Visualising big data in R

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The challenge of visualising big data

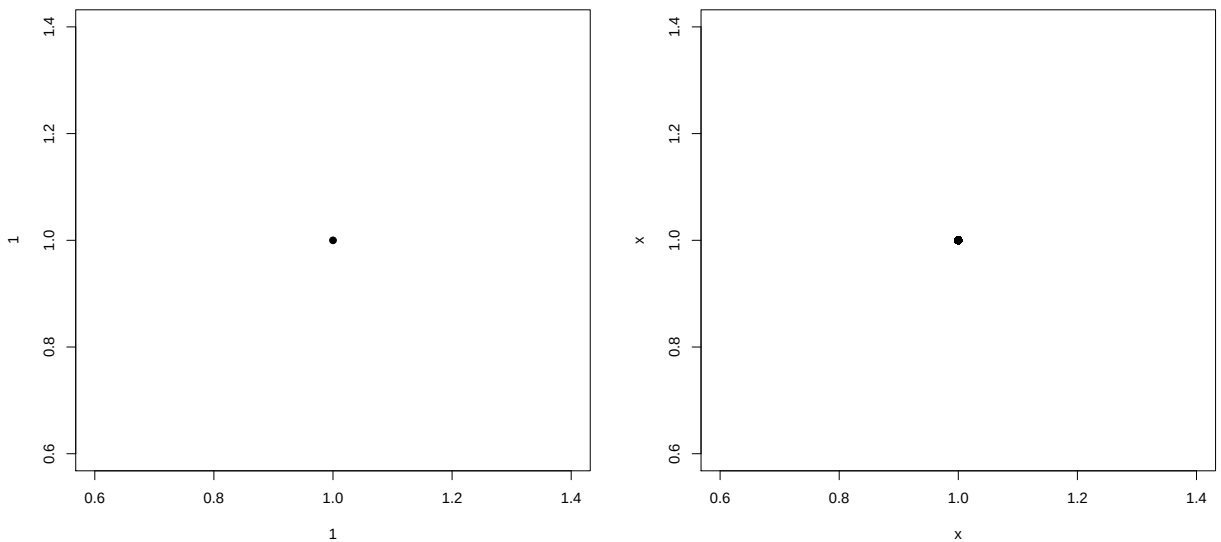
- Only a few million pixels on a screen, but many more data points
- Therefore need to generate a suitable summary to plot instead
- **Directly visualising raw big data is probably pointless**, at least for static graphics (real-time manipulation of big data, e.g. fly throughs is another matter...)

$\rightarrow$ A typical 1D/2D plot of big data will have lots of overlapping & therefore **obscured** points: these different values will be visually indistinguishable

Hidden plot points

- Single vs. multiple overlapping points

```
pdf(file = "N1.pdf", compress = FALSE); plot(1, 1, pch = 19)
bmp(file = "N1.bmp", antialias = "none"); plot(1, 1, pch = 19)
x <- rep(1, 1e3) # 1000 identical points
pdf(file = "N1000.pdf", compress = FALSE); plot(x, x, pch = 19)
bmp(file = "N1000.bmp", antialias = "none"); plot(x, x, pch = 19)
graphics.off()
```



- The 2 plots look identical (apart from subtle anti-aliasing effects)

Image file size comparison

- List the size of each image file (in bytes):

```
sapply(list.files(pattern="N1.*"), function(f) file.info(f)$size)
```

```
 N1000.bmp N1000.pdf    N1.bmp    N1.pdf
    231478     75390    231478     12452
```

- The bitmap graphics raster images are identical in size, but the (uncompressed) vector graphics PDFs differ in size by a factor ~ 6
- Raster graphics resolve overlaps: 1000 overlapping points $\equiv$ 1 point, but vector graphics retain each point as a separate entity
- Similar principle required for Big Data, but need more control...

