Plotting systems in R

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Graphics Devices in R

Graphics device: a place to make plot appear

- Screen device
- File device (pdf, png, jpeg, etc.)

How does a plot get created?

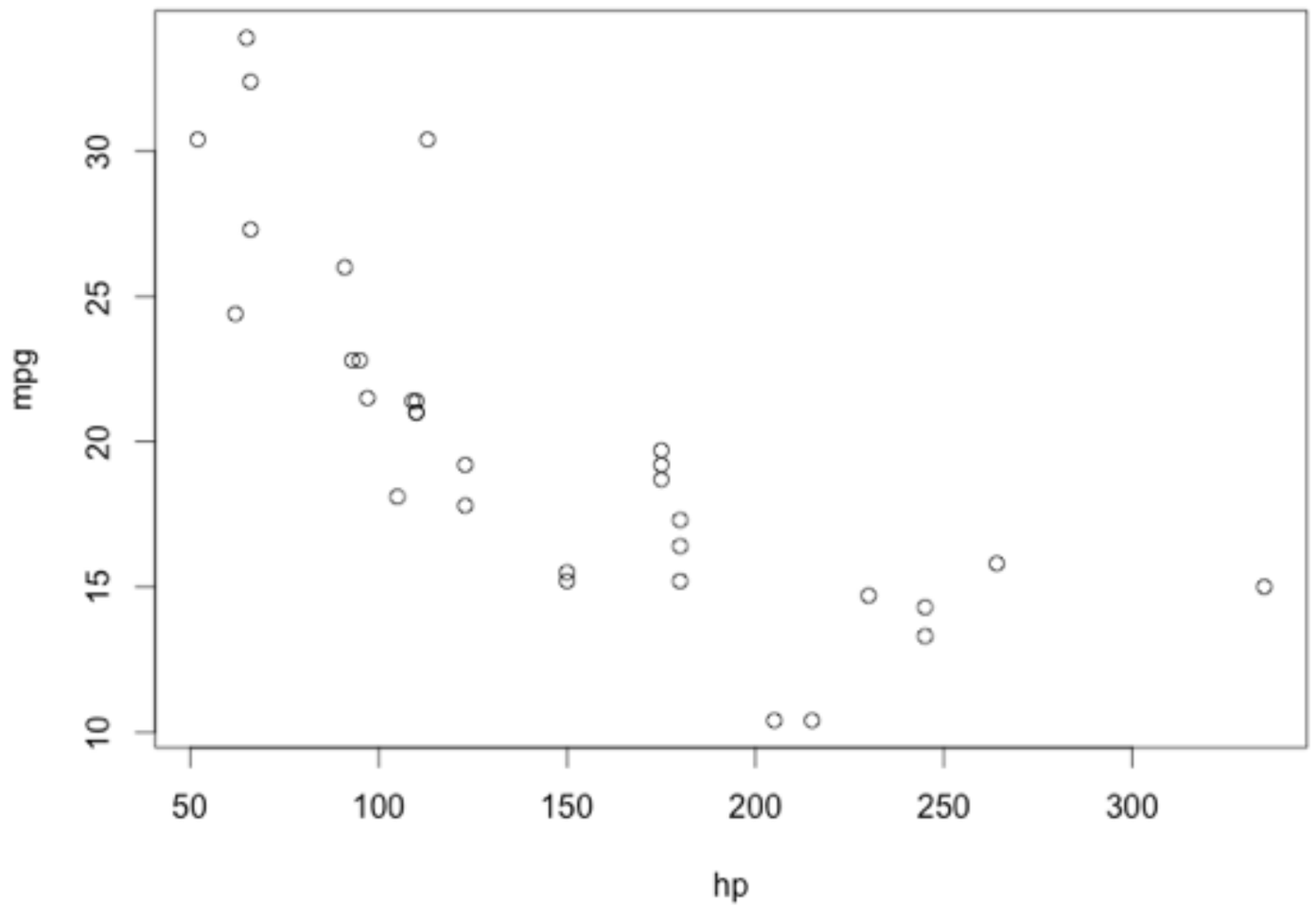
- Call a plotting function, i.e. plot(), xyplot(), qplot()
- The plot appears on a screen device
- Annotate plot, if necessary
- Save it to file, for example.

Screen and file devices

- How the plot will be used?
- Use screen device for quick visualisation or exploratory studies.
- Plotting functions (plot(), qplot(), xyplot()) send output to the *screen device* by default.
- If the plot will be printed, use *file device* instead.

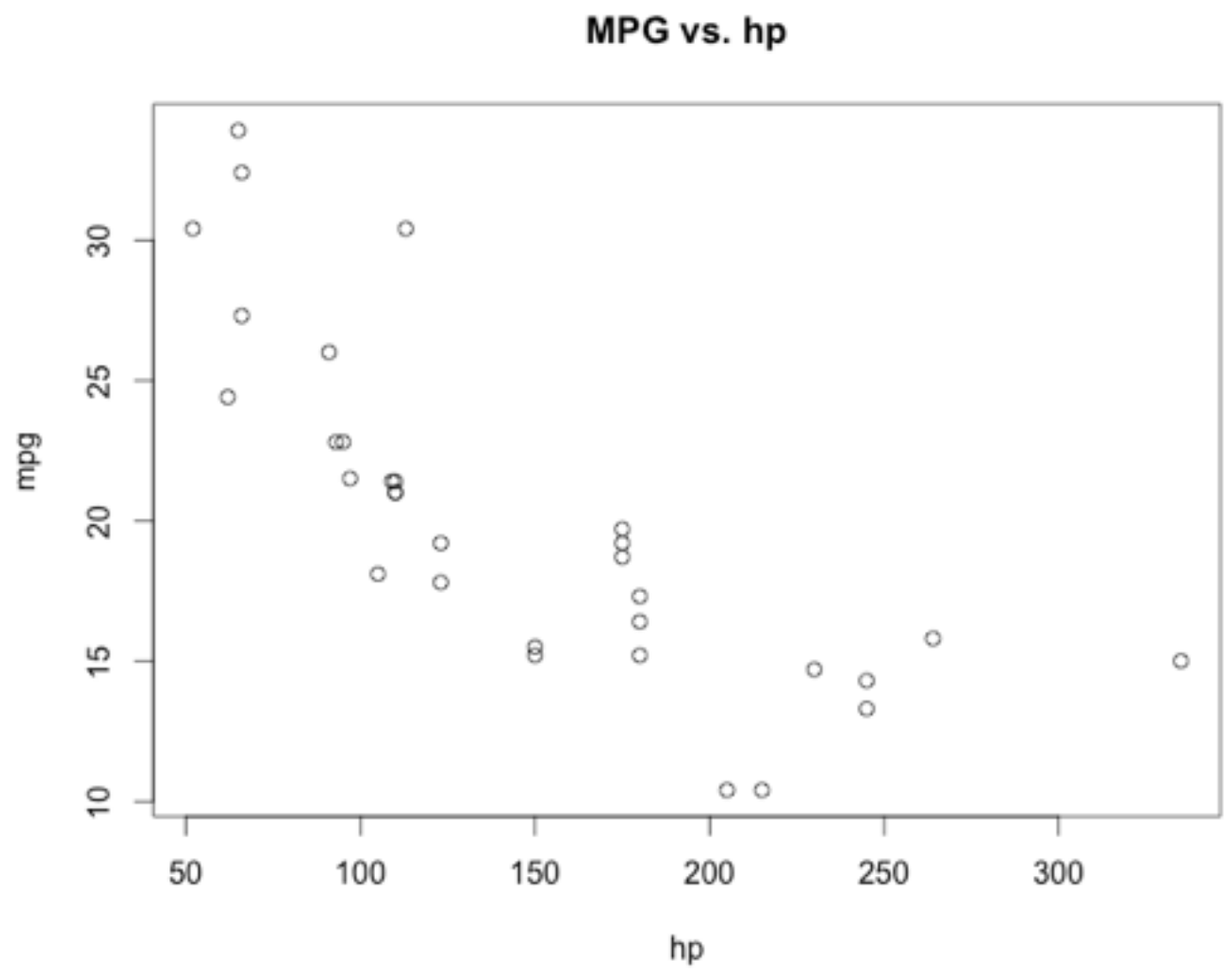
Example

```
attach(mtcars)
head(mtcars[, c("hp", "mpg")])
plot(hp, mpg)
```



