Data Exploration and Visualization with R[1]

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Outline

Data Exploration and Visualization with R [2]

Data Exploration and Visualization

- ▶ Summary and stats
- ▶ Various charts like pie charts and histograms
- ▶ Exploration of multiple variables
- ▶ Level plot, contour plot and 3D plot
- ▶ Saving charts into files of various formats

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[2]Chapter 3: Data Exploration, in book *R and Data Mining: Examples and Case Studies*. http://www.rdatamining.com/docs/RDataMining.pdf

Outline

Size and Structure of Data

```
dim(iris)

## [1] 150   5

names(iris)

## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Wid...
## [5] "Species"

str(iris)

## 'data.frame': 150 obs. of  5 variables:
##  $ Sepal.Length: num  5.1 4.9 4.7 4.6 5 5.4 4.6 5 4.4 4.9 ...
##  $ Sepal.Width : num  3.5 3 3.2 3.1 3.6 3.9 3.4 3.4 2.9 3.1...
##  $ Petal.Length: num  1.4 1.4 1.3 1.5 1.4 1.7 1.4 1.5 1.4 1...
##  $ Petal.Width : num  0.2 0.2 0.2 0.2 0.2 0.4 0.3 0.2 0.2 0...
##  $ Species     : Factor w/ 3 levels "setosa","versicolor",....
```

Attributes of Data

```
attributes(iris)

## $names
## [1] "Sepal.Length" "Sepal.Width"  "Petal.Length" "Petal.Wid...
## [5] "Species"
##
## $row.names
##   [1]   1   2   3   4   5   6   7   8   9  10  11  12  13 ...
##  [16]  16  17  18  19  20  21  22  23  24  25  26  27  28 ...
##  [31]  31  32  33  34  35  36  37  38  39  40  41  42  43 ...
##  [46]  46  47  48  49  50  51  52  53  54  55  56  57  58 ...
##  [61]  61  62  63  64  65  66  67  68  69  70  71  72  73 ...
##  [76]  76  77  78  79  80  81  82  83  84  85  86  87  88 ...
##  [91]  91  92  93  94  95  96  97  98  99 100 101 102 103 1...
## [106] 106 107 108 109 110 111 112 113 114 115 116 117 118 1...
## [121] 121 122 123 124 125 126 127 128 129 130 131 132 133 1...
## [136] 136 137 138 139 140 141 142 143 144 145 146 147 148 1...
##
## $class
## [1] "data.frame"
```

First Rows of Data

```
iris[1:3, ]
```

```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1          5.1         3.5          1.4         0.2  setosa
## 2          4.9         3.0          1.4         0.2  setosa
## 3          4.7         3.2          1.3         0.2  setosa
```

```
head(iris, 3)
```

```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width Species
## 1          5.1         3.5          1.4         0.2  setosa
## 2          4.9         3.0          1.4         0.2  setosa
## 3          4.7         3.2          1.3         0.2  setosa
```

```
tail(iris, 3)
```

```
##     Sepal.Length Sepal.Width Petal.Length Petal.Width    Spe...
## 148          6.5         3.0          5.2         2.0 virgi...
## 149          6.2         3.4          5.4         2.3 virgi...
## 150          5.9         3.0          5.1         1.8 virgi...
```

A Single Column

The first 10 values of `Sepal.Length`

```
iris[1:10, "Sepal.Length"]

##  [1] 5.1 4.9 4.7 4.6 5.0 5.4 4.6 5.0 4.4 4.9

iris$Sepal.Length[1:10]

##  [1] 5.1 4.9 4.7 4.6 5.0 5.4 4.6 5.0 4.4 4.9
```