The bigvis concept

Download the paper (vita.had.co.nz/papers/bigvis.html), by Hadley Wickham: *Bin-summarise-smooth: a framework for visualising large data*

- Bigvis is a *scheme for pre-processing* big datasets
  - output can then be handled by conventional (*R*) plot tools
  - processing done in (fast) compiled C++ code, using `Rcpp` package
- bigvis goal: be able to plot 100 million points in under 5 seconds
- Also provides outlier removal and smoothing:
  - big data means very rare cases can occur $\Rightarrow$ outliers may be more of a problem
  - smoothing very important to highlight trends & suppress noise

Installing bigvis

Project website: github.com/hadley/bigvis

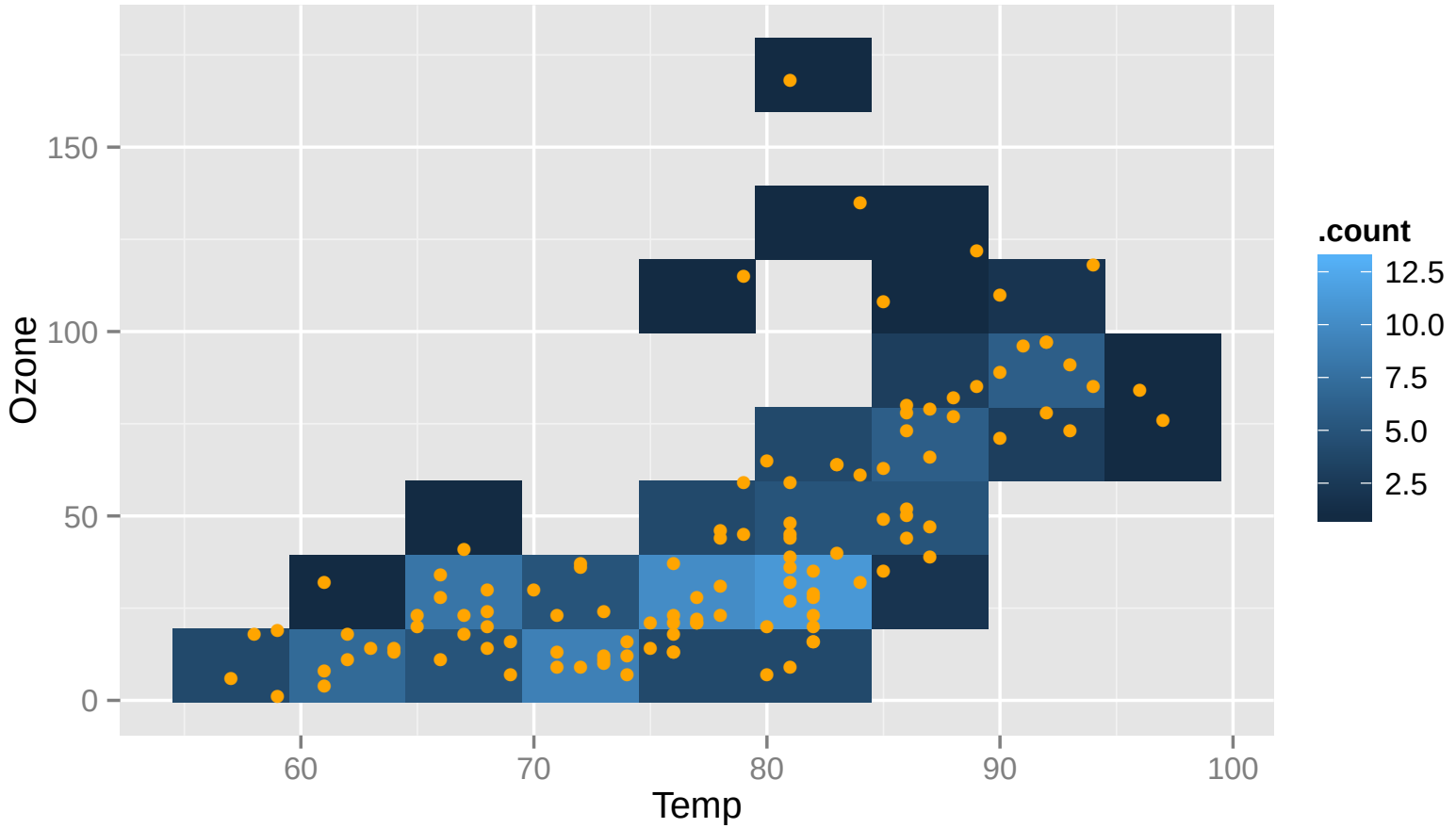
```
install.packages("devtools")
library(devtools)
install_github("bigvis")
```

