Lecture 4: Data Manipulation

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4.1. Data Manipulation

Data Exploration

- R for Data Science (O'Reilly 2017) by Hadley Wickham
- Free Online: http://r4ds.had.co.nz/ (http://r4ds.had.co.nz/)
- Major coverage:
  - Data manipulation (R:dplyr)
  - Data visualization (R:ggplot2)
- Data Exploration = Data manipulation + Data visualization.

Data Wrangling

- Data wrangling (a term used in data science) is the process of transforming/mapping data from raw format into ready-to-analyze format.
- Besides ggplot2() for data visualization, Hadley Wickham has created a series of R packages for data wrangling, including
  - tidyr for tidy data: observations in rows, variables in columns
  - tibble for better ways to create, print and subset data frames
  - dplyr for data manipulation -> today

Feature Engineering

- A term often used in machine learning

> Andrew Ng (Stanford): "Coming up with features is difficult, time-consuming, requires expert knowledge. Applied machine learning is basically feature engineering."

- In statistics: variable creation and transformation
- Dictionary learning with overcomplete features …
- Nowadays, deep learning algorithms aim at automatic feature learning instead of manual feature engineering …

4.2 R:dplyr Package

R::dplyr verbs

- `filter()` to select observations
- `arrange()` to order observations
- `mutate()` to add new variables
- `group_by()` to group variables for summarise
- R::base: `merge()` to combine two data.frames (or R::dplyr xxx_joins)

Filter

```
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
(tmp = filter(iris, Species == 'versicolor' & Sepal.Length > 6.6))
```

```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1          7.0         3.2          4.7         1.4 versicolor
## 2          6.9         3.1          4.9         1.5 versicolor
## 3          6.7         3.1          4.4         1.4 versicolor
## 4          6.8         2.8          4.8         1.4 versicolor
## 5          6.7         3.0          5.0         1.7 versicolor
## 6          6.7         3.1          4.7         1.5 versicolor
```

- Rowwise selection of samples/observations
- Similar to base:which or subsetting

Arrange

```
arrange(tmp, Sepal.Length, Sepal.Width, desc(Petal.Length))
```

```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width    Species
## 1          6.7         3.0          5.0         1.7 versicolor
## 2          6.7         3.1          4.7         1.5 versicolor
## 3          6.7         3.1          4.4         1.4 versicolor
## 4          6.8         2.8          4.8         1.4 versicolor
## 5          6.9         3.1          4.9         1.5 versicolor
## 6          7.0         3.2          4.7         1.4 versicolor
```