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Summary of Data

Function `summary()`

- ▶ numeric variables: minimum, maximum, mean, median, and the first (25%) and third (75%) quartiles
- ▶ categorical variables (factors): frequency of every level

```
summary(iris)
```

```
##   Sepal.Length    Sepal.Width    Petal.Length    Petal.Wid...
##   Min.   :4.300   Min.   :2.000   Min.   :1.000   Min.   :0....
##   1st Qu.:5.100   1st Qu.:2.800   1st Qu.:1.600   1st Qu.:0....
##   Median :5.800   Median :3.000   Median :4.350   Median :1....
##   Mean   :5.843   Mean   :3.057   Mean   :3.758   Mean   :1....
##   3rd Qu.:6.400   3rd Qu.:3.300   3rd Qu.:5.100   3rd Qu.:1....
##   Max.   :7.900   Max.   :4.400   Max.   :6.900   Max.   :2....
##         Species
##   setosa    :50
##   versicolor:50
##   virginica :50
##
##
##
```

```
library(Hmisc)
describe(iris[, c(1, 5)])  # check columns 1 & 5

## iris[, c(1, 5)]
##
##  2 Variables      150  Observations
## --------------------------------------------------------------...
## Sepal.Length
##       n missing  unique    Info    Mean     .05     .10    ...
##     150       0      35       1   5.843   4.600   4.800   5...
##     .50     .75     .90     .95
##   5.800   6.400   6.900   7.255
##
## lowest : 4.3 4.4 4.5 4.6 4.7, highest: 7.3 7.4 7.6 7.7 7.9
## --------------------------------------------------------------...
## Species
##       n missing  unique
##     150       0       3
##
## setosa (50, 33%), versicolor (50, 33%)
## virginica (50, 33%)
## --------------------------------------------------------------...
```

Mean, Median, Range and Quartiles

- ▶ Mean, median and range: `mean()`, `median()`, `range()`
- ▶ Quartiles and percentiles: `quantile()`

```
range(iris$Sepal.Length)

## [1] 4.3 7.9

quantile(iris$Sepal.Length)

##   0%  25%  50%  75% 100%
## 4.3  5.1  5.8  6.4  7.9

quantile(iris$Sepal.Length, c(0.1, 0.3, 0.65))

##  10%  30%  65%
## 4.80 5.27 6.20
```
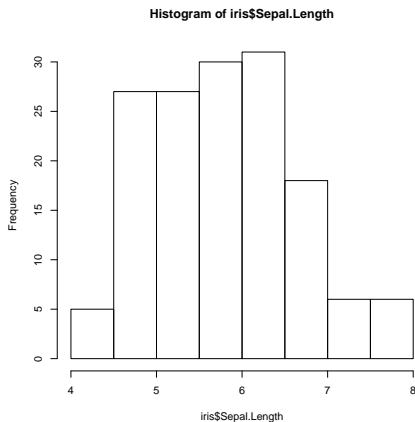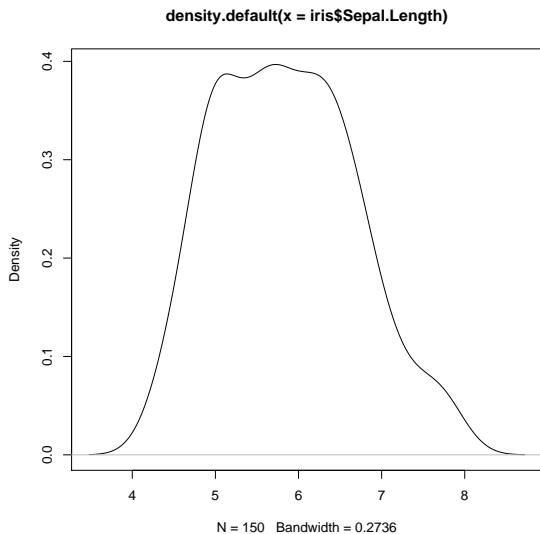
Variance and Histogram

```
var(iris$Sepal.Length)

## [1] 0.6856935

hist(iris$Sepal.Length)
```

Histogram of iris$Sepal.Length

Density

```
plot(density(iris$Sepal.Length))
```

density.default(x = iris$Sepal.Length)