Recent blog article about *bigvis*:

blog.revolutionanalytics.com/2013/04/visualize-large-data-sets-with-the-bigvis-package.html

bigvis applied to a small dataset

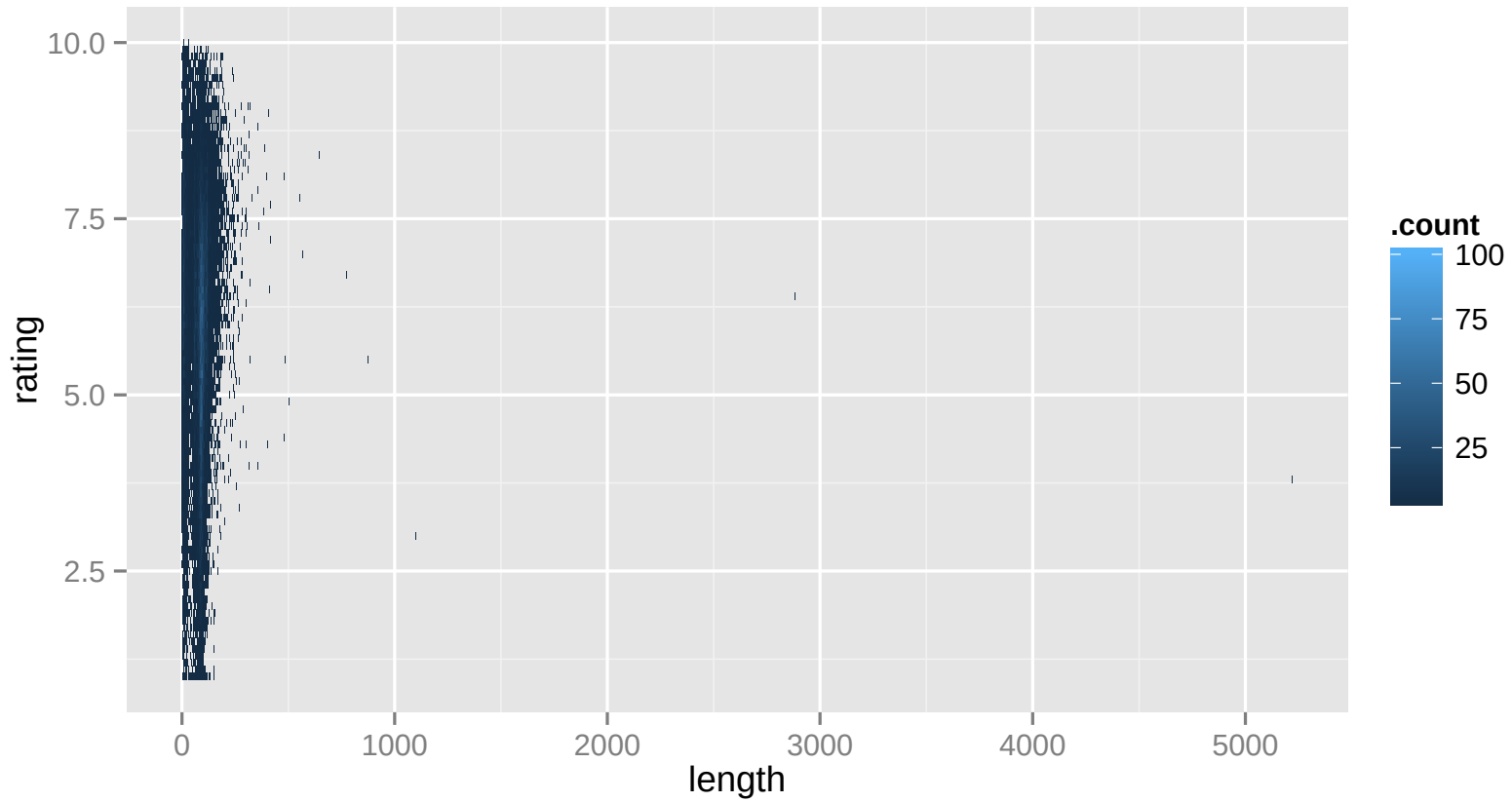
```
library(bigvis); library(ggplot2)   # load packages
binData <- with(airquality, condense(bin(Ozone, 20), bin(Temp, 5)) )
p <- ggplot(data=binData, aes(Temp, Ozone, fill=.count)) + geom_tile()
p + geom_point(data=airquality, aes(fill=NULL), colour="orange")
```