Example

```
attach(mtcars)
head(mtcars[, c("hp", "mpg")])
plot(hp, mpg)
title("MPG vs. hp”) # Add a title
```



Available plotting systems

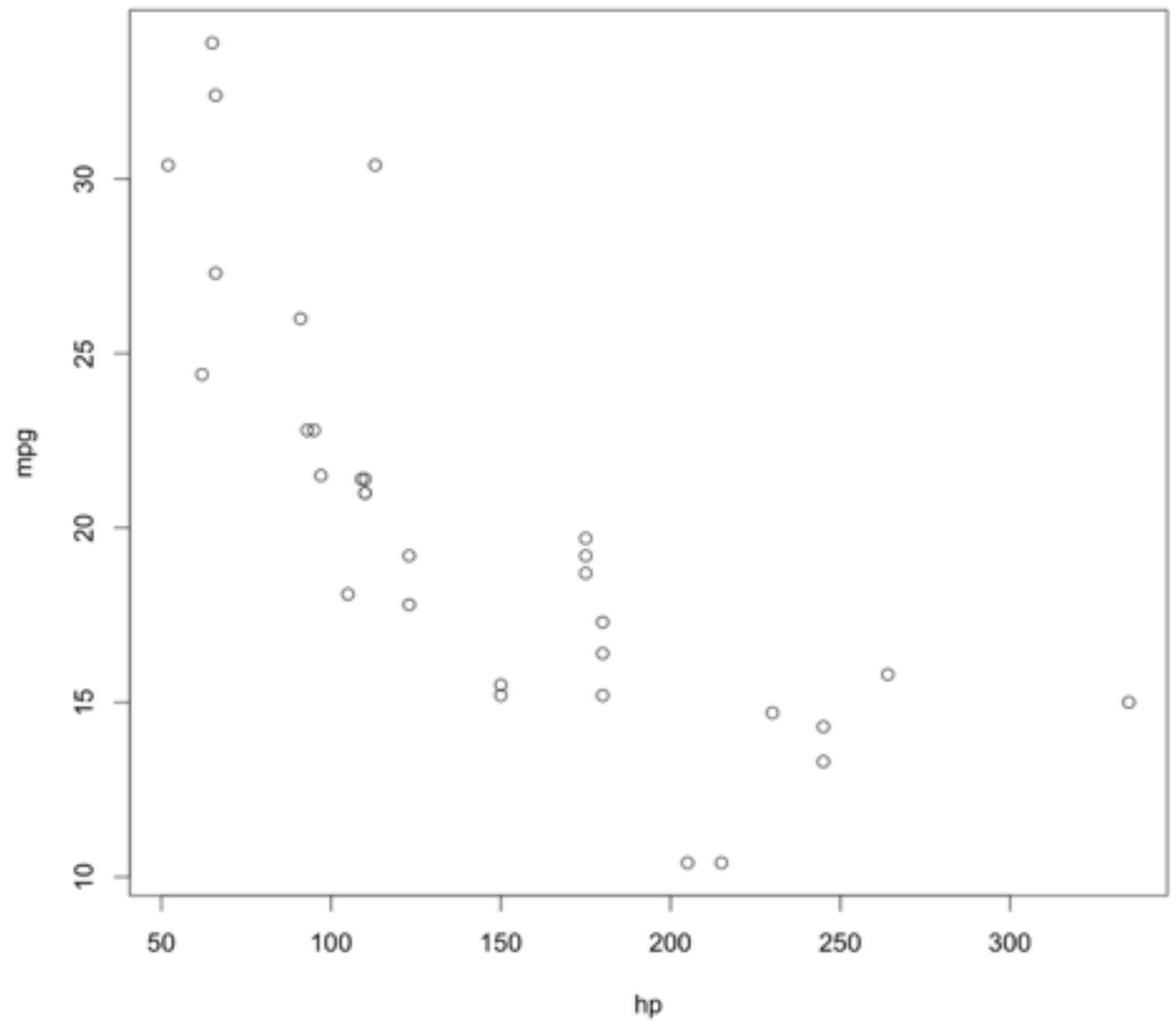
- Base
- lattice
- ggplot2

Base plotting system

- Installed by default
- Quickest way to visualise your data
- Plot can be further updated using additional options

Simple example

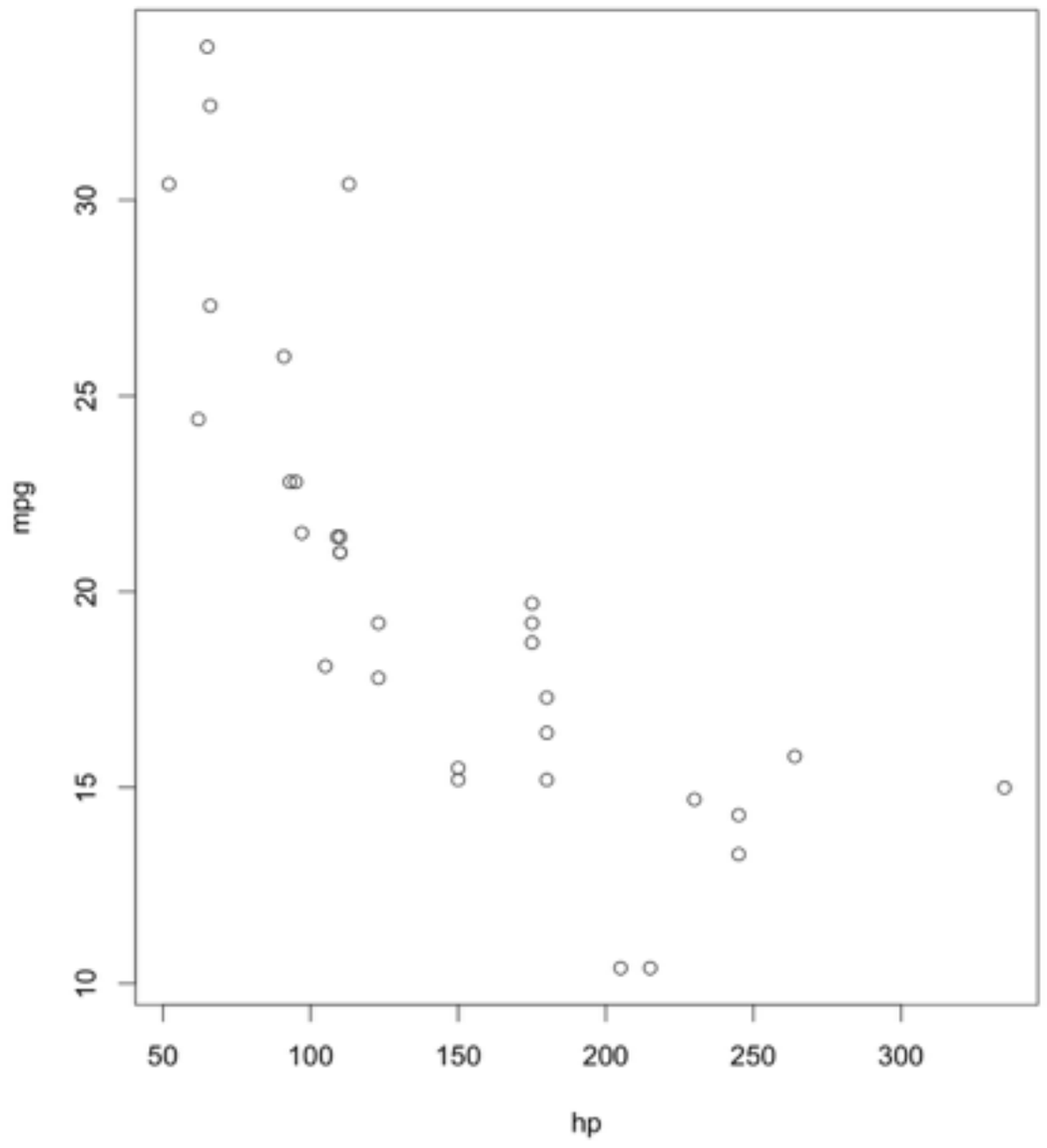
attach(mtcars)
plot(hp, mpg)