N = 150   Bandwidth = 0.2736

Pie Chart
Frequency of factors: `table()`

```
table(iris$Species)

##
##     setosa versicolor  virginica
##         50         50         50

pie(table(iris$Species))
```
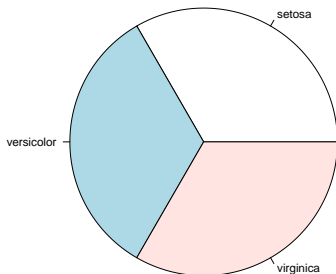
Bar Chart

```
barplot(table(iris$Species))
```
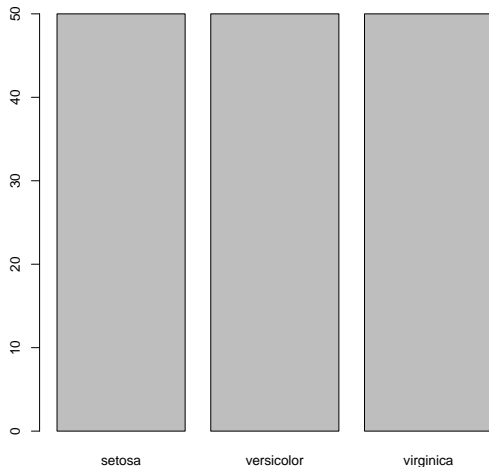
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Correlation

Covariance and correlation: `cov()` and `cor()`

```
cov(iris$Sepal.Length, iris$Petal.Length)

## [1] 1.274315

cor(iris$Sepal.Length, iris$Petal.Length)

## [1] 0.8717538

cov(iris[, 1:4])

##              Sepal.Length Sepal.Width Petal.Length Petal.Width
## Sepal.Length    0.6856935  -0.0424340    1.2743154   0.5162707
## Sepal.Width    -0.0424340   0.1899794   -0.3296564  -0.1216394
## Petal.Length    1.2743154  -0.3296564    3.1162779   1.2956094
## Petal.Width     0.5162707  -0.1216394    1.2956094   0.5810063

# cor(iris[,1:4])
```

Aggreation

Stats of `Sepal.Length` for every `Species` with `aggregate()`

```
aggregate(Sepal.Length ~ Species, summary, data = iris)

##       Species Sepal.Length.Min. Sepal.Length.1st Qu.
## 1     setosa             4.300                4.800
## 2 versicolor             4.900                5.600
## 3  virginica             4.900                6.225
##   Sepal.Length.Median Sepal.Length.Mean Sepal.Length.3rd Qu.
## 1             5.000             5.006              5.200
## 2             5.900             5.936              6.300
## 3             6.500             6.588              6.900
##   Sepal.Length.Max.
## 1            5.800
## 2            7.000
## 3            7.900
```

Boxplot

- ▶ The bar in the middle is median.
- ▶ The box shows the interquartile range (IQR), i.e., range between the 75% and 25% observation.

```
boxplot(Sepal.Length ~ Species, data = iris)
```
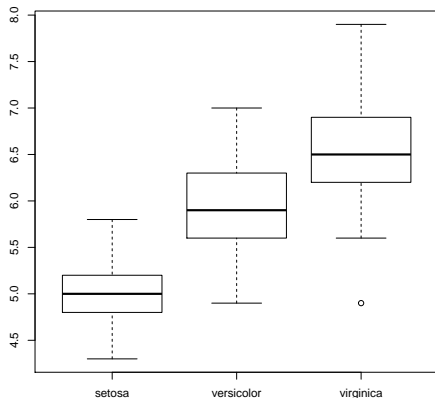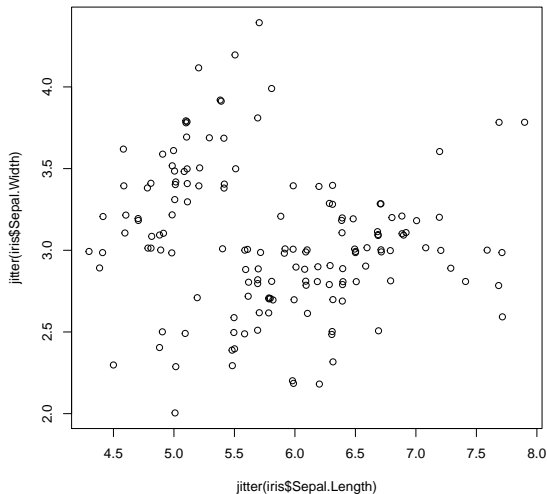
Scatter Plot

```
with(iris, plot(Sepal.Length, Sepal.Width, col = Species,
                pch = as.numeric(Species)))
```
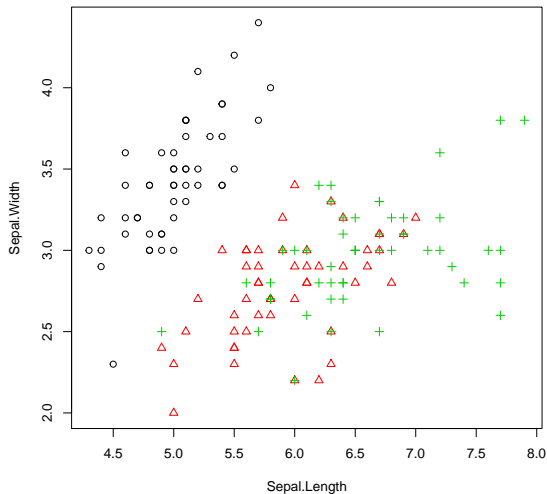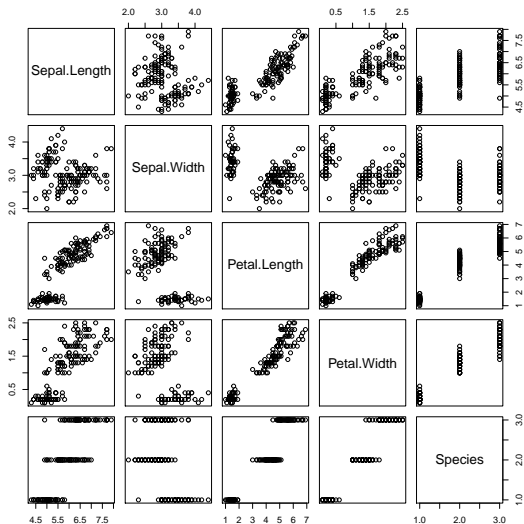
Scatter Plot with Jitter