Movie length vs. IMDB rating: *big-ish* data, with outliers!

- ∼ 130,000 row data frame (`bigvis::movies`, from imdb.com)

```
Nbin <- 1e4  # number of bins
binData <- with(movies, condense(bin(length, find_width(length, Nbin)),
                                 bin(rating, find_width(rating, Nbin))))
ggplot(data=binData, aes(length, rating, fill = .count)) + geom_tile()
```



. . . in case you were wondering

- Which films are longer than. . . 1000 minutes?! ($\sim$ 17 hours!)

```
longest <- subset(movies, length > 1e3)
longest[c("title", "length", "rating")]
```

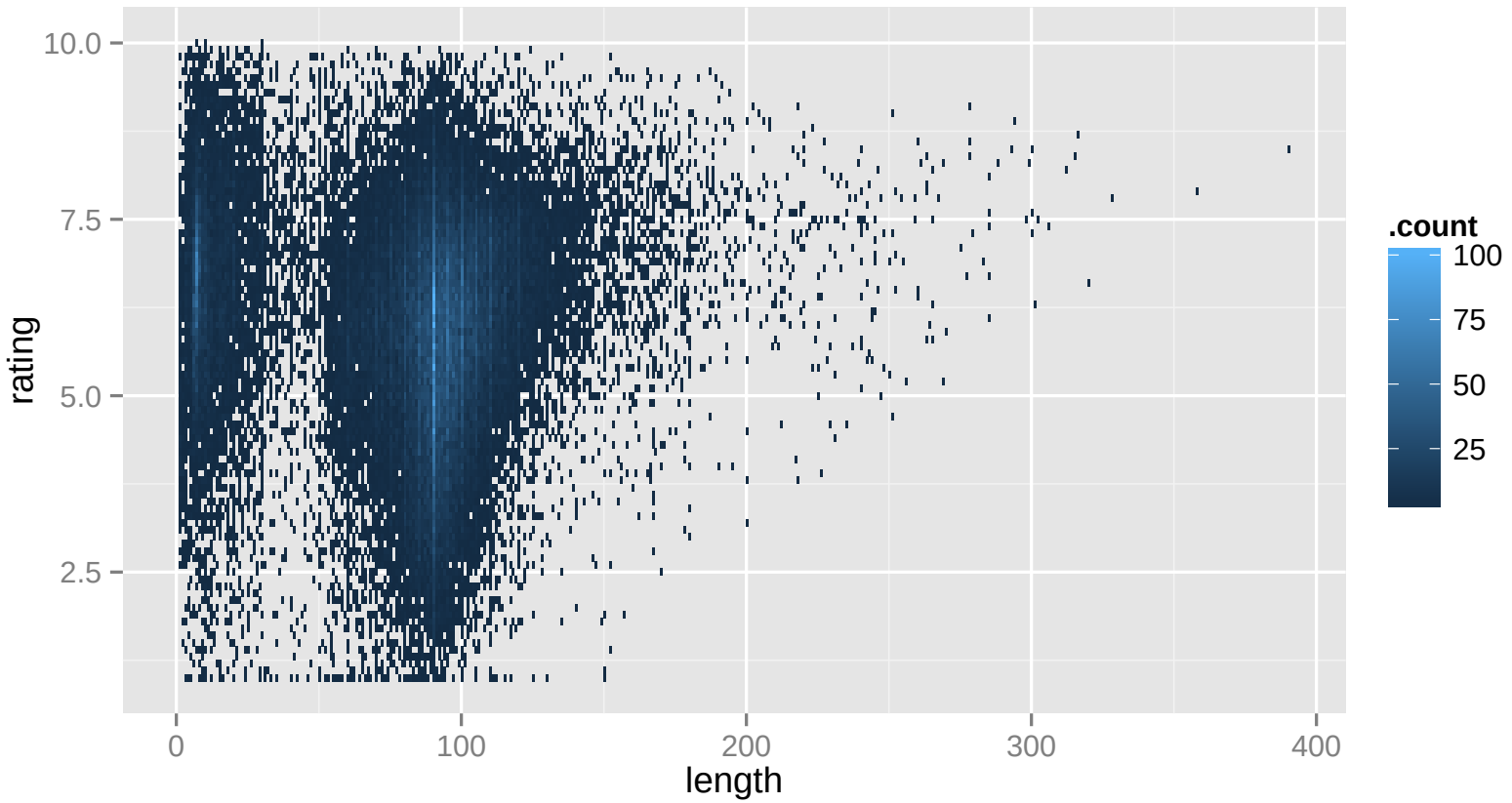
title	length	rating
Cure for Insomnia, The	5220	3.8
Four Stars	1100	3
Longest Most Meaningless Movie in the World, The	2880	6.4

