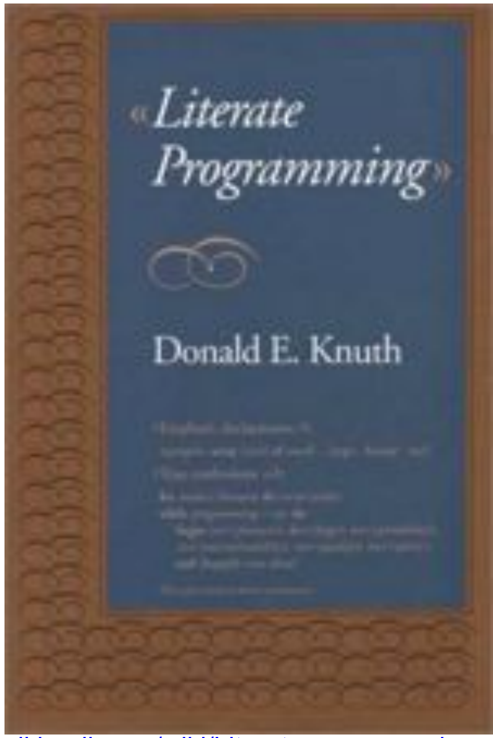
Scripts define HOW
The report defines WHAT & WHY

Literate programming

Let us change our traditional attitude to the construction of programs: Instead of imagining that our main task is to instruct a computer what to do, **let us concentrate rather on explaining to humans what we want the computer to do**.

– Donald E. Knuth
Literate Programming, 1984



https://en.wikipedia.org/wiki/Literate_programming

KnitR

Writing reports

- **HTML** - HyperText Markup Language, used to create web pages. Developed in 1993
- **LaTeX** – a typesetting system for production of technical/scientific documentation, PDF output. Developed in 1994
- **Sweave** – a tool that allows embedding of the R code in LaTeX documents, PDF output. Developed in 2002
- **Markdown** – a lightweight markup language for plain text formatting syntax. Easily converted to HTML

HTML example

HTML files have **`.html`** extension

Pairs of tags define content/formatting

- **`<h1> Header level 1 </h1>`**
- **`<a href="http://www….”> Link </a>`**
- **`<p> Paragraph </p>`**

```
<!DOCTYPE html>
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=utf-8"/>
</head>

<body>
<h1>Markdown example</h1>

<p>This is a simple example of a Markdown document.</p>

You can emphasize code with <strong>bold</strong> or <em>italics</em>, or
<code>monospace</code> font.
</body>
</html>
```

https://support.rstudio.com/hc/en-us/articles/205368677-R-Markdown-Dynamic-Documents-for-R

LaTeX example

LaTeX files usually have a **`.tex`** extension

LaTeX commands define appearance of text, and other formatting structures

```
\documentclass{article}
\usepackage{graphicx}

\begin{document}

\title{Introduction to \LaTeX{}}
\author{Author's Name}

\maketitle

\begin{abstract}
This is abstract text: This simple document shows very basic features of
\LaTeX{}.
\end{abstract}

\section{Introduction}
```

http://www.electronics.oulu.fi/latex/examples/example_1/

Sweave example

Sweave files typically have **`.Rnw`** extension
LaTeX syntax for text, **`<<chunk_name>>= <code> @`** syntax outlines code blocks