Function jitter(): add a small amount of noise to the data

```
plot(jitter(iris$Sepal.Length), jitter(iris$Sepal.Width))
```

A Matrix of Scatter Plots

```
pairs(iris)
```

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3D Scatter plot

```
library(scatterplot3d)
scatterplot3d(iris$Petal.Width, iris$Sepal.Length, iris$Sepal.Width)
```
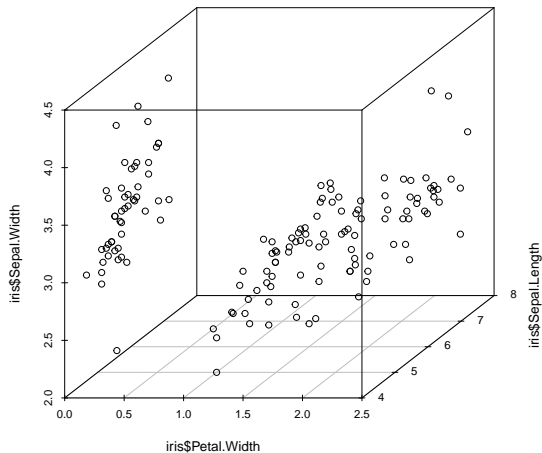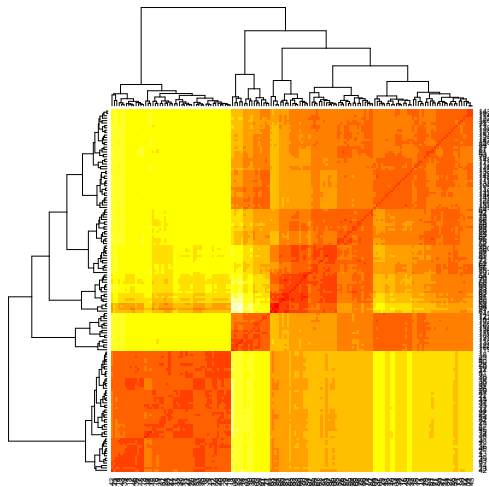
Interactive 3D Scatter Plot

Package *rgl* supports interactive 3D scatter plot with `plot3d()`.

```
library(rgl)
plot3d(iris$Petal.Width, iris$Sepal.Length, iris$Sepal.Width)
```