...aptly named!

Bigvis plot with outliers removed

- Outliers a problem with Big Data: extreme events do occur
- Update previous plot to use `bigvis peel` function to strip off outermost (1%, by default) extreme values:

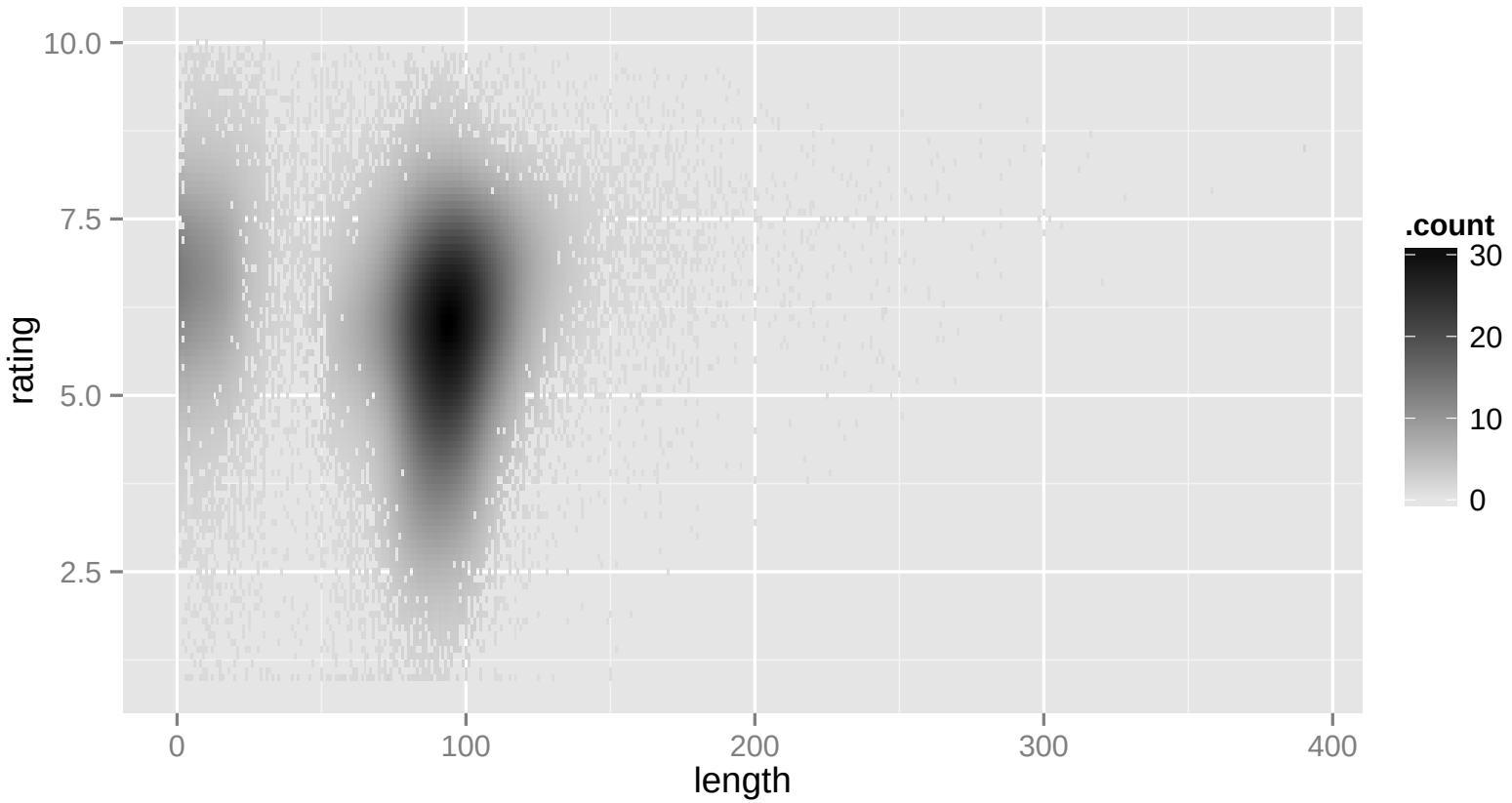
```
last_plot() %+% peel(binData)  # same plot, different dataset
```



