Open Source for Academics:
An Introduction to LaTeX and R

C. Gustav Helmers     David Ubilava     Benoît Delbecq

SAEA 2010 Annual Meeting, February 6-9, 2010, Orlando, FL

February 8, 2010
Outline

Using \LaTeX

Latex at work

Homework

Using R

R Examples

Sweave

Beamer

References

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Open Source for Academics
Latex Introduction

Things to do:

1. Should I write in Latex?
2. Install a Latex distribution
3. Install a graphical front end
4. Create a simple Latex document
Should I write in Latex?

No!

- No support from computer department
- Word is great
- Daunting at first
- It is not WYSIWYG
- Not very user friendly
- Customization is hard
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Yes!

- Word has notable limitations
- Latex is a scientific standard
- Focus on what you write
- Great for referencing
- It’s free
- Works on (almost) any computer
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If your current approach is working, why change it?
Where can I send latex files?

- Collaborators may want other formats
Where can I send latex files?

- Collaborators may want other formats
- Verify that journal accepts Latex
- Examples of those that do:
  - American Economic Review (AER)
  - American Journal of Agricultural Economics (AJAE)
  - Canadian Journal of Economics (CJE)
  - European Review of Agricultural Economics (ERAE)
  - International Economic Review (IER)
  - Economica
Install a Latex distribution

The language and packages that latex uses is called its *distribution*. One of these is called MikTex:

http://miktex.org/2.8/setup

1. Click the download section and choose the “Basic installer”
2. Save the file on your desktop
3. When it’s done, double click the file
4. Install it in C:\Latex\MikTex2.8
   1. Install Packages on the fly: YES.
   2. Preferred paper size: LETTER
Install a graphical front end

There are many front ends for latex, but I suggest using one of the free alternatives - TexnicCenter

1. Go to http://www.texniccenter.org/
2. Click on “Download” and subsequently “TeXnicCenter Installer”
3. Save it to your desktop
4. Double click and install the file you just saved
5. Start TexnicCenter in the Start Menu
6. When it asks you where you have your Miktex distribution choose C:\Latex\MikTex2.8\miktex\bin
7. Go to Build menu → Select Output Profiles → Latex =>
Create a simple \LaTeX document

1. Create a folder for your \LaTeX files in your data directory. Example: \texttt{C:\Latex\MyLatexFiles}. Do not use spaces in names or folders.

2. Go to your directory and create an empty text file and change the name to \texttt{myreferences.bib} (or create it in \url{http://jabref.sourceforge.net/})

3. Create a project in \texttt{TexnicCenter} (options are not very important)
Necessary contents of a LaTeX file

Most aspects of writing a LaTeX document are flexible. However, there is a necessary core for the document to work.

Writing the code

```latex
\documentclass{article}
\begin{document}
Hello
\end{document}
```
Most aspects of writing a LaTeX document are flexible. However, there is a necessary core for the document to work.

Writing the code

\documentclass{article}
\begin{document}
Hello
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Converting from LaTeX to pdf

Build->Current_file->Build
If there are no warning messages on the bottom of the screen
Build->View_output
Basic troubleshooting

Warnings, errors, and bad boxes

Your output window shows whether building your document was a success.

Errors - The document has a serious problem
Warnings - Minor problem, but you should troubleshoot
Bad boxes - Text or image is forced to be outside the margins
Basic troubleshooting

Warnings, errors, and bad boxes

Your output window shows whether building your document was a success.

*Errors* - The document has a serious problem

*Warnings* - Minor problem, but you should troubleshoot

*Bad boxes* - Text or image is forced to be outside the margins

Solution

Examine the code depending on the message at the bottom of your screen. *F9* shows next error, *F10* shows next warning, and *F11* shows the next bad box
Create a simple Latex document

\documentclass{article}
\usepackage{fullpage,graphicx,multirow}
\title{My Latex Document}
\author{C. Gustav Helmers}
\begin{document}
\maketitle
\section{Introduction}
This is my first sentence.

\end{document}
Create a simple Latex document

My Latex Document

Claes Gustav Helmers

June 4, 2008

1 Introduction

This is my first sentence.