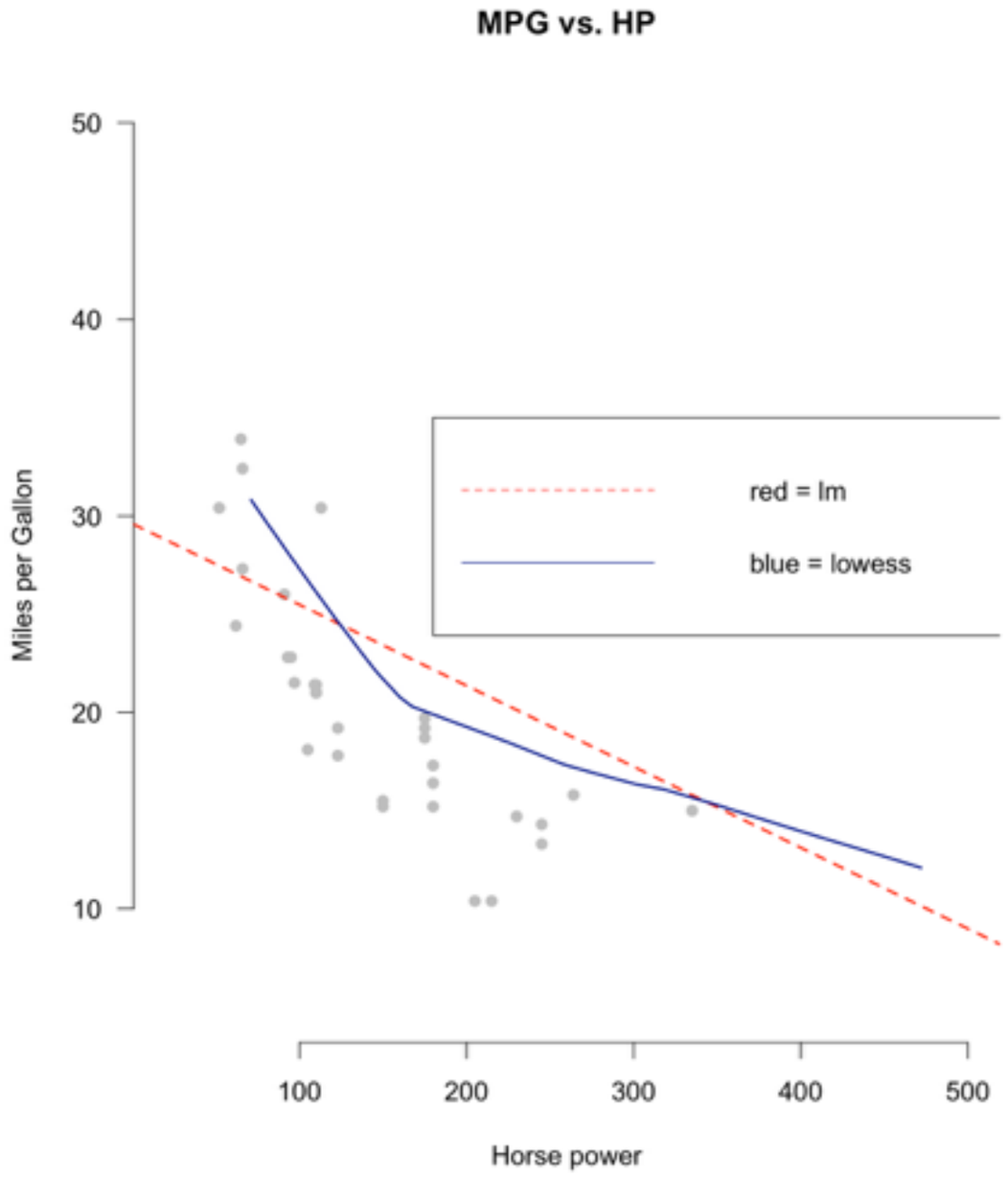


Extended example

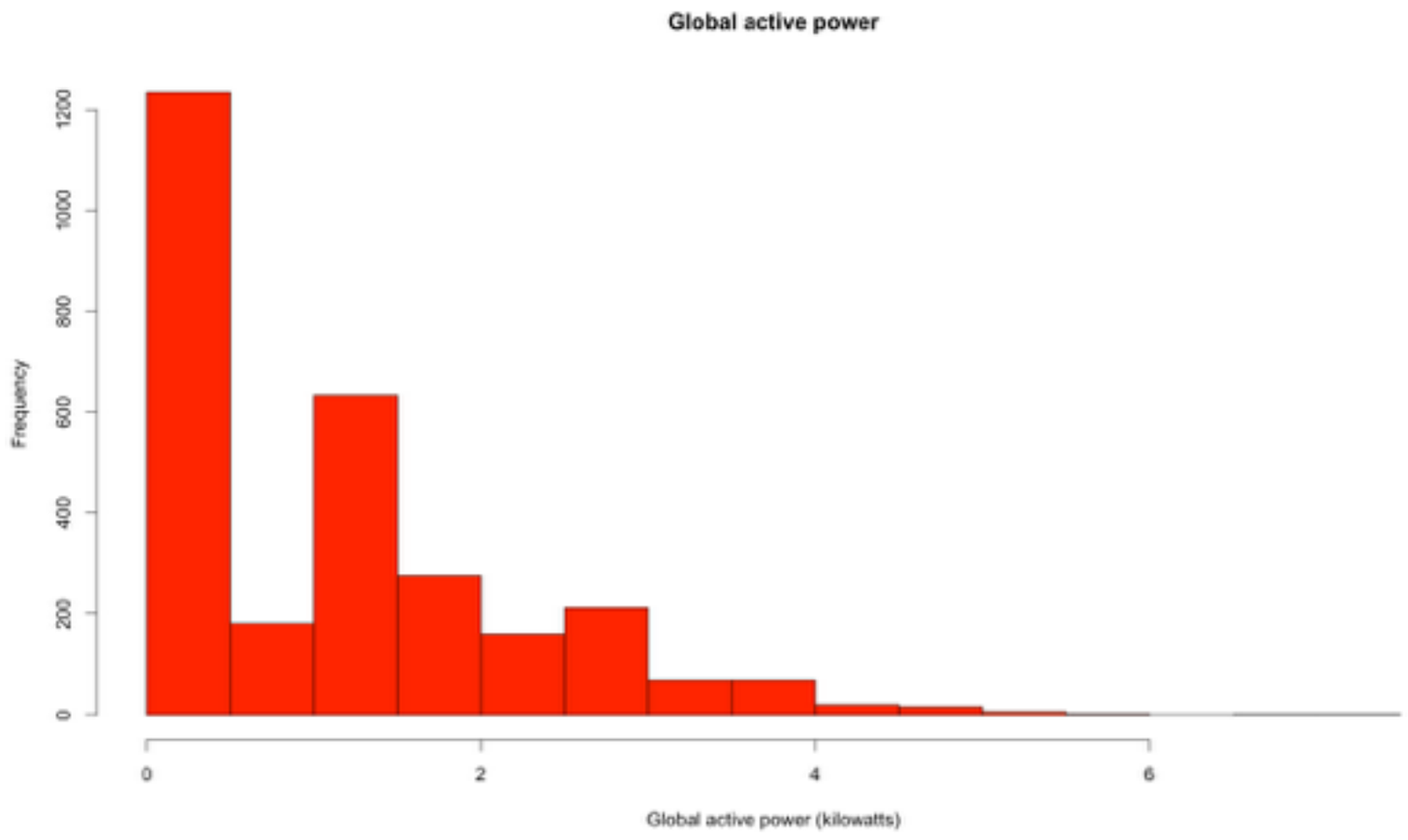
```
plot(disp,mpg,
     main = "MPG vs. HP",    # Add a title
     type = "p",
     col = "grey",                  # Change the color of the points
     pch = 16,                      # Change the plotting symbol  see help(points)
     cex = 1,                      # Change size of plotting symbol
     xlab = “Horse power",   # Add a label on the x-axis
     ylab = "Miles per Gallon",        # Add a label on the y-axis
     bty = "n",                    # Remove the box around the plot
     #asp = 1,                     # Change the y/x aspect ratio see help(plot)
     font.axis = 1,                # Change axis font to bold italic
     col.axis = "black",             # Set the color of the axis
     xlim = c(20,500),               # Set limits on x axis
     ylim = c(5,50),               # Set limits on y axis
     las=1)                       # Make axis labels parallel to x-axis
```

