Graphics

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Graphics

An English cliche says "One picture is worth ten thousand words". John Tukey, a renowned mathematical statistician, was one of the pioneers of statistical graphs in the computer era. Nowadays, powerful software is able to produce dazzling statistical graphs, sometimes web-based and interactive. Outside of academia, journalism hooks a wide readership with professional data-based graphs. New York Times and The Economists are first-rate examples; South China Morning Post sometimes also does a respectable job. A well designed statistical graph can deliver an intuitive and powerful message. I consider graph prior to table when writing a research report or an academic paper. Graph is lively and engaging. Table is tedious and boring.

We have seen an example of R graph in the OLS regression linear example in Lecture 1. `plot` is a generic command for graphs, and is the default R graphic engine. It is capable of producing preliminary statistical graphs.

Over the years, developers all over the world have had many proposals for more sophisticated statistical graphs. In my opinion, `ggplot2`, contributed by Hadley Wickham, is the best.

`ggplot2` is an advanced graphic system that generates high-quality statistical graphs. It is not possible to cover it in a lecture. Fortunately, the author wrote a comprehensive reference **ggplot2 book**, which can be downloaded via the CUHK campus network (VPN needed).

Wickham also developed `reshape2`, a package dedicated mainly to prepare data frames for `ggplot2`.

The workflow of ggplot is to add the elements in a graph one by one, and then print out the graph all together. In contrast, `plot` draws the main graph at first, and then adds the supplementary elements later.

`ggplot2` is particularly good at drawing multiple graphs, either of the same pattern or of different patterns. Multiple subgraphs convey rich information and easy comparison.

Example

Plot the density of two estimators under three different data generating processes. This is an example to generate subgraphs of the same pattern.

```
load("big150.Rdata")
library(ggplot2)
```

```
## Warning: package 'ggplot2' was built under R version 3.4.2
```

```
library(reshape2)
```

```
## Warning: package 'reshape2' was built under R version 3.4.2
```