Heat Map

Calculate the similarity between different flowers in the `iris` data with `dist()` and then plot it with a heat map
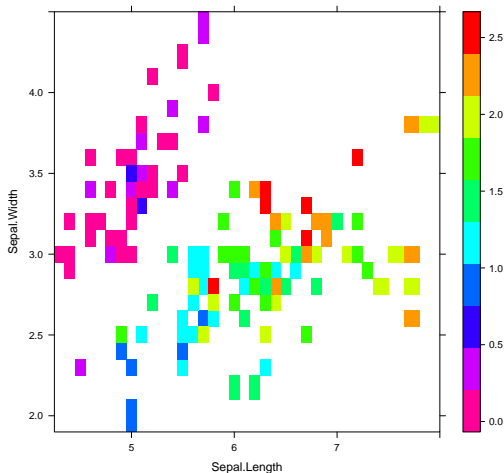
```
dist.matrix <- as.matrix(dist(iris[, 1:4]))
heatmap(dist.matrix)
```

Level Plot

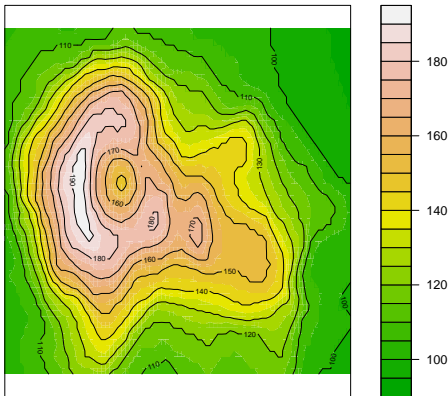Function `rainbow()` creates a vector of contiguous colors.

```
library(lattice)
levelplot(Petal.Width ~ Sepal.Length * Sepal.Width, iris, cuts = 9,
    col.regions = rainbow(10)[10:1])
```
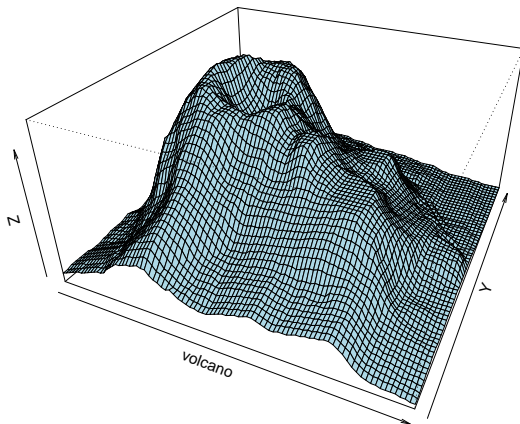
Contour