Extended example



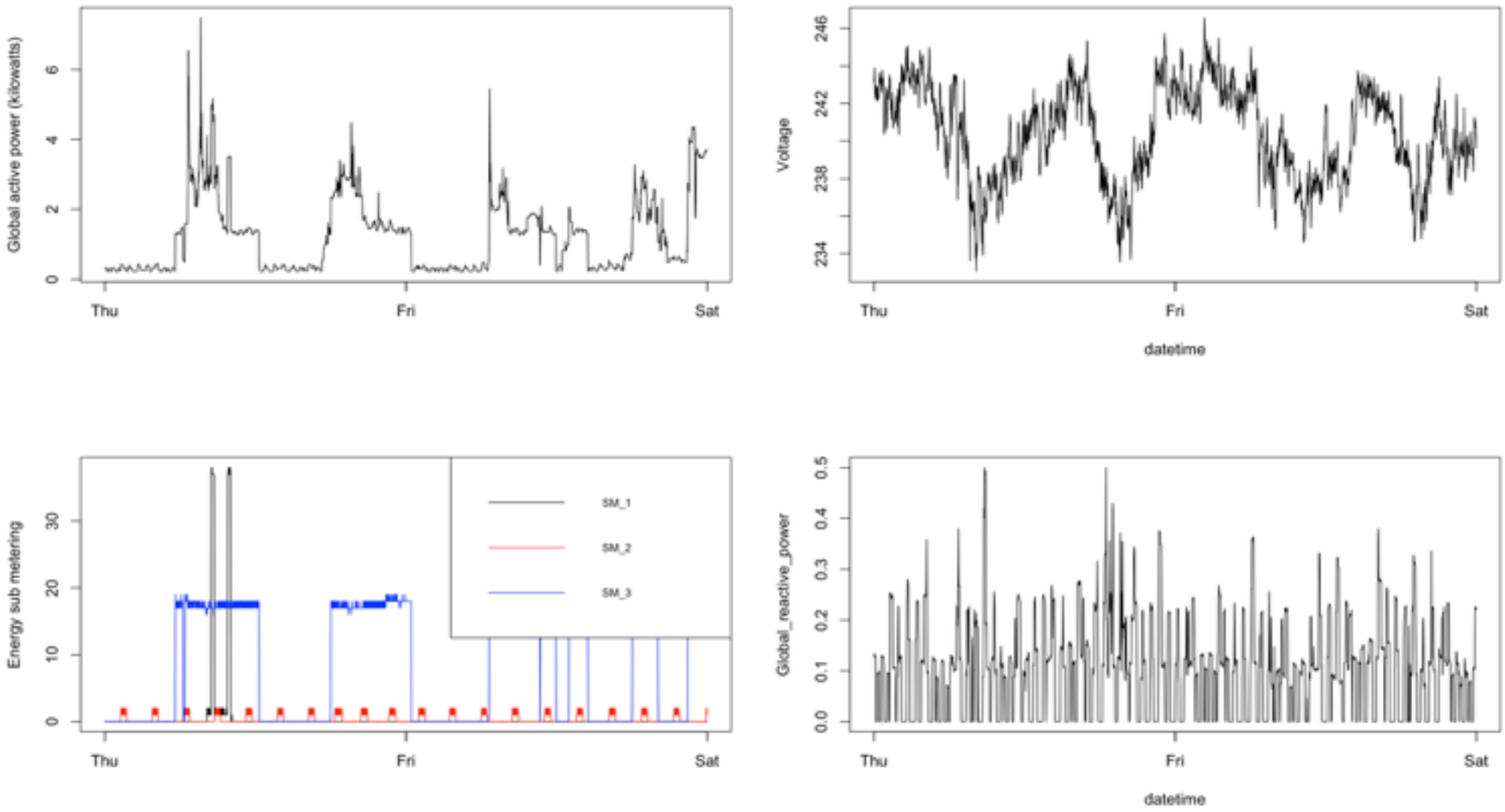


More examples



More examples

par(mfrow=c(2,2))



The Lattice Plotting System

- Multivariate data
- Uses formulas
- Single function call

The Lattice Plotting System

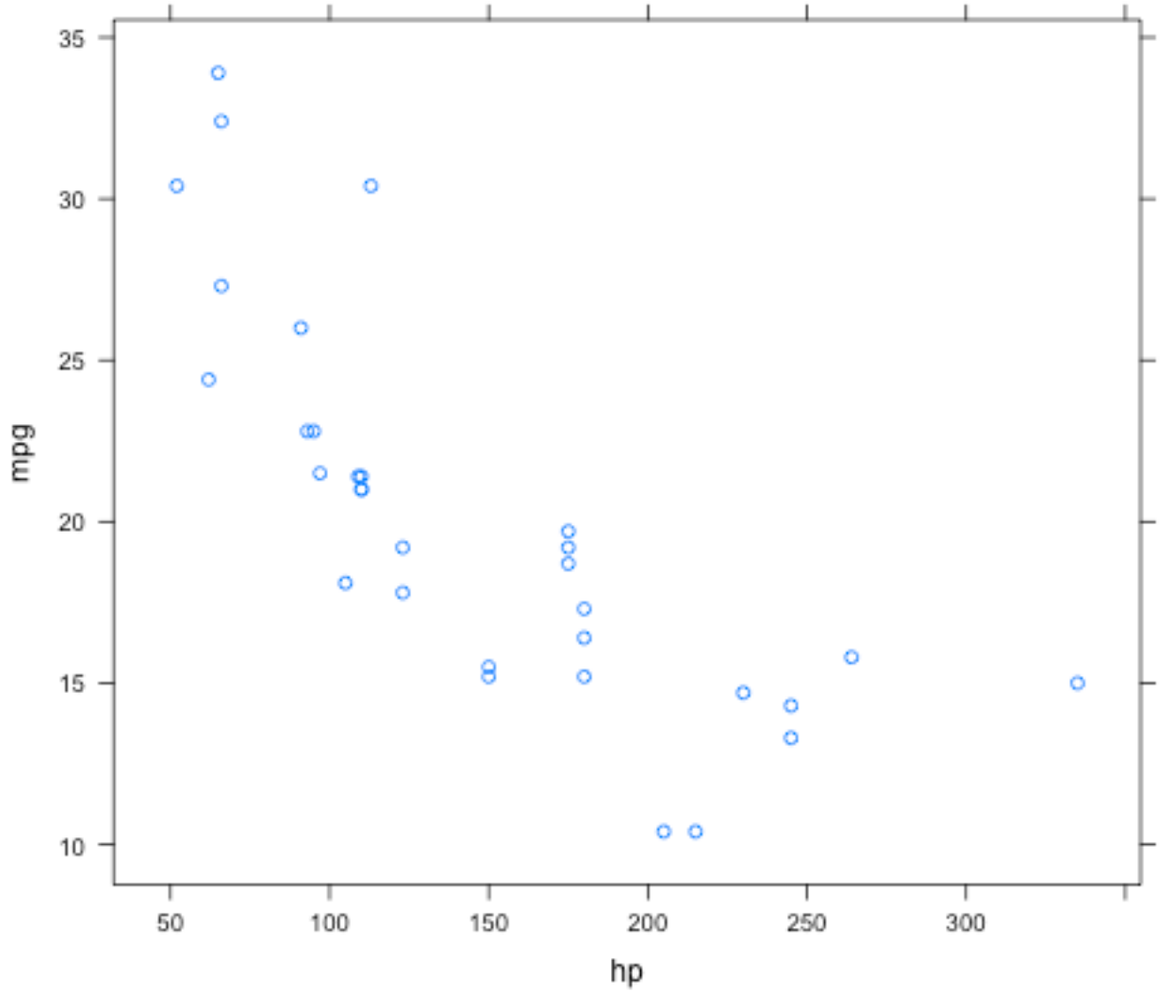
- **lattice**: code for producing Trellis graphics, includes functions like xyplot(), bwplot(), levelplot()
- **Grid**: implements a different graphics system and the lattice package are on top of it

