AccessLex Institute

R and LaTeX

Materials: https://github.com/PrisonRodeo/July-2017-git

July 12, 2017

R

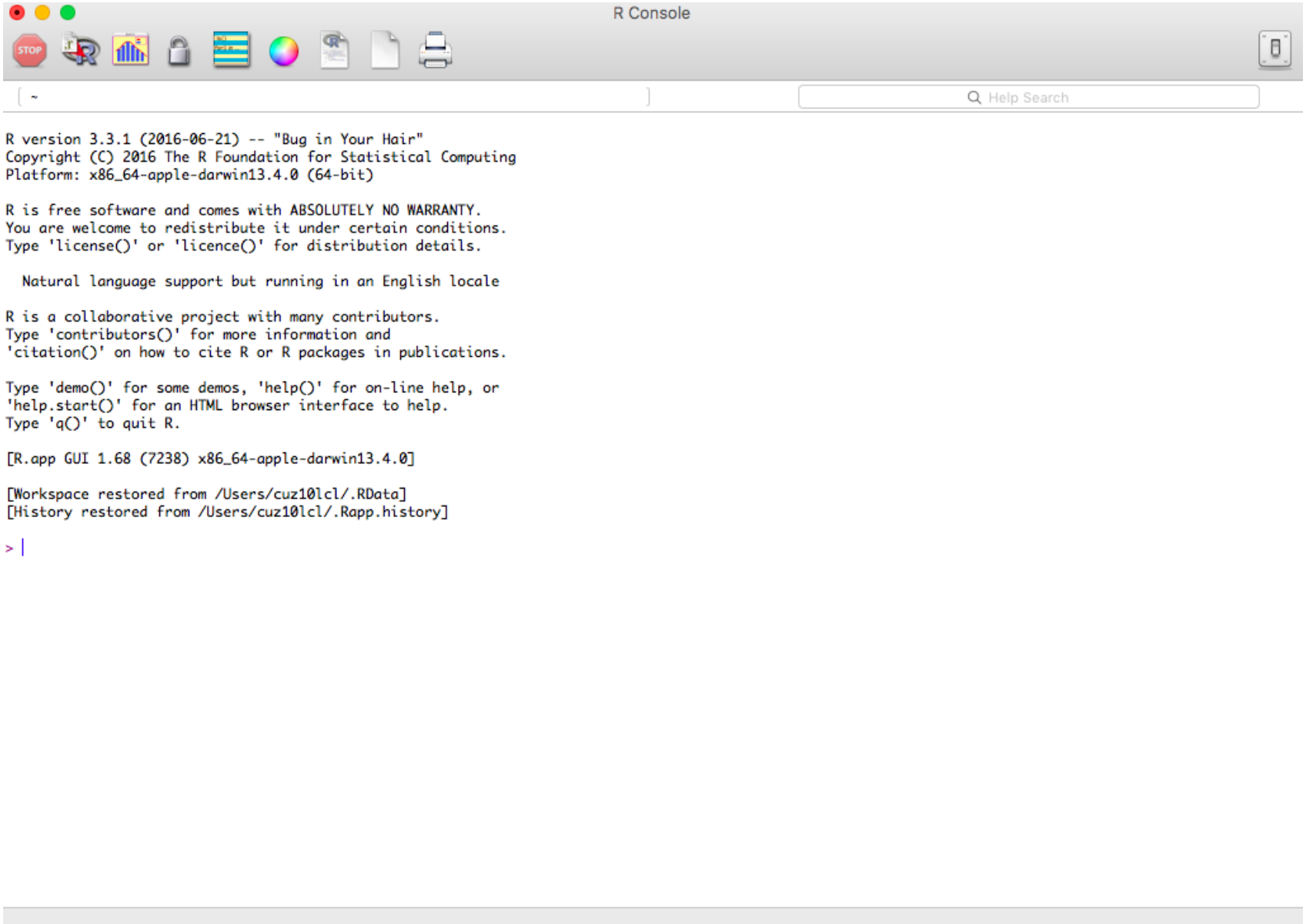
R (and RStudio)

- R
  - "R is a free software environment for statistical computing and graphics."
  - The R Project: https://www.r-project.org/
  - Comprehensive R Archive Network (CRAN): https://cran.r-project.org/