The preamble is everything that is written before \begin{document}

Everything after is the contents of your document
Introduction to the preamble

The preamble tells Latex about the format of your paper.
Here we are writing an article with a title and an author.
Introduction to the preamble

The preamble tells Latex about the format of your paper. Here we are writing an article with a title and an author.

Packages add features to your document similarly to other programs such as R. In this example we use three packages, each separated by a comma.
Common commands - Sections

\tableofcontents
\newpage
\section{Introduction}
An indexed expression can also appear on the receiving end of an assignment, in which the assignment operation is performed only on those elements of the vector.

\subsection{Background}
An indexed expression can also appear on the receiving end of an assignment, in which the assignment operation is performed only on those elements of the vector...

\subsubsection{Something very interesting}
An indexed expression can also appear on the receiving end of an assignment, in which the assignment operation is performed only
Common commands - Sections

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\section - Creates a section header
\subsection - Creates a subsection header
\subsubsection - Creates a sub-subsection header

Spacing does not affect text output, but an empty line indicates a line break.
A brief note about \LaTeX{} environments

The following indicates an environment which is usually treated as one object:

\begin{<command>}
  ...
\end{<command>}

Examples are equations, tables, and pictures. They can also indicate centering text or similar which is not regarded as an object.

\begin{center}
  ...
\end{center}
How to create a table I

A spreadsheet style table in \LaTeX{} usually consists of two environments:

- A \textit{table} command - Creates an object which makes the environment “solid” so that it is not divided
- A \textit{tabular} command - Which arranges texts into clearly defined columns

The \textit{tabular} command can be used by itself for arranging text into columns, but it cannot be referenced and may be split over two pages.
How to create a table II

1. They are a series of columns *inside* an object.
2. Ampersands (&) indicate new columns.
3. Two backslashes (\\) indicate a new line.
4. Note how to draw lines in the table.
How to create a table II

1. They are a series of columns *inside* an object
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<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_{it}$</td>
<td>Price of hotel $i$ in period $t$</td>
</tr>
<tr>
<td>$Q_m$</td>
<td>Relevant market capacity</td>
</tr>
<tr>
<td>$\varepsilon_{it}$</td>
<td>Error term associated with observation $i$ in period $t$</td>
</tr>
<tr>
<td>$l_i$</td>
<td>Luxury level</td>
</tr>
<tr>
<td>$Q_i$</td>
<td>Unit capacity</td>
</tr>
<tr>
<td>$p_{mt}$</td>
<td>Market price</td>
</tr>
<tr>
<td>$\mu_i$</td>
<td>Fixed effect for</td>
</tr>
<tr>
<td>$\nu_k$</td>
<td>Residual error</td>
</tr>
<tr>
<td>type</td>
<td>Ownership type</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Discount rate</td>
</tr>
</tbody>
</table>

Table 1: Variable description
How to create a table II

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</tbody>
</table>

Table 1: Variable description
How to write an equation I

\[ y = x\beta + \varepsilon \]  \hspace{1cm} (1)

Equation 1 shows the well known OLS equation
How to write an equation I

\[ y = x\beta + \varepsilon \quad (1) \]

Equation 1 shows the well known OLS equation

We can also write equations like \( \rightarrow \frac{3}{4x} = 5 \).

\[ x \cdot \left( \sqrt{\frac{256}{16}} \right) = 4x \]

Try the online equation editor at
http://www.sitmo.com/latex/
A nice way of showing a series of equations is by using \textit{eqnarray}. This function aligns rows of equations similarly to the \textit{tabular} function.

\begin{eqnarray}
  x + y & = & z \\
  z & = & 3y + 1 \\
  x & \geq & 0
\end{eqnarray}

Equations 2 - 4 shows an array. Equations number themselves and update every time the document is built.
Managing references

To include references in a document we need a *bib* file. Change the preferences in Google Scholar:

Google Scholar → Scholar preferences → Bibliography manager → Show links to import citations into: BibTex

Import them and paste the text in your created bib file.
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Basics

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SAEA 2010 Annual Meeting

Open Source for Academics
Organizing your Latex stuff - List of references

Before \end{document}
\newpage \bibliographystyle{chicago}
\bibliography{biblan}
\addcontentsline{toc}{section}{References}

(Source: http://www.biochem.ucl.ac.uk/~james/latex/bibliography.html)
Getting to know LaTeX

To do

- Build a simple document using the `fullpage` package from scratch. Create a table of contents with subsections.
- Look around the menus in TeXnicCenter. Most necessary tools are there.
- Keep in mind that the point of using LaTeX is to avoid unnecessary formatting. Let the program arrange your text for you.
Latex quirks

- Remember to build often (the steps in building)
- Do not disregard warnings
- Google is your friend
What is R?