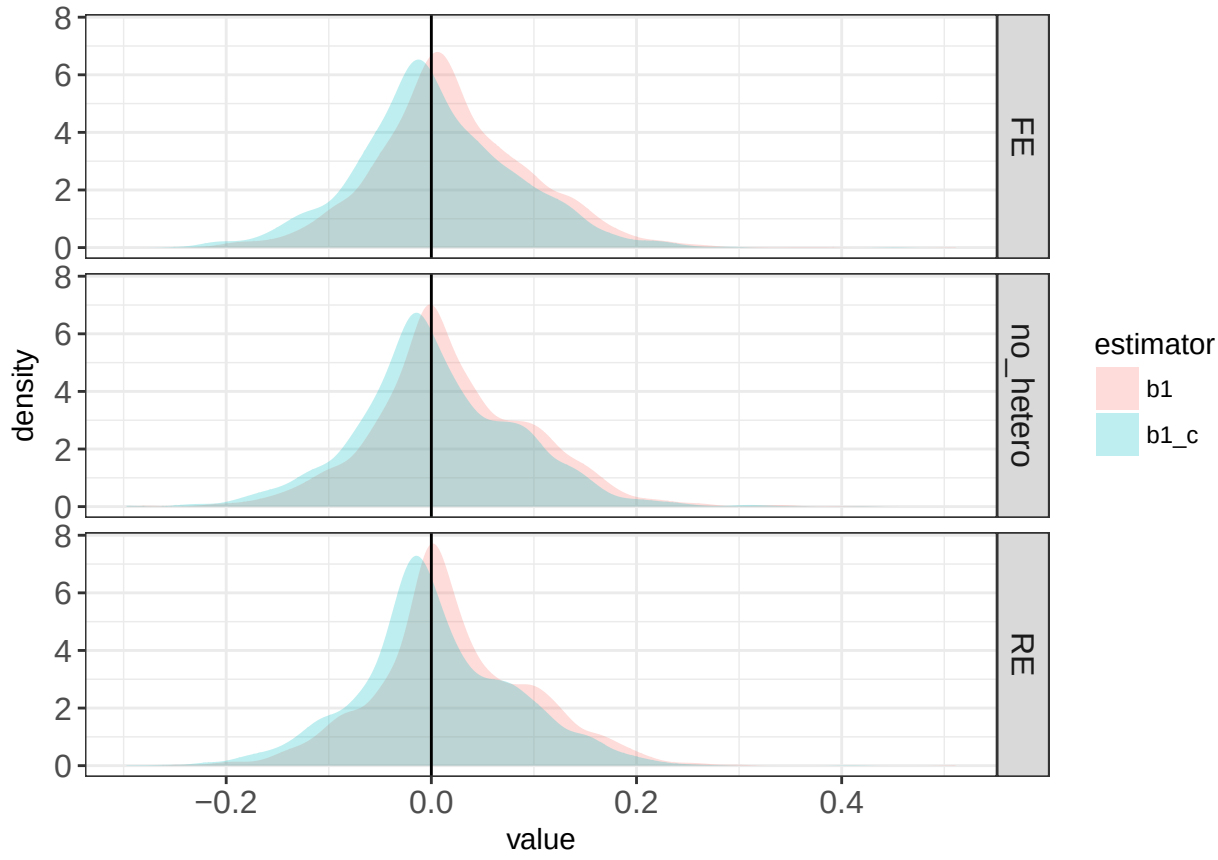
```
big150_1 = big150[, c("typb", "numb",  "b1", "b1_c")]
print(head(big150_1))
```

```
##       typb numb           b1        b1_c
## 12001   FE  150  0.124616242  0.11690387
## 12002   FE  150  0.267670157  0.25202802
## 12003   FE  150 -0.030689329 -0.03976746
## 12004   FE  150  0.121169923  0.11866138
## 12005   FE  150  0.008300031 -0.02399673
## 12006   FE  150 -0.026199118 -0.05231120
```

```
big150_1 = melt(big150_1, id.vars = c("typb", "numb"), measure.vars = c("b1", "b1_c"))
names(big150_1)[3] = c("estimator")
print(head(big150_1))
```

```
##   typb numb estimator        value
## 1   FE  150        b1  0.124616242
## 2   FE  150        b1  0.267670157
## 3   FE  150        b1 -0.030689329
## 4   FE  150        b1  0.121169923
## 5   FE  150        b1  0.008300031
## 6   FE  150        b1 -0.026199118
```

```
p1 = ggplot(big150_1)
p1 = p1 + geom_area(stat = "density", alpha = .25,
                    aes(x = value, fill = estimator),  position = "identity")
p1 = p1 + facet_grid( typb ~ .  )  # this dataset has numb = 150, but no other sample size
p1 = p1 + geom_vline(xintercept = 0)
p1 = p1 + theme_bw()
p1 = p1 + theme(strip.text = element_text( size = 12),
                axis.text = element_text( size = 12))
print(p1)
```

