Computer Animations for Demonstrating Statistical Procedures: Methods and Implementations

Yihui Xie

Statistical Graphics: Data and Information Visualization in Today’s Multimedia Society (Data Viz VI)
Outline

1 Motivation
   - Sometimes Statistics Classes Are Like This...
   - Sometimes Things Can Be Different...

2 Methods
   - How to Generate Animations in R
   - The animation Package
   - Convert R Animations to Other Forms

3 Examples

4 Summary
Motivation

1 Motivation
- Sometimes Statistics Classes Are Like This...
- Sometimes Things Can Be Different...

2 Methods
- How to Generate Animations in R
- The animation Package
- Convert R Animations to Other Forms

3 Examples

4 Summary
Freeze! Listen to Me!

Figure 1: Hey, buddy, this is not funny!
Cooked in Examinations...

Figure 2: Are we like hot “dogs” when in examinations?
How Far Can Our Imagination Reach?

Figure 3: This is not Harry Potter!
Nobody’s Sleeping There?

Figure 4: Me at a forum, talking about animations.
A Simple Illustration: Steps of the $k$NN Algorithm

knn.ani()
Where Do I Begin?

- Simulations that involve with random numbers: flip coins, drop (Buffon’s) needles, LLN, CLT, etc.
- Sampling and Resampling (& sub-sampling): bootstrapping, jackknife, cross-validation, SRSWOR, etc.
- Computations that contains *intuitive* iterations: Newton’s method, gradient descent, etc.
- Time series or any series that show changes along a certain variable.
Methods

1 Motivation
   • Sometimes Statistics Classes Are Like This...
   • Sometimes Things Can Be Different...

2 Methods
   • How to Generate Animations in R
   • The animation Package
   • Convert R Animations to Other Forms

3 Examples

4 Summary
A Naive Method: Successive Plots in a Loop

```r
cl = rainbow(360)
for (i in 1:360) {
  plot(1, ann = F, type = "n", axes = F)
  text(1, 1, "Animation", srt = i,
       col = cl[i], cex = 7 * i/360)
  Sys.sleep(0.01)
}
```

Figure 5: A rotation (rotation.swf)
To Turn Ideas into Animations

Infrastructure  R base graphics (grid graphics in future?)

Implementation  plot again and again... (and record the sequence of images)

Insane Ideas  focus on the visual display of statistical theories to help people think in a step-by-step manner

Internet  AniWiki: Animations in Statistics (http://animation.yihui.name)
Three Kinds of Animations: (1) HTML Pages
Three Kinds of Animations: (2) GIF/MPG by ImageMagic
Three Kinds of Animations: (3) Flash by SWF Tools

coverage rate: 0.926

CI: $\bar{x} \pm \frac{z_{\alpha/2} \sigma}{\sqrt{n}}$, $\bar{x} \pm z_{\alpha/2} \sigma / \sqrt{n}$

Samples

2 25
Examples

1 Motivation
- Sometimes Statistics Classes Are Like This...
- Sometimes Things Can Be Different...

2 Methods
- How to Generate Animations in R
- The animation Package
- Convert R Animations to Other Forms

3 Examples

4 Summary
Time to relax now! Let’s watch some movies.
Summary

1 Motivation
   • Sometimes Statistics Classes Are Like This...
   • Sometimes Things Can Be Different...

2 Methods
   • How to Generate Animations in R
   • The animation Package
   • Convert R Animations to Other Forms

3 Examples

4 Summary
They told me: “very interesting, impressive”, but only one person told me “useful” so far; I’m so sorry about that :-(

I think (insist?) animation is an effective measure to prevent students from sleeping, and this is an important step before teaching them knowledge :-D Besides, animations may help them understand statistical methods more quickly.

“I hear and I forget, I see and I remember, I do and I understand.” – Xun Zi (an ancient Chinese Confucian philosopher)

There are limitations: a lot of theories have nothing to do with animations (it’s not my fault); no GUI (necessary?); ...
Thanks

Questions & Comments?