- R is an effective statistical language for data handling, computing and graphics, which can be displayed on screen or stored as hard-copy.
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- R is simple to implement, which includes intuitive way of programming conditionals, loops, user-defined recursive functions, etc.
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- R is simple to implement, which includes intuitive way of programming conditionals, loops, user-defined recursive functions, etc.
- R is free
How to get R?

- R Project Web-Site: http://cran.r-project.org/
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  - R Documentation
  - R Packages
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R Description

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- R Documentation
- R Packages
- Download and Install R
- Tinn-R: http://www.sciviews.org/Tinn-R/
- And, of course, Google is your friend
Data Handling

- Importing data:

```r
dat <- read.table("dat.csv", header=TRUE, sep="","", na.strings="NA", dec=".", strip.white=TRUE)
```
Data Handling

- Importing data:

```r
dat <- read.table("dat.csv", header=TRUE, sep="","", na.strings="NA", dec=".", strip.white=TRUE)
```

- Exporting data:

```r
write(dat, file="dat_2.txt", sep="","", append=FALSE)
```
Some Data Manipulation

Selecting a column from a matrix:

\[ y \leftarrow \text{dat}[,1] \]
Some Data Manipulation

Selecting a column from a matrix:

```r
y <- dat[,1]
```

Selecting a block from a matrix:

```r
b <- dat[1:10,1:10]
```
Simple Plots

```r
plot(x, y, col="purple", xlab="Unemployment Rate", ylab="Inflation", main="Philips Curve")
abline(lm(y~x), col="red", lwd=2)
```

![Philips Curve](image-url)
par(mar=c(8,4,2,4))
ts.plot(cbind(y,x),col=c("blue","red"),xlab="time",ylab="Percent")
par(xpd=NA)
legend(20,-8,legend=c("Inflation","Unemployment Rate"),
col=c("blue","red"),lty=c(1,1),bty="n",ncol=2)
Linear Estimation

\[
\begin{align*}
    b & \leftarrow \text{solve(crossprod}(X)\text{)} \times \text{crossprod}(X,y) \\
    \text{yhat} & \leftarrow X \times b \\
    e & \leftarrow y - \text{yhat} \\
    \text{sig} & \leftarrow \text{as.vector(crossprod}(e) / (\text{nrow}(X) - \text{ncol}(X))) \\
    \text{varmat} & \leftarrow \text{sig} \times \text{solve(crossprod}(X)) \\
    \text{se} & \leftarrow \text{as.matrix(sqrt(diag(varmat)))} \\
    \text{trat} & \leftarrow b / \text{se} \\
    \text{pval} & \leftarrow 2 \times \text{pt(-abs(trat),df=(nrow}(X) - \text{ncol}(X))) \\
    \text{tab} & \leftarrow \text{cbind(b,se,trat,pval)} \\
    \text{colnames(tab)} & \leftarrow c("estimate","s.e.","t-ratio","p-value") \\
    \text{rownames(tab)} & \leftarrow c("intercept","unemployment")
\end{align*}
\]
## Linear Estimation

<table>
<thead>
<tr>
<th></th>
<th>estimate</th>
<th>s.e.</th>
<th>t-ratio</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>intercept</td>
<td>4.746</td>
<td>0.624</td>
<td>7.602</td>
<td>0.000</td>
</tr>
<tr>
<td>unemployment</td>
<td>-0.395</td>
<td>0.125</td>
<td>-3.162</td>
<td>0.002</td>
</tr>
</tbody>
</table>
Introducing Loops and Functions