Main plot functions

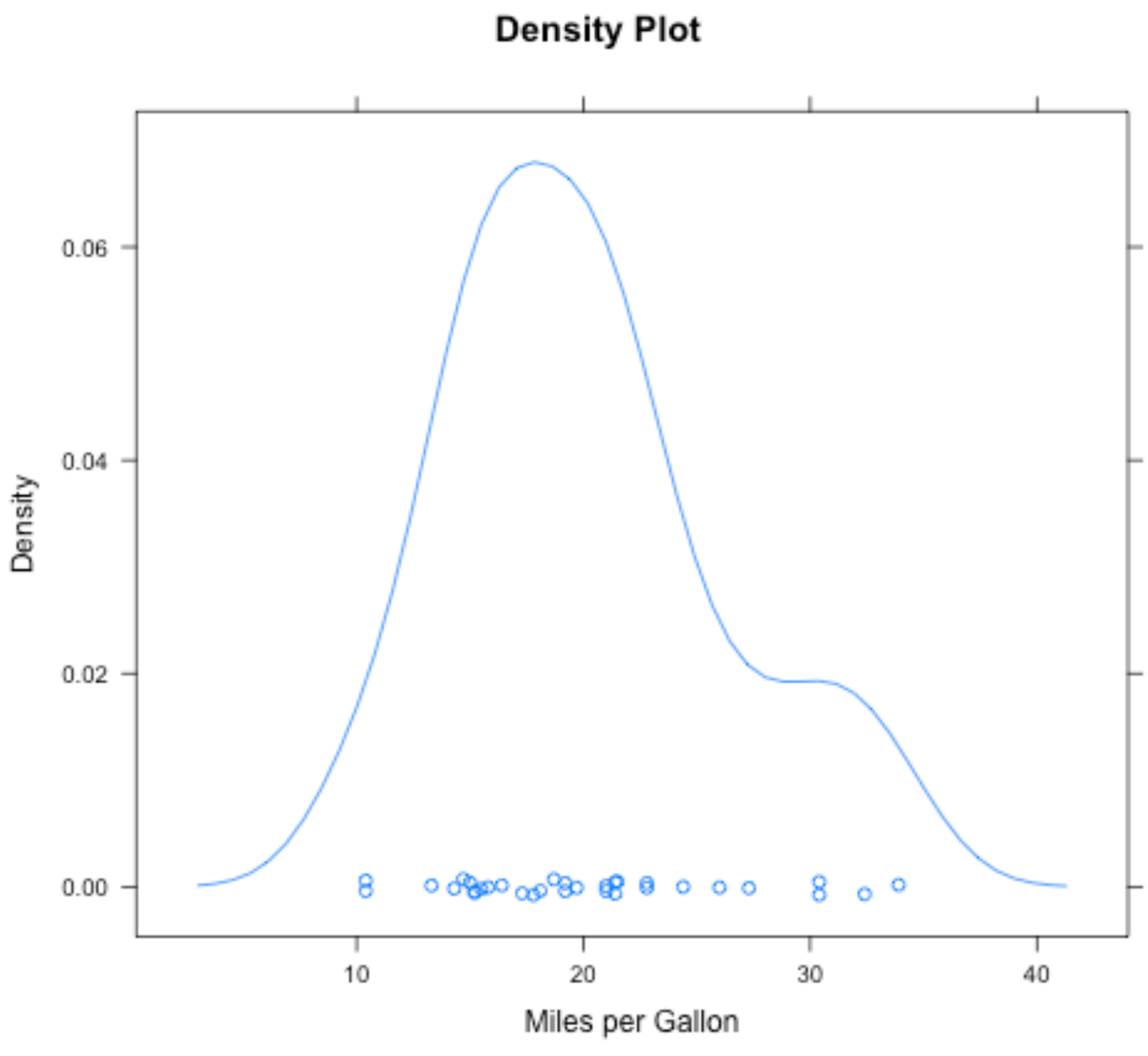
- xyplot(): scatterplots
- bwplot(): boxplots
- histogram(): histograms
- stripplot(): a boxplot points
- dotplot(): plot dots on "violin strings"
- splom(): scatterplot matrix
- levelplot(), contourplot(): for "image" data

Example

```
library(lattice)
attach(mtcars)
xyplot(mpg ~ hp, data = mtcars)
```



Extended example



More examples

- See lattice_example_1.R

ggplot2 Plotting System

- “Grammar of Graphics” by Leland Wilkinson, written by Hadley Wickham
- Data must be a data frame
- Uses grammar
- Web site: http://ggplot2.org

What is "Grammar of Graphics"?

"In brief, the grammar tells us that a statistical graphic is a mapping from data to aesthetic attributes (colour, shape, size) of geometric objects (points, lines, bars). The plot may also contain statistical transformations of the data and is drawn on a specific coordinate system”- ggplot2 book

qplot() and ggplot()

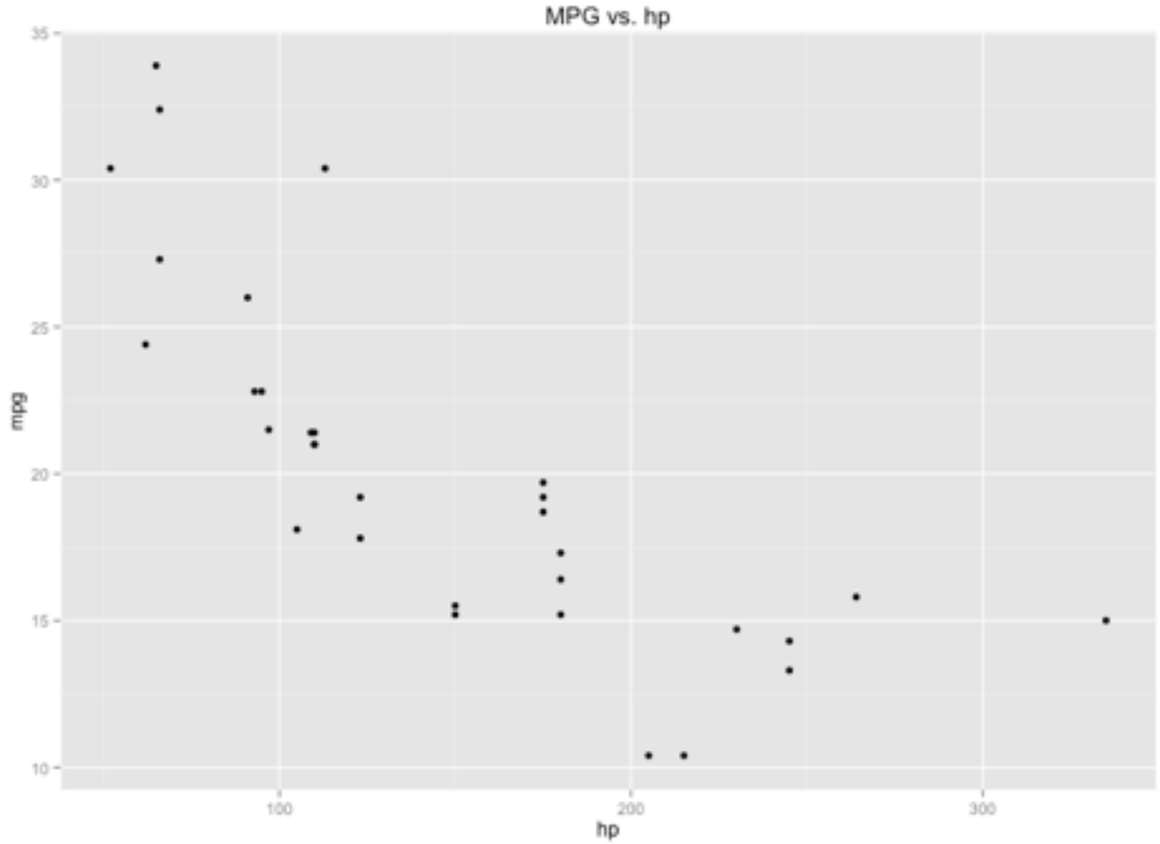
- qplot() - works like plot() function in base plotting system data
- should represent a data frame
- *aesthetic* (size, colour, shape) and *geoms* (points, lines)
- core of ggplot()

qplot

- qplot() - works like plot() function in base plotting system data
- Should represent a data frame
- *aesthetic* (size, colour) and *geoms* (points, lines)
- Core of ggplot()