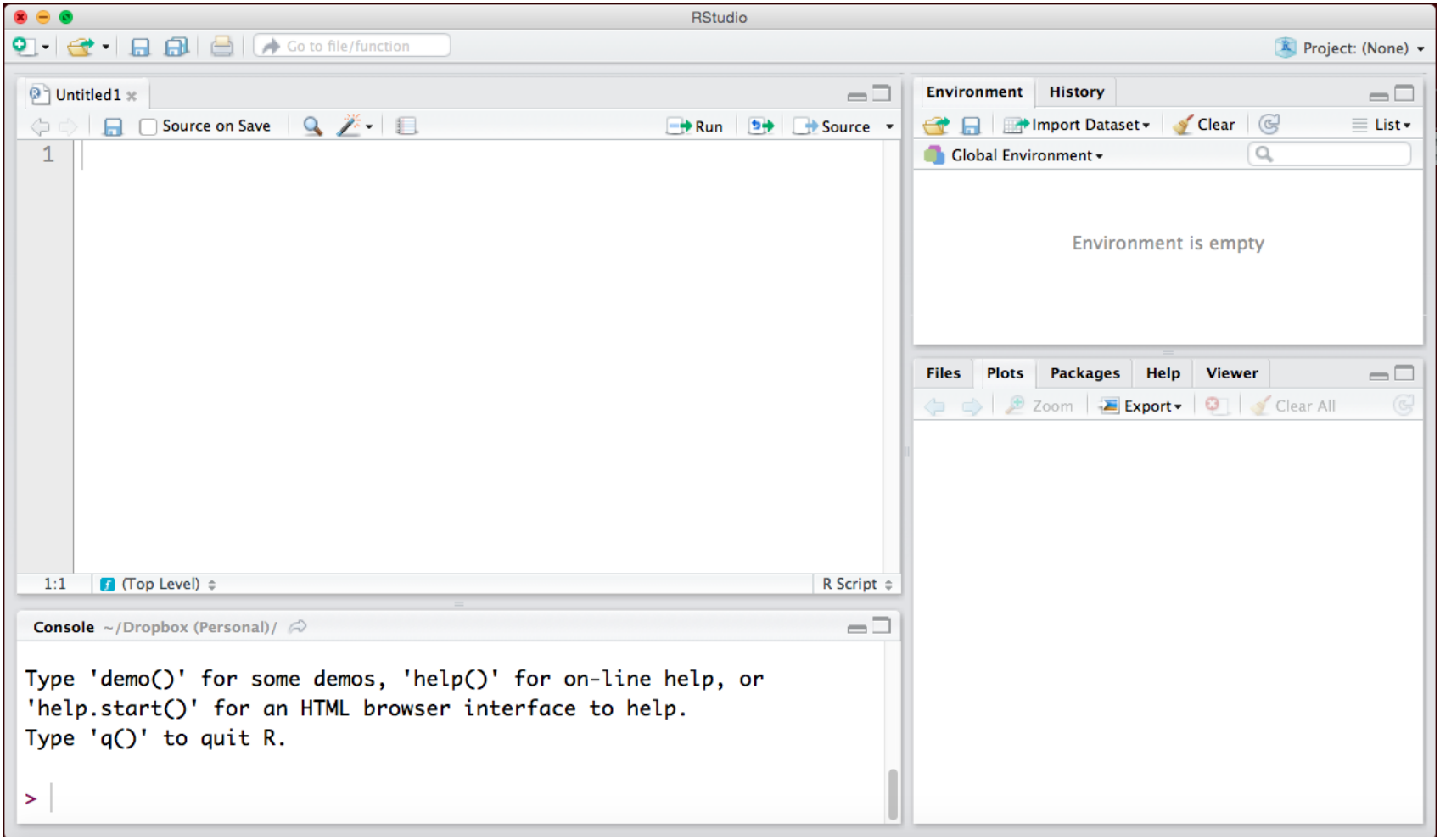
- RStudio
  - A free, open-source GUI for R
  - Website: https://www.rstudio.com/

R:

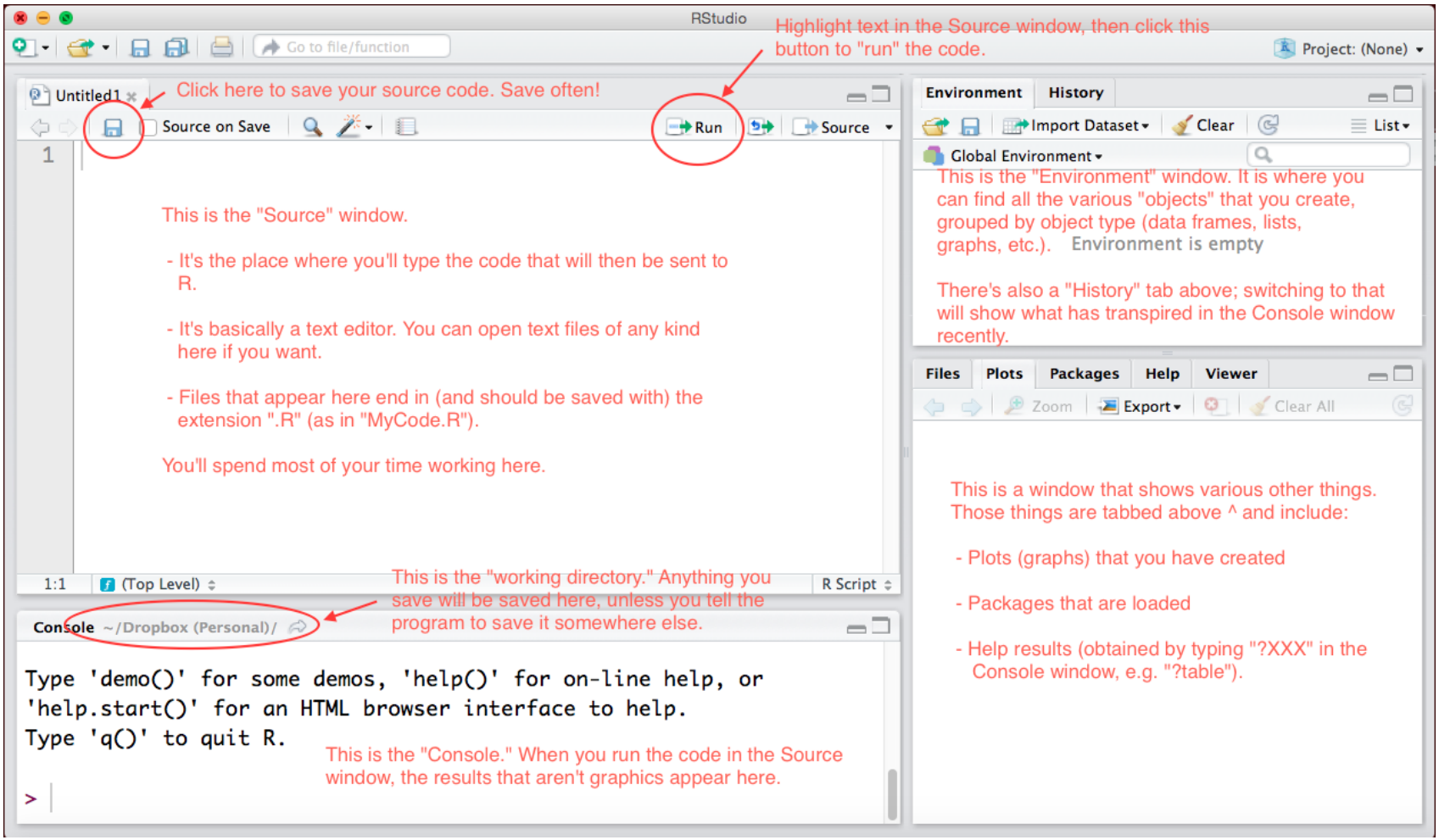
- Is an **object-oriented** language
- Is made up of:
  - Objects
  - Functions
  - Classes (of objects and functions)
- Is **Turing complete**
- Is **modular**
  - User-created **packages**
  - Organized into **task views** (https://cran.r-project.org/web/views/)
- Runs on UNIX/Linux/OS-X/Windows


R Console
STOP
~
Help Search
R version 3.3.1 (2016-06-21) -- "Bug in Your Hair"
Copyright (C) 2016 The R Foundation for Statistical Computing
Platform: x86_64-apple-darwin13.4.0 (64-bit)
R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.
Natural language support but running in an English locale
R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
[R.app GUI 1.68 (7238) x86_64-apple-darwin13.4.0]
[Workspace restored from /Users/cuz10lcl/.RData]
[History restored from /Users/cuz10lcl/.Rapp.history]
>

RStudio


RStudio
Go to file/function
Project: (None)
Untitled1
Source on Save
Run
Source
1
1:1
(Top Level)
R Script
Console ~/Dropbox (Personal)/
Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
>
Environment
History
Import Dataset
Clear
List
Global Environment
Environment is empty
Files
Plots
Packages
Help
Viewer
Zoom
Export
Clear All

RStudio (annotated)



Inside the Source Window

This:

```
> table(df$X)
```

... means "Type the phrase 'table(df$X)' on the command line," or – equivalently – "Type the phrase 'table(df$X)' into your Source code, and then run it."

Inside the Source Window

More often, you'll see:

```
with(df, plot(Y~X,pch=19,col="red")) # draw a scatterplot
abline(h=0,lty=2) # add a horizontal line at zero
abline(v=0,lty=2) # add a vertical line at zero
text(df$X,df$Y,labels=df$names,pos=1) # add labels
```

... which means "Put this block of text into your Source code, and then run it."