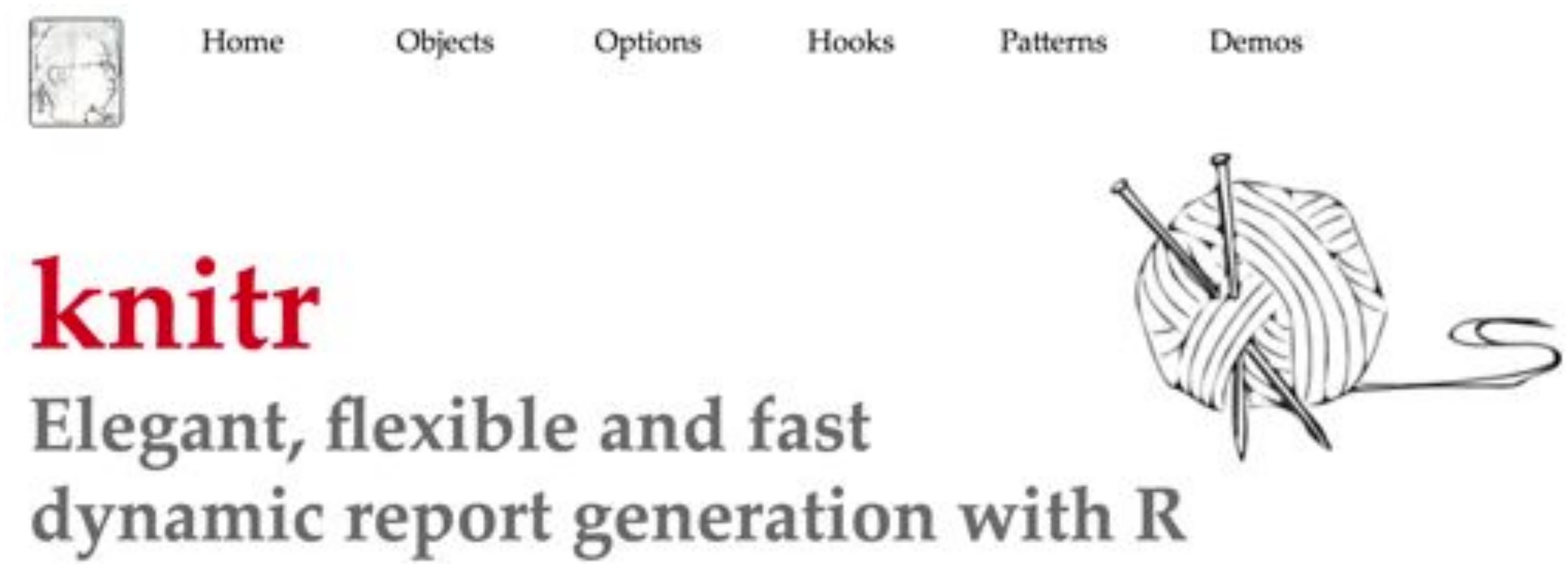
```
\documentclass{article}

\usepackage{amsmath}

\usepackage{natbib}
\usepackage{indentfirst}

\DeclareMathOperator{\logit}{logit}

% \VignetteIndexEntry{Logit-Normal GLMM Examples}

\begin{document}

First we attach the data.
<<booth>>=
library(bernor)
data(booth)
attach(booth)
@
```

KnitR

- KnitR – a package for dynamic report generation written in R Markdown. PDF, HTML, DOCX output. Developed in 2012

https://github.com/yihui/knitr

```
install.packages('knitr', dependencies = TRUE)
```



http://yihui.name/knitr/

Markdown syntax

Emphasis

```
*italic*   **bold**
_italic_   __bold__
```

Headers

```
# Header 1
## Header 2
### Header 3
```

Lists

Unordered List

```
* Item 1
* Item 2
    + Item 2a
    + Item 2b
```

Ordered List

```
1. Item 1
2. Item 2
3. Item 3
    + Item 3a
    + Item 3b
```

```
superscript^2^
~~strikethrough~~
```

Links

```
http://example.com
[linked phrase](http://example.com)
```

Images

```
![](http://example.com/logo.png)
![optional caption text](figures/img.png)
```

Blockquotes

```
A friend once said:
> It's always better to give
> than to receive.
```

