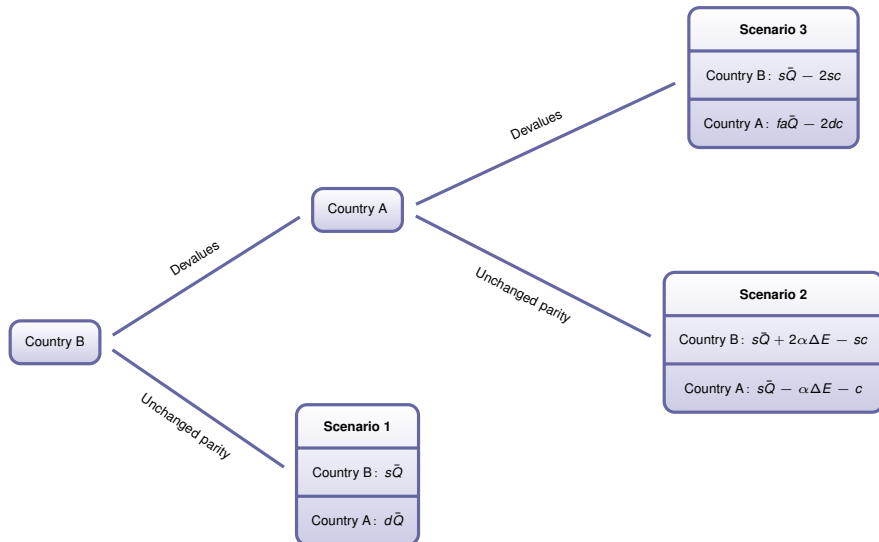## Sound with multimedia by pdflatex

`\usepackage{multimedia}`

Play

Position Nodes by Matrix Layout

Randomization

Fixed-Parameter Algorithms

Parallel Computation

Partial Solutions — Solving Problems

Approximation

Exact Algorithms

Describing Complexity

Comparing Complexity

Classifying Complexity

Measuring Complexity — Complexity Measures

Computational Complexity

Problem Measures — Computational Problems

Problem Aspects

Problem Domains

Key Problems

Programming in Logic

Computational Models — Oracle Machines

Binary Decision Diagrams

Turing Machines

Random-Access Machines

Circuits

Tree

Scenario 3

Country B : $s\bar{Q} - 2sc$

Country A : $fa\bar{Q} - 2dc$

Country A

Devalues

Devalues

Unchanged parity

Country B

Unchanged parity

Scenario 2

Country B : $s\bar{Q} + 2\alpha\Delta E - sc$

Country A : $s\bar{Q} - \alpha\Delta E - c$

Scenario 1

Country B : $s\bar{Q}$

Country A : $d\bar{Q}$

Rigid body dynamics

- Coriolis acceleration

$$\vec{a}_p = \vec{a}_o + \frac{{}^b d^2}{dt^2}\vec{r} + 2\vec{\omega}_{ib} \times \frac{{}^b d}{dt}\vec{r} + \vec{\alpha}_{ib} \times \vec{r} + \vec{\omega}_{ib} \times (\vec{\omega}_{ib} \times \vec{r})$$

Rigid body dynamics

- Coriolis acceleration

$$\vec{a}_p = \vec{a}_o + \frac{^bd^2}{dt^2}\vec{r} + 2\vec{\omega}_{ib} \times \frac{^bd}{dt}\vec{r} + \vec{\alpha}_{ib} \times \vec{r} + \vec{\omega}_{ib} \times (\vec{\omega}_{ib} \times \vec{r})$$

- Transversal acceleration

Rigid body dynamics

- Coriolis acceleration

$$\vec{a}_p = \vec{a}_o + \frac{{}^b d^2}{dt^2}\vec{r} + 2\vec{\omega}_{ib} \times \frac{{}^b d}{dt}\vec{r} + \vec{\alpha}_{ib} \times \vec{r} + \vec{\omega}_{ib} \times (\vec{\omega}_{ib} \times \vec{r})$$

