

R in Teaching and Testing

Duncan Murdoch

Department of Statistical and Actuarial Sciences
University of Western Ontario

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What is Sweave?

- **Sweave** is an R function that is part of a *literate programming system*. It allows you to mix text with R code in a single document.
- **Sweave** will process the document to produce \LaTeX (or other) formats for processing and display.
- The more recent **knitr** package (Xie, 2013) has functions similar to **Sweave**. For most users, I'd recommend **knitr** instead of **Sweave** nowadays, and the second half of the talk is written in **knitr**.
- The first part of this talk is about my package **Sweavetest**; it was started many years ago using **Sweave**.

Simple example

The idea of *Sweave* is that your document corresponds to a session of R. You embed text like

```
<<simpleexample, fig=TRUE>>=  
set.seed(123)  
x <- 1:10  
y <- rnorm(10)  
y  
plot(x, y)  
@
```

into your **.Rnw** file, ...

Simple example

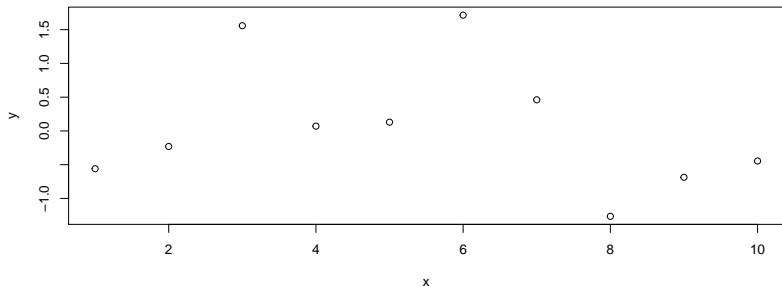
and *Sweave* converts it into this:

```
\begin{Schunk}
\begin{Sinput}
> set.seed(123)
> x <- 1:10
> y <- rnorm(10)
> y
\end{Sinput}
\begin{Soutput}
 [1] -0.56047565 -0.23017749  1.55870831  0.07050839  0.12928774
 [6]  1.71506499  0.46091621 -1.26506123 -0.68685285 -0.44566197
\end{Soutput}
\begin{Sinput}
> plot(x, y)
\end{Sinput}
\end{Schunk}
\includegraphics{figs/part1-simpleexample}
```

Simple example

which \LaTeX processes into this:

```
> set.seed(123)
> x <- 1:10
> y <- rnorm(10)
> y
[1] -0.56047565 -0.23017749  1.55870831  0.07050839  0.12928774
[6]  1.71506499  0.46091621 -1.26506123 -0.68685285 -0.44566197
> plot(x, y)
```



How to Use Sweave

One easy way to use *Sweave* is in RStudio (RStudio Inc., 2014). Here are the basic steps:

- 1 Write a document that will look like a \LaTeX document with “code chunks” of R mixed in. Name it `doc.Rnw`.
- 2 Tell RStudio to “Compile PDF”. It will run *Sweave* (`"doc.Rnw"`) in R to process the code and produce `doc.tex`, then will run *pdflatex* to produce your beautiful `doc.pdf` output.

Other editors are also possible; my *patchDVI* package helps with some of them (e.g. TeXShop, TeXWorks, WinEdt, etc.).

Sweavetest

- ***Sweavetest*** is a package whose main purpose is to use ***Sweave*** to help write and grade multiple choice tests. It includes a few other course-management functions.
- I've had numerous students help me with it over the years; most recently Adam Rahman (who presented a poster about it in Edmonton), Vivian Chu and Xinjie Li.
- Today I'll give a very short tour.

Multiple Choice Tests

At UWO, we teach several large introductory statistics courses. We usually test them using multiple choice tests. These suffer from well-known problems:

- The questions are hard to write. They need to be unambiguous, with a single correct answer given, and the distractors (the wrong choices) should match common misconceptions.
- It is very easy for students to cheat: they only need to copy one letter.