contour() and filled.contour() in package *graphics*
contourplot() in package *lattice*

```
filled.contour(volcano, color = terrain.colors, asp = 1, plot.axes = co
    add = T))
```
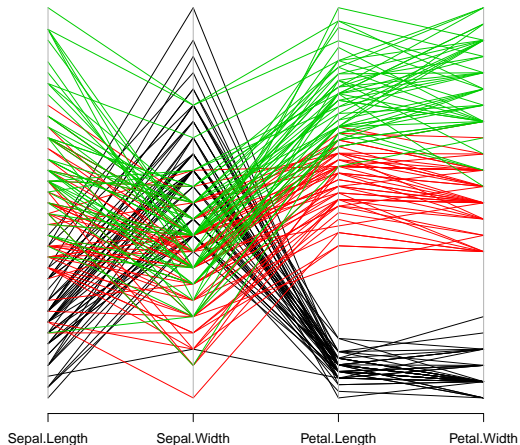
3D Surface

```
persp(volcano, theta = 25, phi = 30, expand = 0.5, col = "lightblue")
```
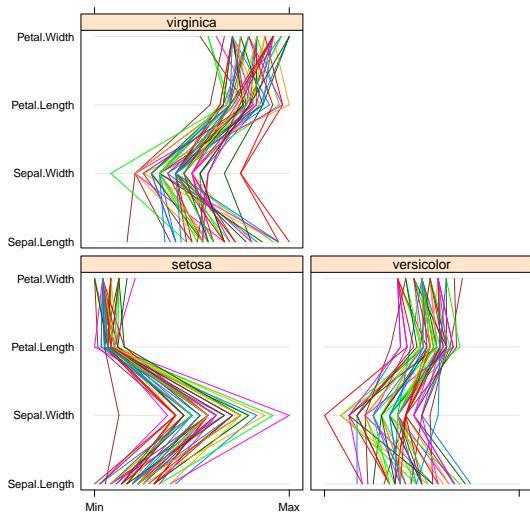
Parallel Coordinates

```
library(MASS)
parcoord(iris[1:4], col = iris$Species)
```
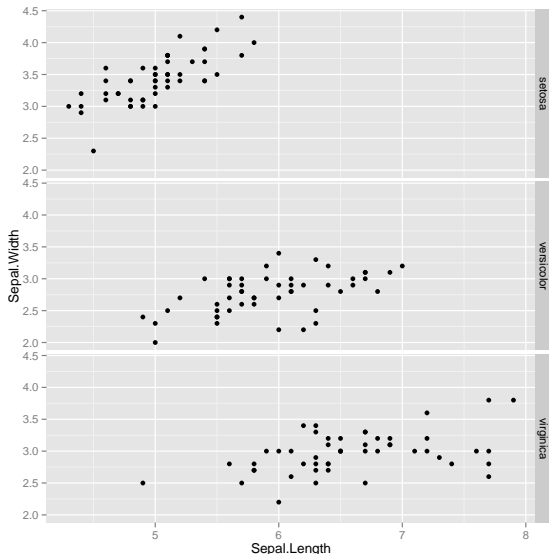
Parallel Coordinates with Package *lattice*

```
library(lattice)
parallelplot(~iris[1:4] | Species, data = iris)
```

Visualization with Package *ggplot2*

```
library(ggplot2)
qplot(Sepal.Length, Sepal.Width, data = iris, facets = Species ~ .)
```

Outline

Save Charts to Files

- Save charts to PDF and PS files: `pdf()` and `postscript()`
- BMP, JPEG, PNG and TIFF files: `bmp()`, `jpeg()`, `png()` and `tiff()`
- Close files (or graphics devices) with `graphics.off()` or `dev.off()` after plotting

```r
# save as a PDF file
pdf("myPlot.pdf")
x <- 1:50
plot(x, log(x))
graphics.off()
# Save as a postscript file
postscript("myPlot2.ps")
x <- -20:20
plot(x, x^2)
graphics.off()
```

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Further Readings

- Examples of ggplot2 plotting:
  `http://had.co.nz/ggplot2/`
- Package *iplots*: interactive scatter plot, histogram, bar plot, and parallel coordinates plot (iplots)
  `http://stats.math.uni-augsburg.de/iplots/`
- Package *googleVis*: interactive charts with the Google Visualisation API
  `http://cran.r-project.org/web/packages/googleVis/vignettes/googleVis_examples.html`
- Package *ggvis*: interactive grammar of graphics
  `http://ggvis.rstudio.com/`
- Package *rCharts*: interactive javascript visualizations from R
  `http://rcharts.io/`

Online Resources

- ▶ Chapter 3: Data Exploration, in book *R and Data Mining: Examples and Case Studies*

  http://www.rdatamining.com/docs/RDataMining.pdf

- ▶ R Reference Card for Data Mining

  http://www.rdatamining.com/docs/R-refcard-data-mining.pdf

- ▶ Free online courses and documents

  http://www.rdatamining.com/resources/

- ▶ RDataMining Group on LinkedIn (12,000+ members)

  http://group.rdatamining.com

- ▶ RDataMining on Twitter (2,000+ followers)

  @RDataMining

The End
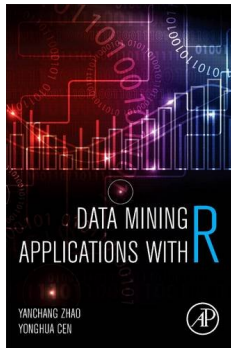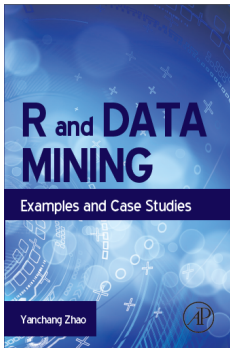
Thanks!

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