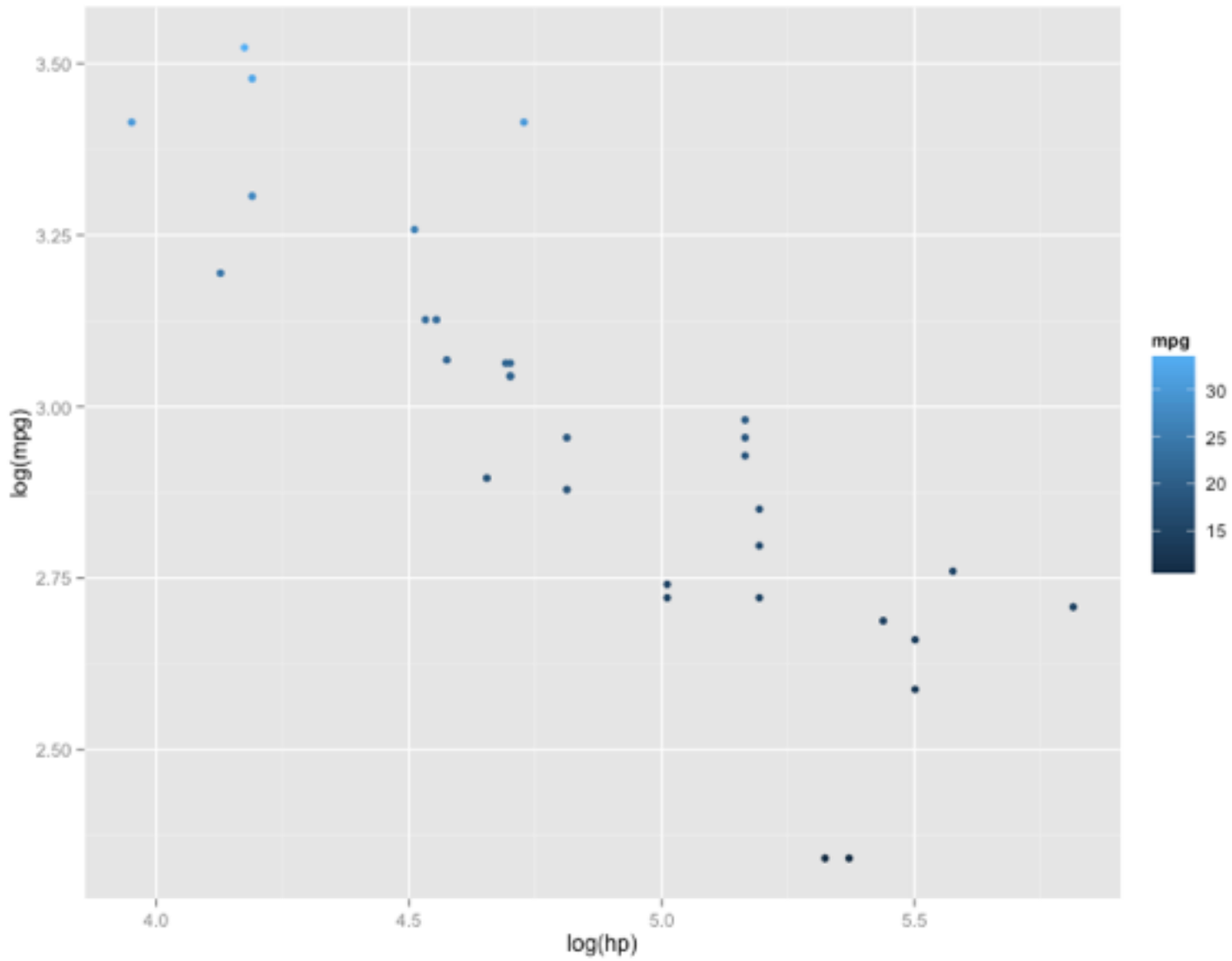
Example

```
library(ggplot2)
attach(mtcars)
head(mtcars)
# Simple plot:
qplot(data=mtcars,x=hp, y=mpg,main="MPG vs. hp")
```



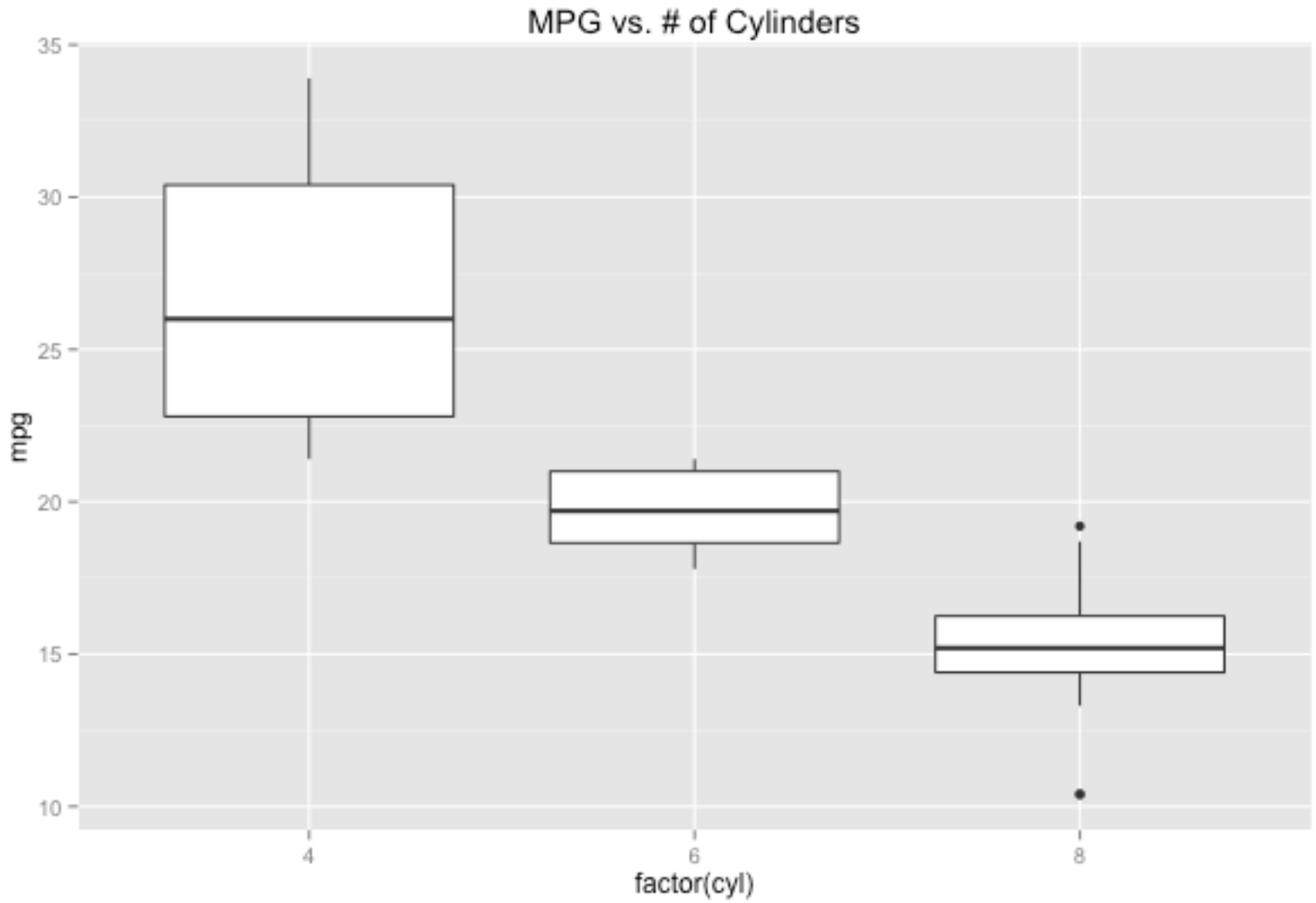
Example

```
# Color gradient
qplot(data=mtcars,x=log(hp),y=log(mpg),color=mpg)
```



Example

# Boxplots:
qplot(data=mtcars,x=factor(cyl), y=mpg,geom="boxplot", main="MPG vs. # of Cylinders")



Components of ggplot()

- A **data frame**
- **aesthetic mapping** (how data are mapped to colour and size)
- **geoms** (points, shapes, lines)
- **facets**
- **stats** (binning, smoothing, quantiles)
- **scales** (for aesthetic mapping, i.e. male='red', female='blue')
- **coordinate system**