Note:

- R / RStudio ignores line breaks
- Anything to the right of a "#" is a comment

Very basic R examples...

(see `AccessLex-2017-R-Intro.R` in the github repo)

Help For Learning R(Studio)

In rough order of preference:

- Quick-R (`http://www.statmethods.net/`)
- The "Level-Zero" R Tutorial (doesn't integrate RStudio, but is otherwise very good)
- Statistics with R
- The Do It Yourself Introduction to R
- Also be sure to consult the AccessLex "Useful R Resources" guide (on GitHub).

Example Data: Infant Mortality

```
> url <- getURL("https://raw.githubusercontent.com/PrisonRodeo/
    July-2017-git/master/Data/CountryData2000.csv")
> Data <- read.csv(text = url) # read the "Country" data
> rm(url)
>
> # Summary statistics
>
> # install.packages("psych") <- Install psych package, if necessary
> library(psych)

> with(Data, describe(infantmortalityperK))
  vars   n  mean    sd median trimmed   mad min max range skew kurtosis   se
1    1 179 43.83 40.39     29   38.38 34.26 2.9 167 164.1    1     0.06 3.02

> with(Data, describe(DPTpct))
  vars   n  mean    sd median trimmed   mad min max range  skew kurtosis   se
1    1 181 81.71 19.77     90   85.23 11.86  24  99    75 -1.31     0.57 1.47
```

OLS Regression

```
> IMDPT<-lm(infantmortalityperK~DPTpct,data=Data,na.action=na.exclude)
> summary.lm(IMDPT)

Call:
lm(formula = infantmortalityperK ~ DPTpct, data = Data)

Residuals:
    Min      1Q  Median      3Q     Max
-56.801 -16.328  -5.105  11.777  86.590

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept) 173.2771     8.4893   20.41   <2e-16 ***
DPTpct       -1.5763     0.1009  -15.62   <2e-16 ***
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1

Residual standard error: 26.19 on 175 degrees of freedom
  (14 observations deleted due to missingness)
Multiple R-squared:  0.5824,Adjusted R-squared:   0.58
F-statistic: 244.1 on 1 and 175 DF,  p-value: < 2.2e-16
```

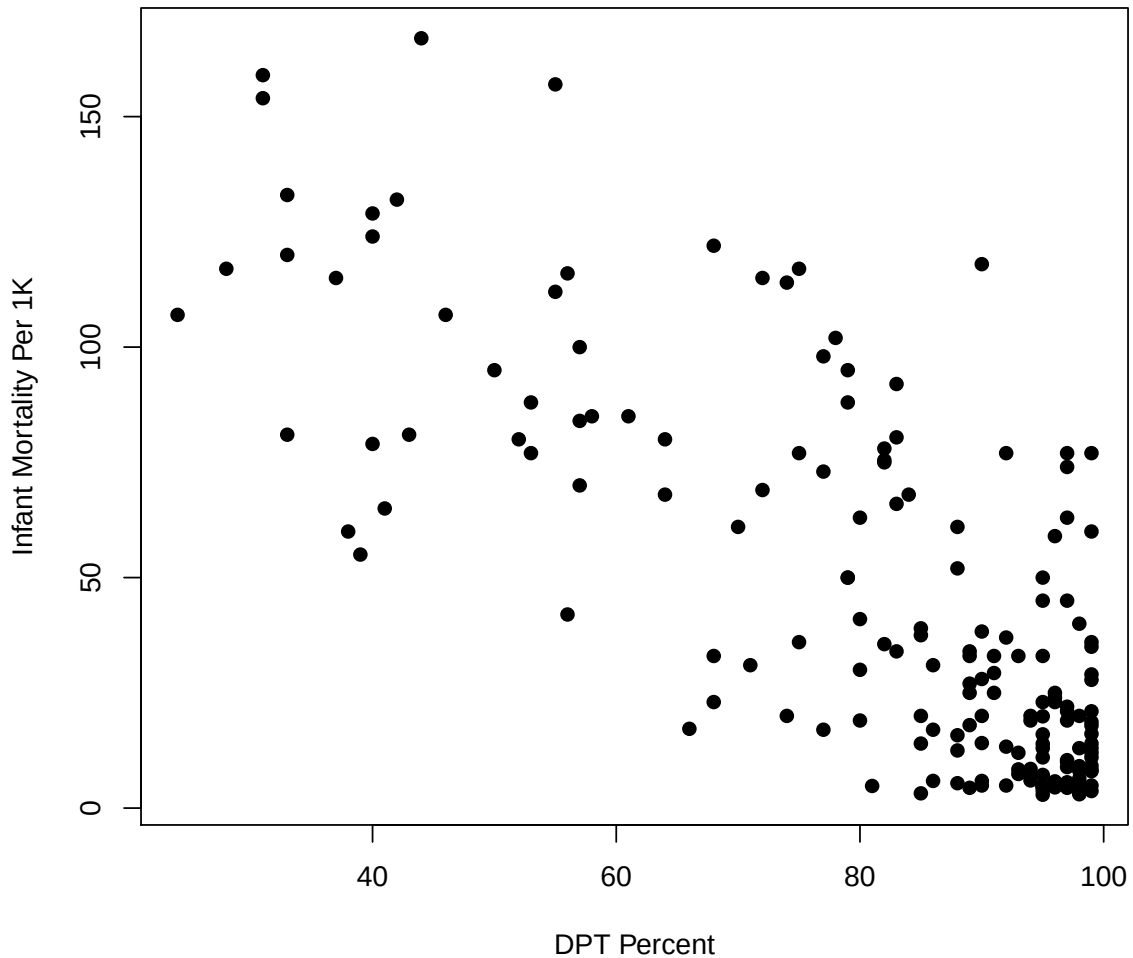
Analysis of Variance

```
> anova(IMDPT)
Analysis of Variance Table

Response: infantmortalityperK
           Df Sum Sq Mean Sq F value    Pr(>F)
DPTpct      1 167423  167423  244.09 < 2.2e-16 ***
Residuals 175 120033     686
---
Signif. codes:  0 *** 0.001 ** 0.01 * 0.05 . 0.1   1
```