A loop:

```r
betamat <- matrix(nrow=1000,ncol=2)
for(i in 1:nrow(betamat)){
  yi <- yhat+sample(e,nrow(y),replace=TRUE)
  bi <- solve(crossprod(X))%*%crossprod(X,yi)
  betamat[i,] <- bi
}
```
Introducing Loops and Functions

A function:

```r
boot.func <- function(yvec, xmat, bootnum)
{
  b0 <- solve(crossprod(xmat)) %*% crossprod(xmat, yvec)
  yhat <- xmat %*% b0
  e0 <- yvec - yhat
  betamat <- matrix(, bootnum, ncol(xmat))
  for(i in 1:bootnum)
  {
    yi <- yhat + sample(e0, nrow(yvec), replace=TRUE)
    bi <- solve(crossprod(xmat)) %*% crossprod(xmat, yi)
    betamat[i,] <- bi
  }
  list(beta.ols=b0, beta.boot=betamat)
}
```

Using a function:

```r
boot.res <- boot.func(y, X, 1000)
```
boxplot(as.data.frame(betamat), horizontal=TRUE, col="gold", range=0, notch=FALSE, names=c("intercept","unemployment"), xlab="parameter distribution")
abline(v=0, col="gray", lwd=2, lty=3)
More Plots

cdf.1 <- ecdf(betamat[,1])
cdf.2 <- ecdf(betamat[,2])
ci.1 <- quantile(betamat[,1],c(0.05,0.95))
ci.2 <- quantile(betamat[,2],c(0.05,0.95))
par(mfrow=c(1,2),mar=c(5,2,1,2))
plot(cdf.1,ylab="CDF",xlab="Constant",main="")
abline(v=ci.1,col="red",lty=3)
plot(cdf.2,ylab="CDF",xlab="Unemployment rate",main="")
abline(v=ci.2,col="red",lty=3)
Saving Tables and Graphs

Formatting Tables:

```
tab.for <- formatC(tab, digits=3, format="f")
```

Latex compatible:

```
tab.lat <- xtable(tab.for)
```

Saving Graphs:

```
png(filename="filename.png", height=400, width=400, bg="white", res=100)
<plot command>
dev.off()
```
R is not flawless

- Originally built for Linux, slower on older Windows platforms (Newer 64 bit Windows systems are similar)
- Gets slower as number of loops increase
- Memory size problems with very large matrices (observe platform differences)
Best of both worlds

- **R** – open source statistical software allowing flexible quantitative analysis combined with powerful graphical features
- **\LaTeX** – open source typesetting language particularly adapted for academic publication

**Sweave**

"Sweave is a tool that allows to embed the R code for complete data analyses in latex documents. The purpose is to create dynamic reports, which can be updated automatically if data or analysis change" (Leisch, 2002).
How does it work?

- **Sweave** is part of the basic R install
- combine R and \LaTeX code in the same .Rnw file
- succession of code chunks:
  - R chunk start with `<<options>>=`
  - \LaTeX chunk start with `@`
- In R...
  - ... run Sweave("file.Rnw"): it executes the R code chunks in the background and creates a .tex file which can be subsequently built into the final document
  - ... run Stangle("file.Rnw"): extracts only the R chunks and combines them in file.r
An example of code and output

The command `plot()` can be applied to many object types in R. When its first argument is a polygon shape file, it draws the polygon contours which may be filled using the argument `col`. Labels and a title may be subsequently added.

```r
<<eval=FALSE>>=
plot(sids,border="lightgray",
col=cm.col[findInterval(sids$data$SID74,breaks)])
text(coordinates(sids)[1],coordinates(sids)[2],
sids$data$SID74, cex=0.5)
title("Number of SIDS in 1974")

We combine both maps in the same figure by setting graphical parameters `mfrow=c(2,1)` in the following command line, placed before calling both `plot()` functions:

```r
<<eval=FALSE>>=
options(SweaveHooks=list(fig=function()
   par(mfrow=c(2,1),mai=c(0.5,0.1,0.5,0.1)))