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Steps to plot with ggplot()

- Plots are build up in layers
- Plot the data
- Overlay a summary
- Add metadata and annotation

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Building Up in Layers

```
> head(maacs)
    logpm25          bmicat NocturnalSympt
2 1.5361795 normal weight               1
3 1.5905409 normal weight               0
4 1.5217786 normal weight               0
5 1.4323277 normal weight               0
6 1.2762320     overweight              8
8 0.7139103     overweight              0

> g <- ggplot(maacs, aes(logpm25, NocturnalSympt))

> summary(g)
data: logpm25, bmicat, NocturnalSympt [554x3]
mapping:  x = logpm25, y = NocturnalSympt
faceting: facet_null()
```

Data Frame

Aesthetics

Initial call to ggplot

Summary of ggplot object

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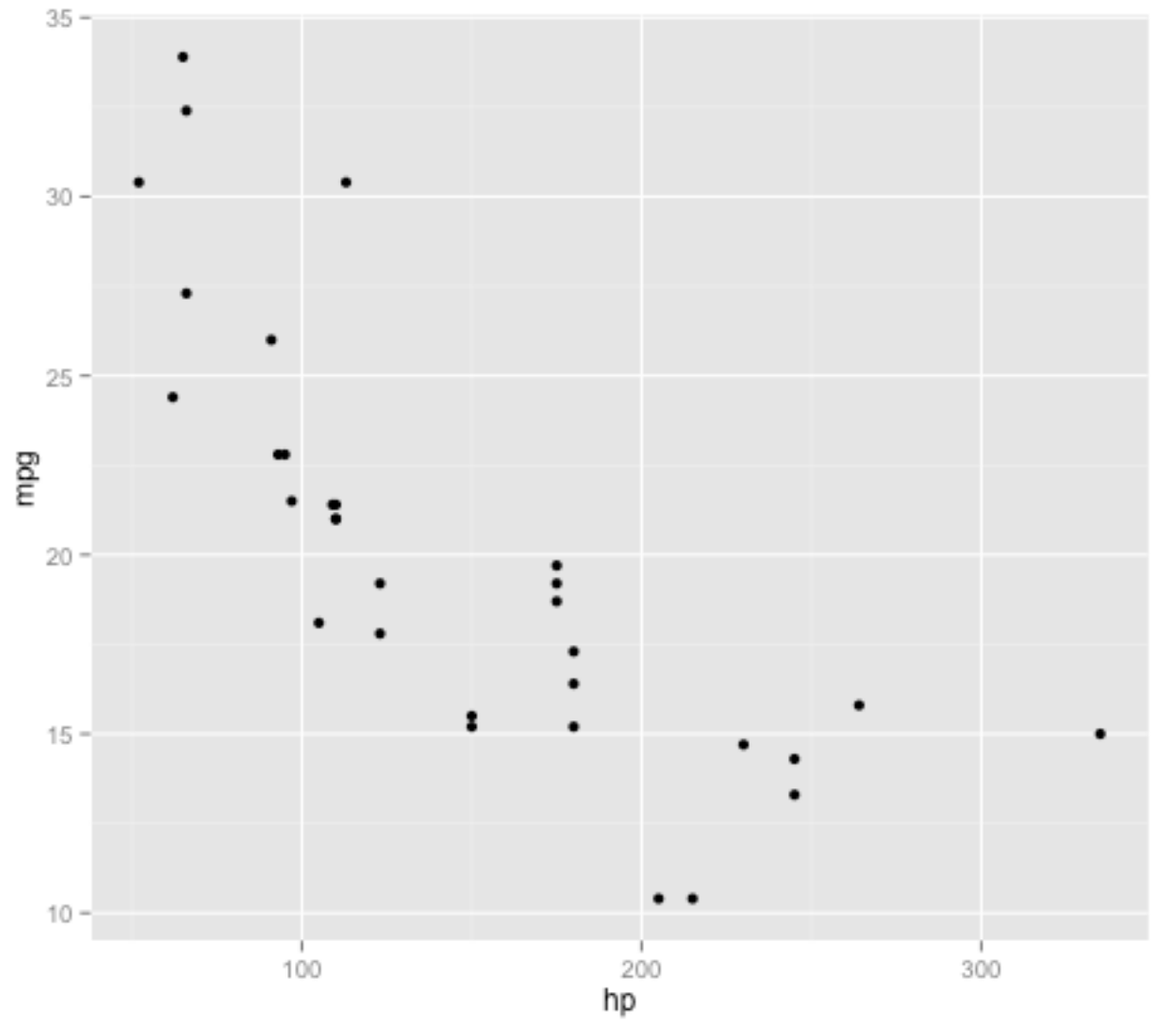
Example

```
# Basic:
ggplot(mtcars, aes(hp, mpg)) + geom_point()
```



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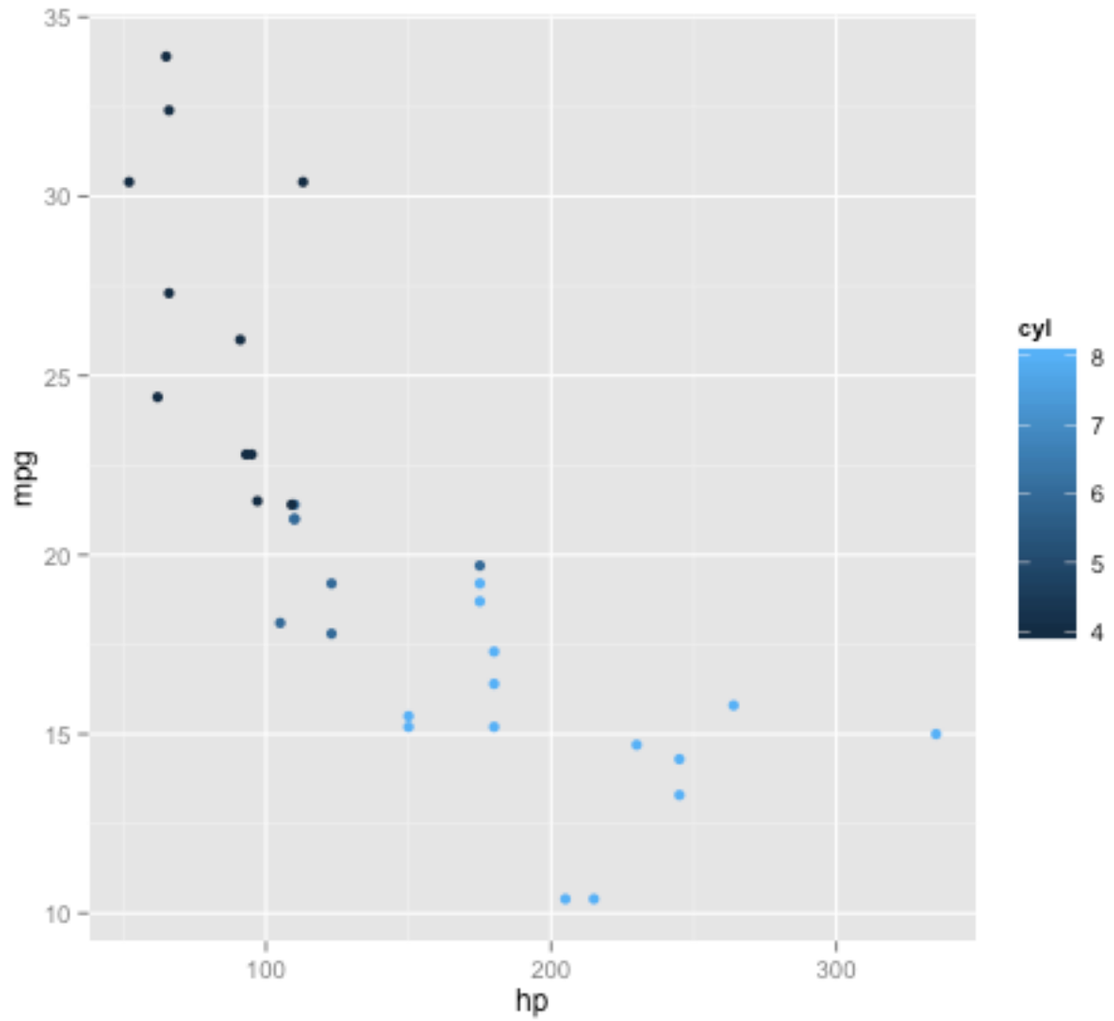
Example