Smoothing in bigvis

- Also use `autoplot` function from `bigvis`; peel off outliers first, then smooth with different bandwidths for `length` & `rating`

```
smoothBinData <- smooth(peel(binData), h=c(20, 1))
autoplot(smoothBinData)
```



Live Demo

```
N <- 1e7
raw <- data.frame(x = rt(N, 2), y = rt(N, 2))  # 10 million rows
## ~3s to run:
system.time( binned <- with(raw, condense(bin(x), bin(y)) ) )

## Plot condensed (i.e. pre-processed) data:
ggplot(data=binned, aes(x,y, fill=.count)) + geom_tile()

## Peel outliers & replot:
system.time( peeled <- peel(binned) )
ggplot(data=peeled, aes(x,y, fill=.count)) + geom_tile()
```

Summary

- Pre-processing to generate statistical summaries is the key to plotting Big Data
- The *R* `bigvis` package is a very powerful tool for plotting large datasets and is still under active development
  - includes features to strip outliers, smooth & summarise data
- v3.0.0 of *R* (released Apr 2013) represents a solid platform for extending the outstanding data analysis & visualisation capabilities of *R* to meet the challenge of Big Data, with excellent prospects for future releases

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Session information

These slides were created with (Emacs) org mode.

R version R version 3.0.0 (2013-04-03), i686-pc-linux-gnu

locale LC_CTYPE=en_GB.UTF-8, LC_NUMERIC=C, LC_TIME=en_GB.UTF-8, LC_COLLATE=en_GB.UTF-8, LC_MONETARY=en_GB.UTF-8, LC_MESSAGES=en_GB.UTF-8, LC_PAPER=C, LC_NAME=C, LC_ADDRESS=C, LC_TELEPHONE=C, LC_MEASUREMENT=en_GB.UTF-8, LC_IDENTIFICATION=C

attached base packages stats, graphics, grDevices, utils, datasets, methods, base

other attached packages ascii_2.1, ggplot2_0.9.3.1, bigvis_0.1, Rcpp_0.10.3

loaded via a namespace (and not attached) codetools_0.2-8, colorspace_1.2-2, dichromat_2.0-0, digest_0.6.3, grid_3.0.0, gtable_0.1.2, labeling_0.1, MASS_7.3-26, munsell_0.4, plyr_1.8, proto_0.3-10, RColorBrewer_1.0-5, reshape2_1.2.2, scales_0.2.3, stringr_0.6.2, tools_3.0.0

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