We finally add the legend:

```r
<<eval=FALSE>>=
legend("bottomright",
legend=c("0-25%", "26%-50%", "51%-75%", "76%-95%", "96%-100%"),
fill=cm.col,bty="n",cex=0.7,y.intersp=1,x.intersp=1)
```
Embedding \texttt{R} code

\begin{verbatim}
\<<options>>=
  \item echo=TRUE: command and output are printed
  \item eval=FALSE: command not executed
  \item results=hide: results not displayed
  \item fig=TRUE: declares following code chunk as a \LaTeX\ figure
\end{verbatim}
Generate and incorporate pictures

```latex
<<echo=FALSE, results=hide>>=
options(SweaveHooks = list(fig = function() par(mfrow=c(2,1), mai=c(0.5,0.1,0.5,0.1))))

<<label=S1maps, fig=TRUE, echo=FALSE, include=FALSE>>=
brks <- quantile(sids$data$SID74, prob=c(0,0.25,0.5,0.75,0.95))
cm.col <- cm.colors(length(brks))
plot[coordinates(sids)[,1],coordinates(sids)[,2], sids$data$SID74, cex=0.5]
title("Number of SIDS in 1974")
plot[coordinates(sids)[,1],coordinates(sids)[,2], sids$data$SID79, cex=0.5]
title("Number of SIDS in 1979")
legend("bottomright", legend=c("0-25\%", "26\%-50\%", "51\%-75\%", "76\%-95\%", "96\%-100\%"), fill=cm.col, bty="n", cex=0.7, y.intersp=1, x.intersp=1)

\begin{figure}
\centering
\includegraphics[width=\textwidth]{S1maps}
\caption{SID count in 1974 and 1979}
\end{figure}
```

Figure 1: SID count in 1974 and 1979
\texttt{\textbf{Sexpr\{\}}}: allows to evaluate \texttt{R} code within a \texttt{\LaTeX} code chunk

\textbf{Code}

The variable of interest is the number of deaths by Sudden Infant Death Syndrome for the \texttt{Sexpr[nrow(sids@data)]} counties of North Carolina. On average \texttt{Sexpr[round(mean(sids@data$SID74),2)]} infants per county were affected in 1974, and \texttt{Sexpr[round(mean(sids@data$SID79),2)]} in 1979. The two maps in figure \ref{fig:sidmap} represent the distribution of the syndrome over space for both years.

\textbf{Output}

The variable of interest is the number of deaths by Sudden Infant Death Syndrome for the 100 counties of North Carolina. On average 6.67 infants per county were affected in 1974, and 8.36 in 1979. The two maps in figure 1 represent the distribution of the syndrome over space for both years.
Why take the time to learn?

1. changes in data or quantitative analysis directly repercuted in the paper
2. teaching tool - \texttt{R} vignettes, spatial econometrics course workbook
3. “reproducible research” (Buckheit and Donoho, 1995) - the final product of research replicable by any independent entity
Wondering how we made these awesome slides?

- **Beamer** - a free open-source alternative to Microsoft Powerpoint for \LaTeX\ users

  **Why use it?** Because it has all the benefits of \LaTeX\ including:
  - equations
  - references
  - labels and tables of contents and figures

  **Once familiar with \LaTeX, adopting Beamer is (almost) pain-free**
Setting up the basics

Use a normal preamble (copy and paste this in TexnicCenter):

- **This is the preamble**
  \documentclass[hyperref={pdfpagelabels=false},handout]{beamer}

- **Each slide is a frame**

  \begin{document}
  \begin{frame}
  \hspace{\textwidth} ... Your presentation here ... \hspace{\textwidth}
  \end{frame}

  \frame{
  \hspace{\textwidth} ... or on another slide \hspace{\textwidth}
  }
  \end{document}
Selected features

Highlighted bullets

- It’s free

\begin{itemize}
  \item <1- |alert@+> It’s free
  \item <2- |alert@+> All the benefits of \LaTeX{}
\end{itemize}
Highlighted bullets

- It’s free
- All the benefits of \LaTeX

\begin{itemize}
  \item <1- |alert@+> It’s free
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\end{itemize}
It’s free

All the benefits of \LaTeX

\begin{itemize}
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\end{itemize}

Do not be alarmed by the high number of pages built

- for \LaTeX each sequential bullet is put on a different overlay (or page)

\begin{verbatim}
LaTeX-Result: 0 Error(s), 5 Warning(s), 13 Bad Box(es), 61 Page(s)
\end{verbatim}
Selected features