- Similar to base:sort and order functions

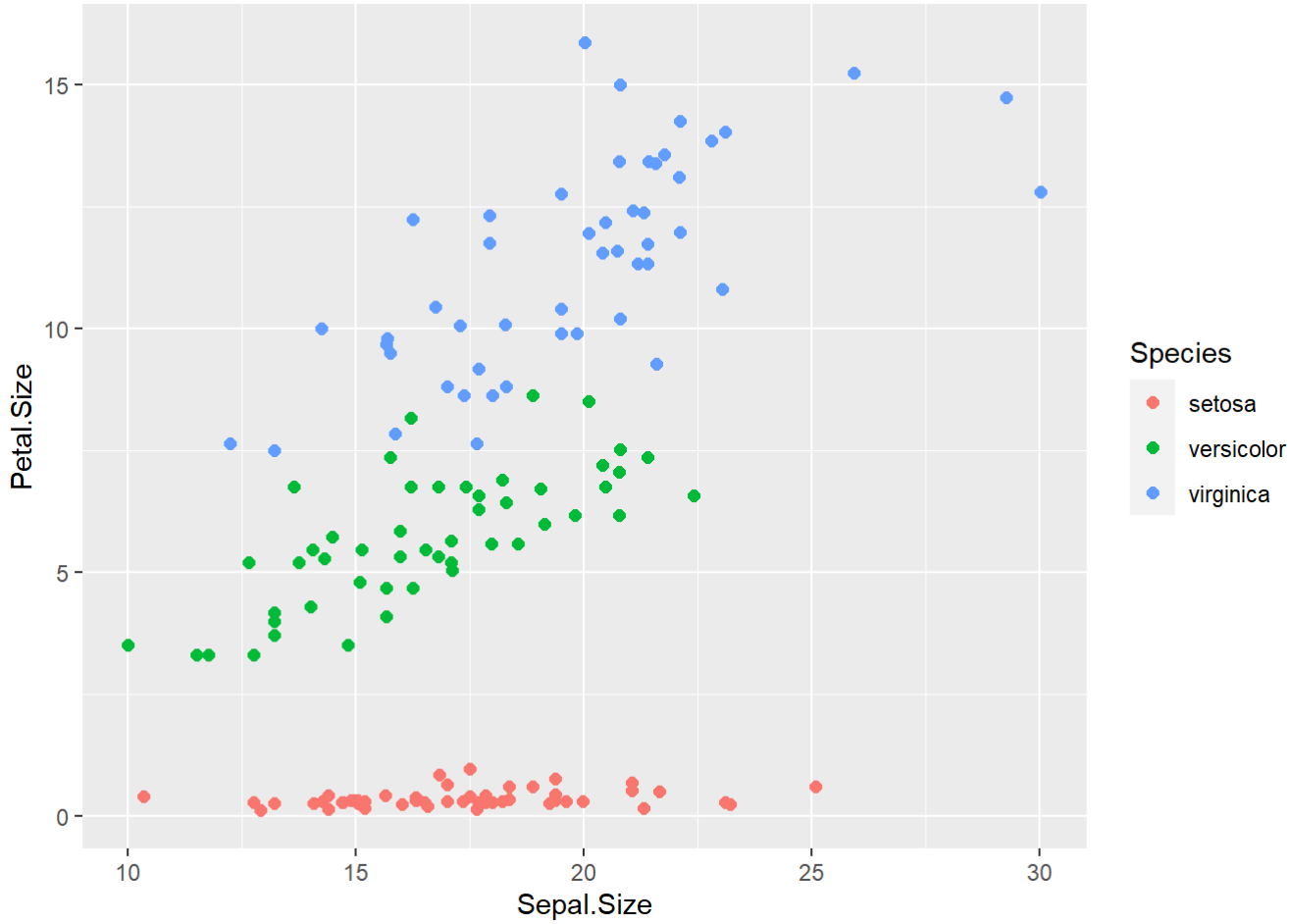
Mutate

```
tmp = mutate(iris, Sepal.Size = Sepal.Length*Sepal.Width,
             Petal.Size = Petal.Length*Petal.Width)
head(tmp)
```

```
##   Sepal.Length Sepal.Width Petal.Length Petal.Width Species Sep
al.Size
## 1          5.1         3.5          1.4         0.2  setosa
17.85
## 2          4.9         3.0          1.4         0.2  setosa
14.70
## 3          4.7         3.2          1.3         0.2  setosa
15.04
## 4          4.6         3.1          1.5         0.2  setosa
14.26
## 5          5.0         3.6          1.4         0.2  setosa
18.00
## 6          5.4         3.9          1.7         0.4  setosa
21.06
##   Petal.Size
## 1       0.28
## 2       0.28
## 3       0.26
## 4       0.30
## 5       0.28
## 6       0.68
```

- New variable/feature creation
- Base commands: tmp$Sepal.Size = …

```
library(ggplot2)
ggplot(tmp, aes(x=Sepal.Size, y=Petal.Size, colour=Species)) +
  geom_point(size=2)
```



Summarise

```
summarise(group_by(tmp, Species), mean(Sepal.Size), mean(Petal.Size))
```

```
## # A tibble: 3 x 3
##   Species    `mean(Sepal.Size)` `mean(Petal.Size)`
##   <fct>                   <dbl>              <dbl>
## 1 setosa                   17.3              0.366
## 2 versicolor               16.5              5.72
## 3 virginica                19.7             11.3
```

Merge

```
(tmp1 = data.frame(Species=levels(iris$Species), x1 = c("A","B","C"), x2 = round(runif(3),3)))
```

```
##      Species x1    x2
## 1     setosa  A 0.147
## 2 versicolor  B 0.522
## 3  virginica  C 0.441
```

```
head(merge(iris, tmp1, by = "Species"))
```

```
##   Species Sepal.Length Sepal.Width Petal.Length Petal.Width x1
x2
## 1  setosa          5.1         3.5          1.4         0.2  A
0.147
## 2  setosa          4.9         3.0          1.4         0.2  A
0.147
## 3  setosa          4.7         3.2          1.3         0.2  A
0.147
## 4  setosa          4.6         3.1          1.5         0.2  A
0.147
## 5  setosa          5.0         3.6          1.4         0.2  A
0.147
## 6  setosa          5.4         3.9          1.7         0.4  A
0.147
```

4.3 Pipes %>%

- The pipe %>% requires R package dplyr or magrittr
- Powerful trick for coding a sequence of operations
- Output of old operation as the first argument of new operation
- Especially useful in combined with ggplot2

```
mtcars %>%
  group_by(cyl) %>%
  summarise(mean_mpg = mean(mpg))
```

```
## # A tibble: 3 x 2
##     cyl mean_mpg
##   <dbl>    <dbl>
## 1     4     26.7
## 2     6     19.7
## 3     8     15.1
```