Horizontal Rule / Page Break

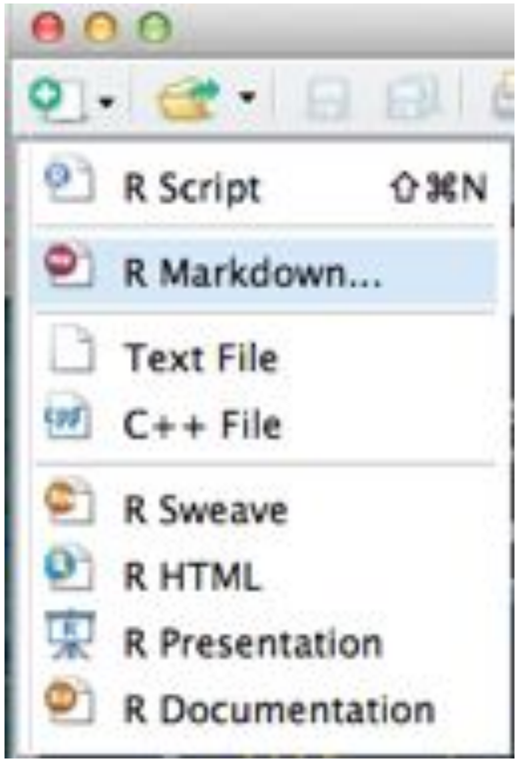
```
******
------
```

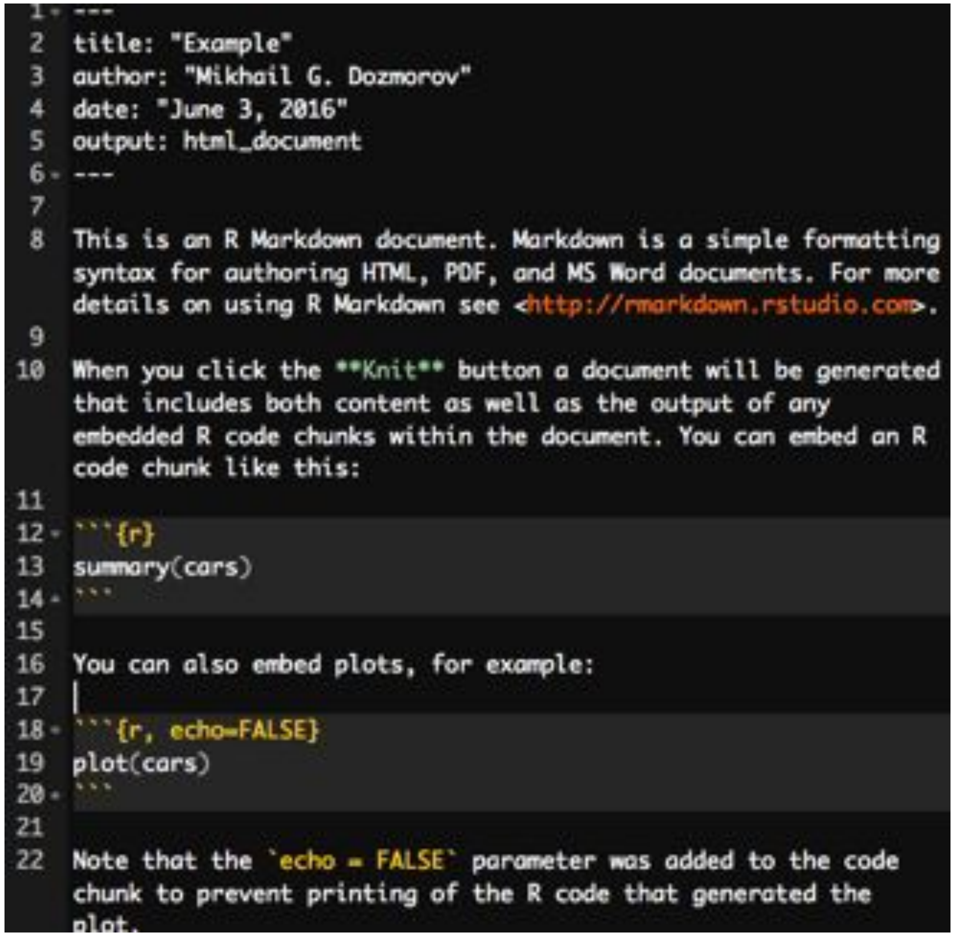
Tables

```
First Header  | Second Header
------------- | -------------
Content Cell  | Content Cell
Content Cell  | Content Cell
```

Creating R markdown document

- Regular file with **`.Rmd`** extension
- Use RStudio





~~~
---
title: "Example"
author: "Mikhail G. Dozmorov"
date: "June 3, 2016"
output: html_document
---

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see <http://rmarkdown.rstudio.com>.

When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document. You can embed an R code chunk like this:

```{r}
summary(cars)
~~~

You can also embed plots, for example:

```{r, echo=FALSE}
plot(cars)
```

Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.
```
```

YAML header (think settings)

YAML - YAML Ain't Markup Language

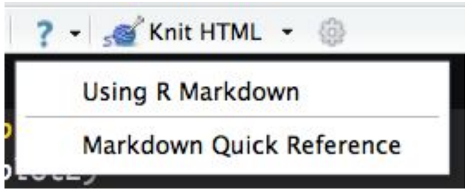
YAML is a simple text-based format for specifying data, like JSON

```
---
title: "Untitled"
author: ″Your Name"
date: ″Current date"
output: html_document
---
```

`output` is the critical part – it defines the output format. Can be **`pdf_document`** or **`word_document`**

R Markdown — Dynamic Documents for R

- An extension of Markdown that allows embedded R code chunks
- Chunks of code are labeled
  - with single backticks, **`` `<code>` ``**, rendered in a monospace font, non-executable. A simple code formatting option
  - with single backticks, **`` `r <code> ` ``**, for inline code. "**r**" indicates executable R code. Instead of hard coding numbers, the inline code allows to evaluate variables in real time.