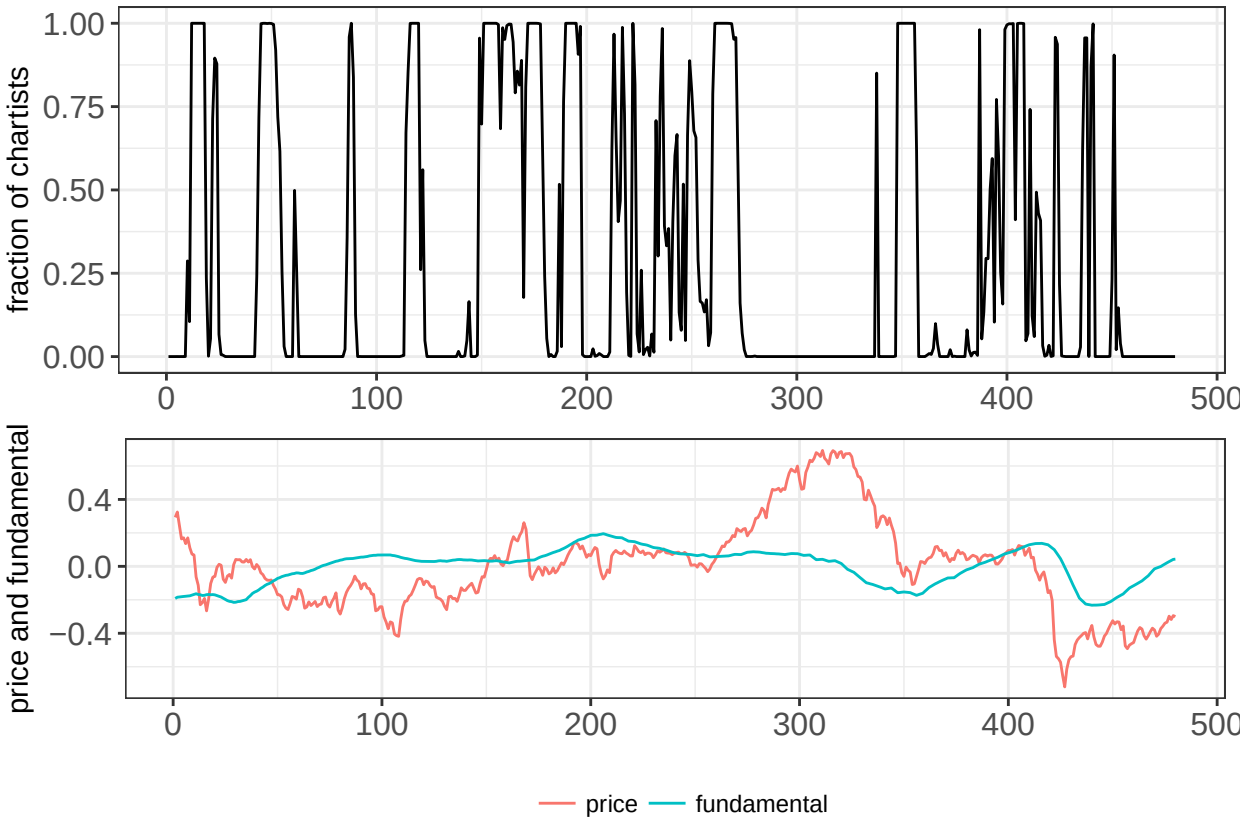


The function `ggplot` specifies which dataset to use for the graph. `geom_***` determines the shape to draw, for example scatter dots, lines, curves or areas. `theme` is to tune the supplementary elements like the background, the size and font of the axis text and so on.

Example

This example aligns two graphs of different patterns in one page.

```
# graph packages
library(lattice)
library(ggplot2)
library(reshape2)
library(gridExtra)

load("multigraph.Rdata") # load data


# unify the theme in the two graphs
theme1 = theme_bw() + theme(axis.title.x = element_blank(),
                            strip.text = element_text( size = 12),
                            axis.text = element_text( size = 12),
                            legend.position = "bottom", legend.title = element_blank())

# sub-graph 1
d1 = data.frame(month = 1:480, m = m_vec)
p1 = qplot( x = month, y = m, data = d1, geom = "line")
p1 = p1 + theme1 + ylab("fraction of chartists")


# sug-graph 2
d2$month = 1:480
p2 = ggplot(d2)
p2 = p2 + geom_line(  aes(x = month, y = value, col = variable) )
p2 = p2 + theme1 +  ylab("price and fundamental")

# generate the grahp
grid.arrange(p1, p2, nrow=2)
```



In order to unify the theme of the two distinctive subgraphs, we define an object `theme1` and apply it in both graphic objects `p1` and `p2`.