Partial solutions

We can mitigate these problems with *Sweavetest*:

- Keep a bank of question patterns, modify the details on each test offering. *Sweavetest* helps, especially with the second part: it can compute random datasets and answers from them using the full power of R. Questions can include plots, R output, etc.
- Produce multiple versions of the same test, with randomly ordered questions, and randomly ordered choices in each question. *Sweavetest* currently does the second, with some preliminary work towards the first.

Example

Consider the 7 values:

```
\begin{center}
$
<<>>=
set.seed(429)
x <- rpois(7, 32)
cat(paste(x, collapse=", "))
@
$
\end{center}
```

What is their median?

```
<<>>=
horiz(median(x), x[4], round(mean(x), 1),
      diff(range(x)), Correct=1)
@
```

Example output

Consider the 7 values:

34, 32, 24, 35, 29, 27, 37

What is their median?

- (A) 13 (B) 32 (C) 31.1 (D) 35

Grading Support

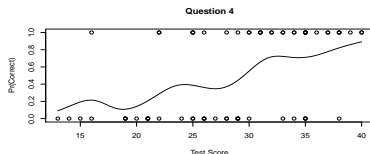
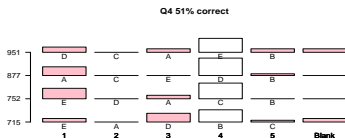
Besides producing the test questions, *Sweavetest* writes out data on the randomization, and uses that to grade the student responses (from Scantron sheets). It can produce a report on each question.

Example report

- 4) What is the binary representation of -10 as an integer in R? (I have added spaces in the numbers to make them more readable; ignore those when working out the answer.)
- 1) 10000000 00000000 00000000 00001010
 - 2) 10000000 00001010
 - 3) 11111111 11111111 11111111 11110101
 - 4) *11111111 11111111 11111111 11110110
 - 5) $-$ 00000000 00000000 00000000 00001010

Option	Frequency	Percentage	Discrimination
1	16	24	-0.2418
2	0	0	0.0000
3	9	13	-0.0065
4	34	51	0.6013
5	4	6	-0.1765

Item Analysis	Values
Difficulty Rating	0.51
Item Discriminator	0.60
Point Biserial	0.48



Other functions

Sweavetest has a lot of other functions for:

- various other question layouts besides *horiz()*.
- recording and reporting on long answer marks.
- merging grades into a class list.
- writing out exam attendance sheets.
- constructing and writing tables of probability distributions.
- etc.

What's missing in Sweavetest?

What's missing?

- The data management functions rely on `.csv` files; this was a bad design decision. Rob Lee is currently working on managing things in an SQLite database.
- A team in Austria involving Nikolaus Umlauf, Achim Zeileis and others have code to print and read custom mark-sense sheets. Vivian Chu has adapted the printing functions to our needs; Rob Lee and I hope to get to the reading code this summer.
- Nikolaus and Achim are also involved in the `exams` package, which maintains a database of questions, categorized by topic, and allows random selection and ordering of questions on each test. I've been working slowly towards reconciling `Sweavetest` with `exams`.

What else is missing?

- The *Sweavetest* documentation isn't really good enough for others to use.
- *Sweavetest* hasn't been released to the public yet.

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The *rgl* slides are in `teachtest2.html`.

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References

JJ Allaire, Jonathan McPherson, Yihui Xie, Hadley Wickham, Joe Cheng, and Jeff Allen. *rmarkdown: Dynamic Documents for R*, 2014. URL <http://rmarkdown.rstudio.com>. R package version 0.4.2.

RStudio Inc. *RStudio: Integrated development environment for R*, 2014. URL <http://www.rstudio.org>. version 0.99.152.

Yihui Xie. *Dynamic Documents with R and knitr*. Chapman and Hall/CRC, 2013. URL <http://yihui.name/knitr/>. ISBN 978-1482203530.