- Transversal acceleration
- Centripetal acceleration

Fancy Box i

> **A fancy title**
>
> To calculate the horizontal position the kinematic differential equations are needed:
>
> $$\dot{n} = u\cos\psi - v\sin\psi \qquad (1)$$
> $$\dot{e} = u\sin\psi + v\cos\psi \qquad (2)$$
>
> For small angles the following approximation can be used:
>
> $$\dot{n} = u - v\delta_\psi \qquad (3)$$
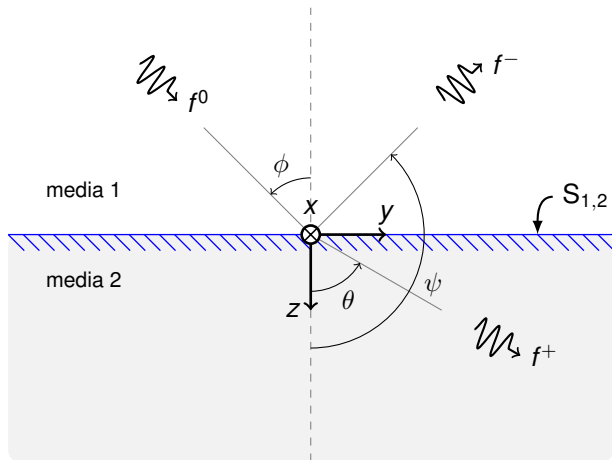> $$\dot{e} = u\delta_\psi + v \qquad (4)$$

Fancy Box ii

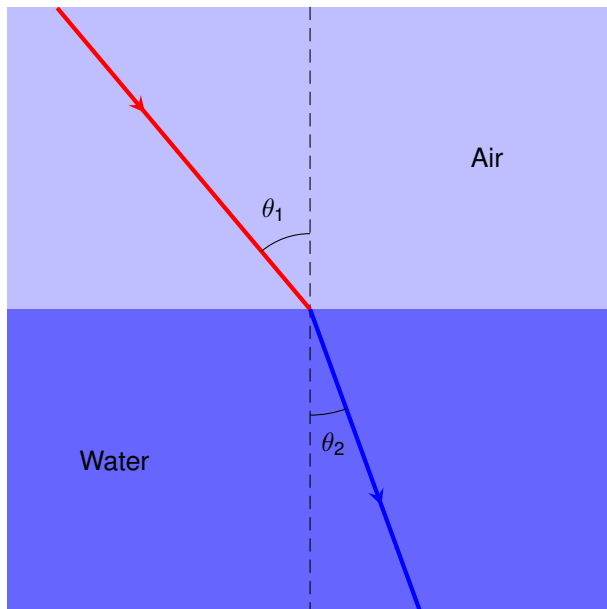Fermat's Last Theorem

Fermat's Last Theorem states that

$$x^n + y^n = z^n$$

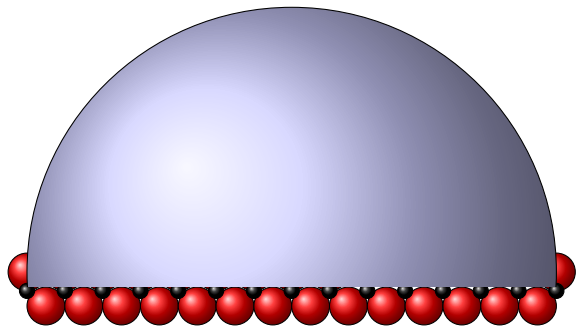has no non-zero integer solutions for x, y and z when $n > 2$.

Reflection and Refraction

Air

Water

θ_1

θ_2

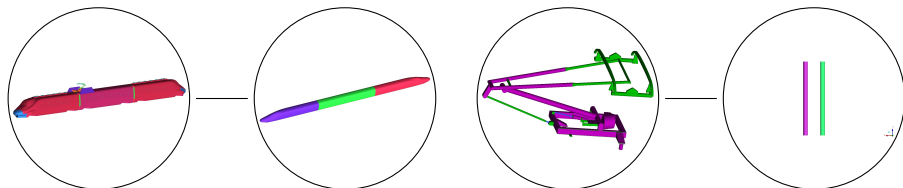## Generalized Filling

Noise generated by train:

- turbulent flow
  - + turbulent boundary layer: surfaces
  - + boundary layer separation: nose of the power car
  - + unsteady wake: rear power car
- flow over structural elements
  - + vortex shedding: pantograph and equipment
  - + cavity noise: inter-coach spacing

10 Appendix
Additional Material

Further Reading

- The Wikibooks
- Beamer's User Guide

Theorem

I got a theorem...

Proof.

This is the proof details attached in Appendix. □

◀ Return

NLAS Validation