A Basic Scatterplot

```
> with(Data,
     plot(DPTpct,infantmortalityperK,pch=19,
          xlab="DPT Percent",ylab="Infant Mortality Per 1K"))
```



LaTeX:

- Is "a document preparation system for high-quality typesetting."
- **Is not a word processor.**
- Runs on UNIX/Linux/OS-X/Windows
- Outputs files in multiple formats (but usually `.pdf`)

The **source file**:

- Defines the document type.
- Loads "packages" that allow different options in document creation.
- Creates the document structure.
- Contains the content of the document itself: text, images, (sometimes) computer code

Source File: Example

R-Latex-Slides-July-2017.tex

Typeset | LaTeX | Macros | Tags | Templates

```
% ------------------------------------------------------------------
\documentclass[11pt]{beamer}
%----- Beamer Options --------------------
%
% Theme examples are HERE:   http://www.hartwork.org/beamer-theme-matrix/
%
\setbeamercolor{title}{fg=black}
\setbeamercolor{title}{bg=white}
\setbeamercolor{frametitle}{fg=black}
\setbeamercolor{frametitle}{bg=white}
\setbeamercolor{enumerate items}{fg=black}
\setbeamertemplate{enumerate item}{\insertenumlabel.}
\setbeamertemplate{enumerate subitem}{\insertenumlabel.\insertsubenumlabel}
\setbeamercolor{itemize item}{fg=black}
\setbeamercolor{itemize item}{fg=black} % all frames will have black bullets
\setbeamercolor{itemize subitem}{fg=black} % all frames will have black bullets
\setbeamercolor{itemize subsubitem}{fg=black} % all frames will have black bullets
\setbeamercolor{enumerate item}{fg=black}
\setbeamercolor{enumerate subitem}{fg=black} % all frames will have black bullets
\setbeamercolor{enumerate subsubitem}{fg=black} % all frames will have black bullets
\setbeamertemplate{navigation symbols}{}
\setbeamertemplate{footline}[frame number]
\setbeamertemplate{itemize items}[default]
\setbeamertemplate{enumerate items}[default]
% Numbered Figures:
\setbeamertemplate{caption}[numbered]
% Theme & Colors:
\usetheme{Pittsburgh}
\usecolortheme{dove}
%\usepackage{beamerthemesplit} % new
```

A minimal example...

A medium example (memorandum)...

R and LaTeX

R + LaTeX: Sweave and `knitr`

- Sweave "...enables the embedding of R code within LaTeX documents to generate a PDF file that includes narrative and analysis, graphics, code, and the results of computations."

- `knitr` is an R package that expands the capabilities of Sweave.

- Key point: **Integrates data analysis and document creation.**
    - Analysis and text are in the same document
    - Documents are *dynamic*: When the data changes, the document changes.

Minimal Example

Calfee / FirstEnergy Memo

Recommendations

Recommendations

- Work with IT on installation, etc.
- Settle on a common implementation of R and LaTeX
- Start small...
- Additional / future training