Overlays

\begin{enumerate}
\item tic \pause
\item tac \pause
\item toe \pause
\item toe
\end{enumerate}
Selected features

Overlays

\pause

\begin{enumerate}
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\item tic \pause
\item tac \pause
\item toe
\end{enumerate}
Selected features

Overlays

\pause

\begin{enumerate}
  \item tic \pause
  \item tac \pause
  \item toe
\end{enumerate}

alternatively

\begin{enumerate}[<+->]
  \item tic
  \item tac
  \item toe
\end{enumerate}
Selected features

Overlays

- \pause

\begin{enumerate}
\item tic \pause
\item tac \pause
\item toe
\end{enumerate}

- alternatively

\begin{enumerate}[<+->]
\item tic
\item tac
\item toe
\end{enumerate}
Selected features

\textbf{Overlays}

\begin{itemize}
\item \texttt{\textbackslash pause}
\end{itemize}

\begin{verbatim}
\begin{enumerate}
\item tic \pause
\item tac \pause
\item toe
\end{enumerate}
\end{verbatim}

\textbf{alternatively}

\begin{verbatim}
\begin{enumerate}[<+->]
\item tic
\item tac
\item toe
\end{enumerate}
\end{verbatim}
Selected features

Overlays

- \texttt{\textbackslash pause}

\begin{enumerate}
  \item \texttt{tic \textbackslash pause}
  \item \texttt{tac \textbackslash pause}
  \item \texttt{toe}
\end{enumerate}

Alternatively

\begin{enumerate}[<+->]
  \item \texttt{tic}
  \item \texttt{tac}
  \item \texttt{toe}
\end{enumerate}
\begin{itemize}
\item Frere Jacques
\item Dormez-vous?
\item Sonnez les matines
\item Din, Ding, Dong
\end{itemize}
\begin{itemize}
\item Frère Jacques
\item Dormez-vous?
\item Sonnez les matines
\item Din, Ding, Dong
\end{itemize}
\begin{itemize}
\item<1-> Frère Jacques
\item<3> Dormez-vous?
\item<2-4> Sonnez les matines
\item<2,5> Din, Ding, Dong
\end{itemize}
Overlays (cont’d)

\begin{itemize}
\item<1-> Frère Jacques
\item<3> Dormez-vous?
\item<2-4> Sonnez les matines
\item<2,5> Din, Ding, Dong
\end{itemize}

- Frère Jacques
- Sonnez les matines
Overlays (cont’d)

\begin{itemize}
\item<1-> Frère Jacques
\item<3> Dormez-vous?
\item<2-4> Sonnez les matines
\item<2,5> Din, Ding, Dong
\end{itemize}

Frère Jacques

Din, Ding, Dong

Slide 5
Selected features

Columns and figures

\begin{columns}
\begin{column}{0.45\textwidth}
\begin{figure}
\pgfimage[width=0.70\textwidth]{belltower}
\caption{Purdue University Bell Tower}
\end{figure}
\end{column}
\begin{column}{0.45\textwidth}
[code]
\end{column}
\end{columns}

Figure: Purdue University Bell Tower
Nice boxes

My slide

Interesting box

\begin{beamerboxesrounded}{My slide}{Interesting box}\end{beamerboxesrounded}
Selected features

Beamer article and handouts

Replacing the first line of your document gives you the presentation in outline form

\documentclass{article}
\usepackage{beamerarticle}

If you prefer handouts, change the original first line from:

\documentclass[hyperref={pdfpagelabels=false}]{beamer}

to:

\documentclass[hyperref={pdfpagelabels=false},handout]{beamer}
References


Online resources

Great help site: http://en.wikibooks.org/wiki/LaTeX
Another nice automatic math site:
http://www.bgoncalves.com/online/latex/
Learning equations:
http://www.personal.ceu.hu/tex/cookbook.html
The beamer package:
http://www.math.umbc.edu/~rouben/beamer/
Good resource for counters:
Related Purdue AgEcon Web Links

This presentation:
http://www.agecon.purdue.edu/files/opensource.pdf

Department Beamer template:
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http://openboilers.blogspot.com/