```
There are `r paste(nrow(my_data))` rows
The estimated correlation is `r cor(x, y)`
```

DEMO

https://support.rstudio.com/hc/en-us/articles/205368677-R-Markdown-Dynamic-Documents-for-R

Large code chunks

Marked with triple backticks

~~~
```{r chunk_name, options}
<code>
```
~~~

- The chunk name is optional
- By default, the code AND its output are displayed in the final report

Modifying behavior of R code chunks

Chunk options, comma-separated

`echo=FALSE` hides the code, but not the results/output. Default: TRUE

`results='hide'` hides the results/output. 'hold' – hold all the output until the end of a chunk. Default: 'asis'

`eval=FALSE` disables code execution. Default: TRUE

`cache=TRUE` turn on caching of calculation-intensive chunk. Default: FALSE

fig.width=##, fig.height=## customize the size of a figure generated by the code chunk

Global chunk options

Some options you would like to set globally, instead of typing them for each chunk

~~~
```{r global_options, include=FALSE}
knitr::opts_chunk$set(fig.width=12,
fig.height=8, fig.path='Figs/', echo=FALSE,
warning=FALSE, message=FALSE)
```
~~~

`warning=FALSE and message=FALSE` suppress any R warnings or messages from being included in the final document

`fig.path='Figs/'` the figure files get placed in the Figs subdirectory. (Default: not saved at all)

An example of R Markdown document

~~~
```{r setup, echo=FALSE}
library(ggplot2)
```

There are `r paste(length(LETTERS))` letters in English alphabet.

```{r count_combinations, echo=FALSE}
max_number_of_combinations <- 5
count_combinations <- list()
for (i in 1:max_number_of_combinations) {
  count_combinations <- c(count_combinations, ncol(combn(length(LETTERS), i)))
}
```

A total of `r paste(count_combinations[[2]])` pairwise combinations of them can be selected. Or,
`r paste(count_combinations[[3]])` combinations of three letters can be selected.

```{r fig.height=4, fig.width=4}
combination_counts <- data.frame(
  combinations = seq(1, length(count_combinations)),
  counts = unlist(count_combinations),
  stringsAsFactors = FALSE)

ggplot(combination_counts, aes(x = combinations, y = counts, fill = factor(combinations))) +
  geom_bar(stat = "identity") +
  ggtitle("Alphabet combinatorics") +
  theme(legend.position="none")
```
~~~

Displaying data as tables

- **KnitR** has built-in function to display a table

```
data(mtcars)
knitr::kable(head(mtcars))
```

- **pander** package allows more customization

```
pander::pander(head(mtcars))
```

- **xtable** package has even more options

```
xtable::xtable(head(mtcars))
```

- **DT** package, an R interface to the DataTables library

```
DT::datatable(mtcars)
```

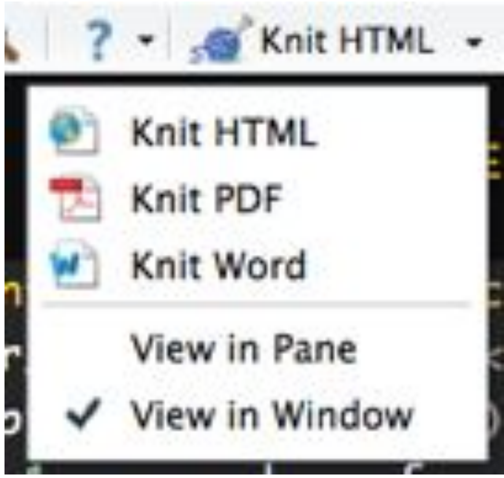
Creating the final report

- Markdown documents **`*.md`** can be converted to HTML using **`markdown::markdownToHTML('markdown_example.md', 'markdown_example.html')`**

- Another option is to use **rmarkdown::render('markdown_example.md')** At the backend it uses **pandoc** command line tool, installed with Rstudio (http://pandoc.org/).

- Rstudio – one button **`knit2html(), knit2pdf`**

Note: **`KnitR`** compiles the document in an R environment separate from yours (think Makefile). Do not use **`./Rprofile`** file.



Things to include in your final report

- **`set.seed(12345)`** – initialize random number generator
- Include **`session_info()`** at the end – outputs all packages/ versions used

~~~
```{r session_info}
diagnostics <- devtools::session_info()
platform <- data.frame(diagnostics$platform %>%
unlist, stringsAsFactors = FALSE)
colnames(platform) <- c("description")
pander(platform)

packages <- as.data.frame(diagnostics$packages)
pander(packages[ packages$`*` == "*", ])
```
~~~

https://github.com/mdozmorov/MDmisc