# With color:
ggplot(mtcars, aes(hp, mpg)) + geom_point(aes(color = cyl))



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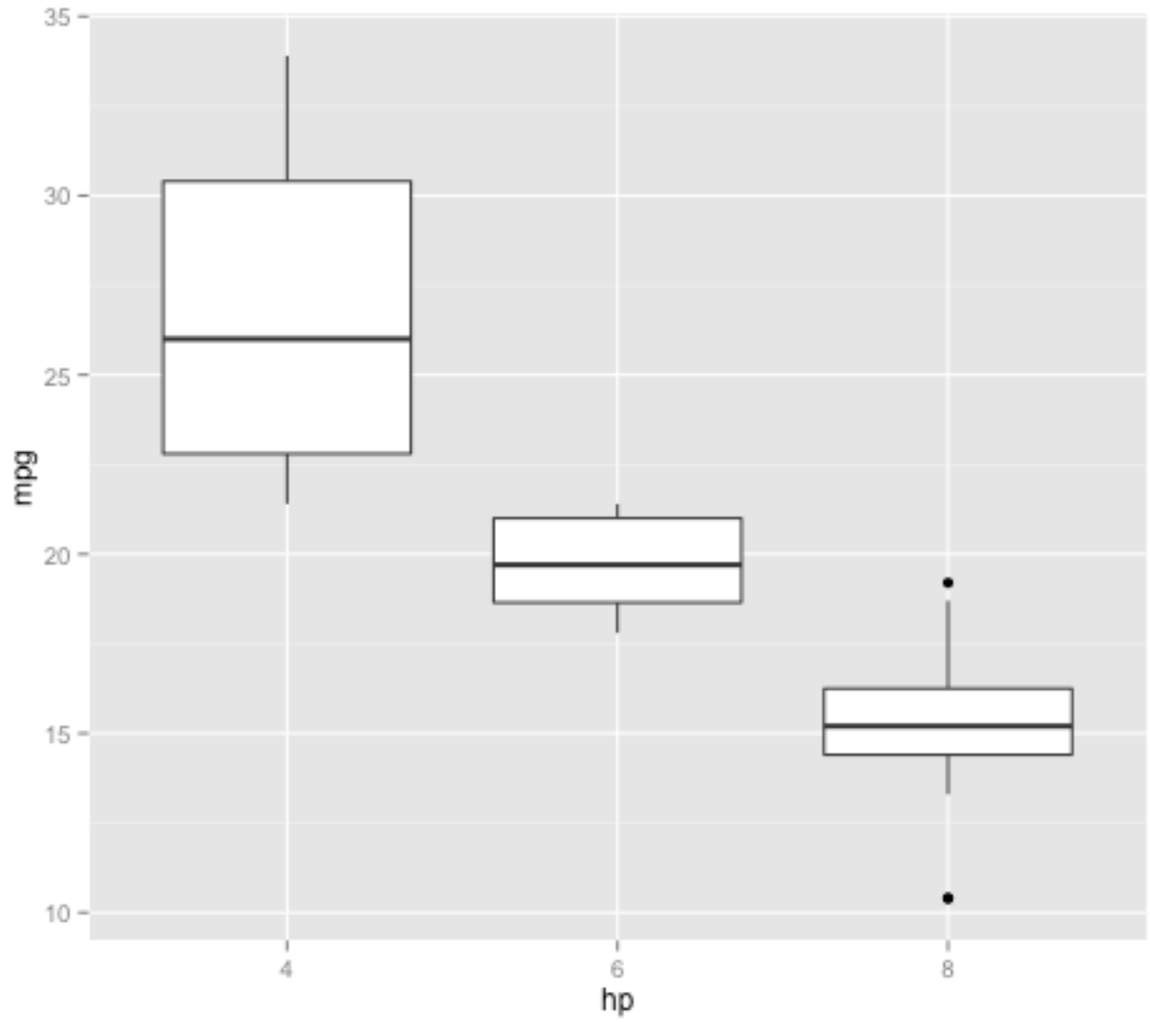
Example

# Boxplots:
ggplot(data=mtcars, aes(hp, mpg)) + geom_boxplot(aes(as.factor(cyl)))



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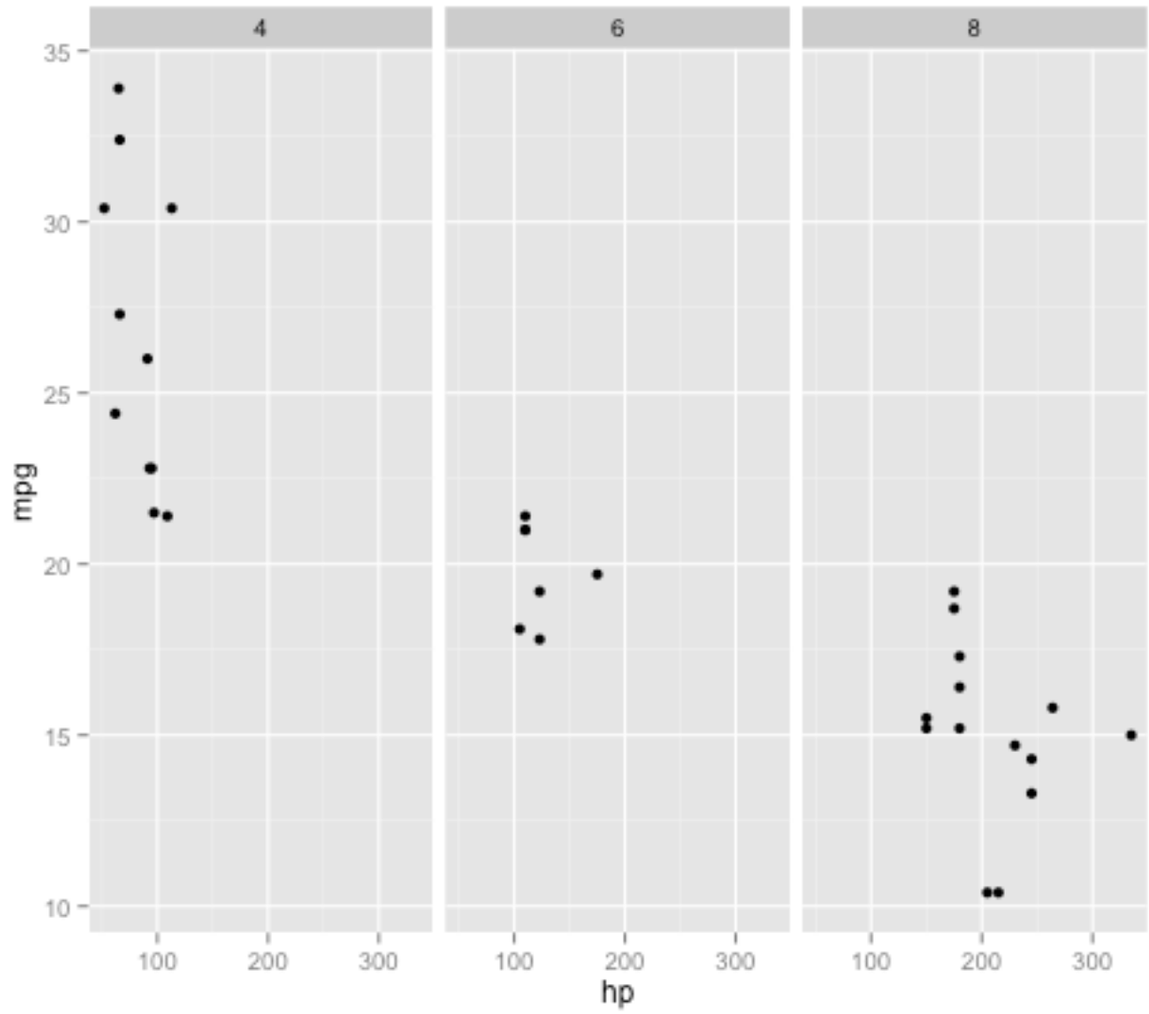
Example

```
# Faceting
mtcars$cyl <- factor(mtcars$cyl)
ggplot(data=mtcars, aes(hp, mpg)) + geom_point() + facet_grid(~ cyl)
```



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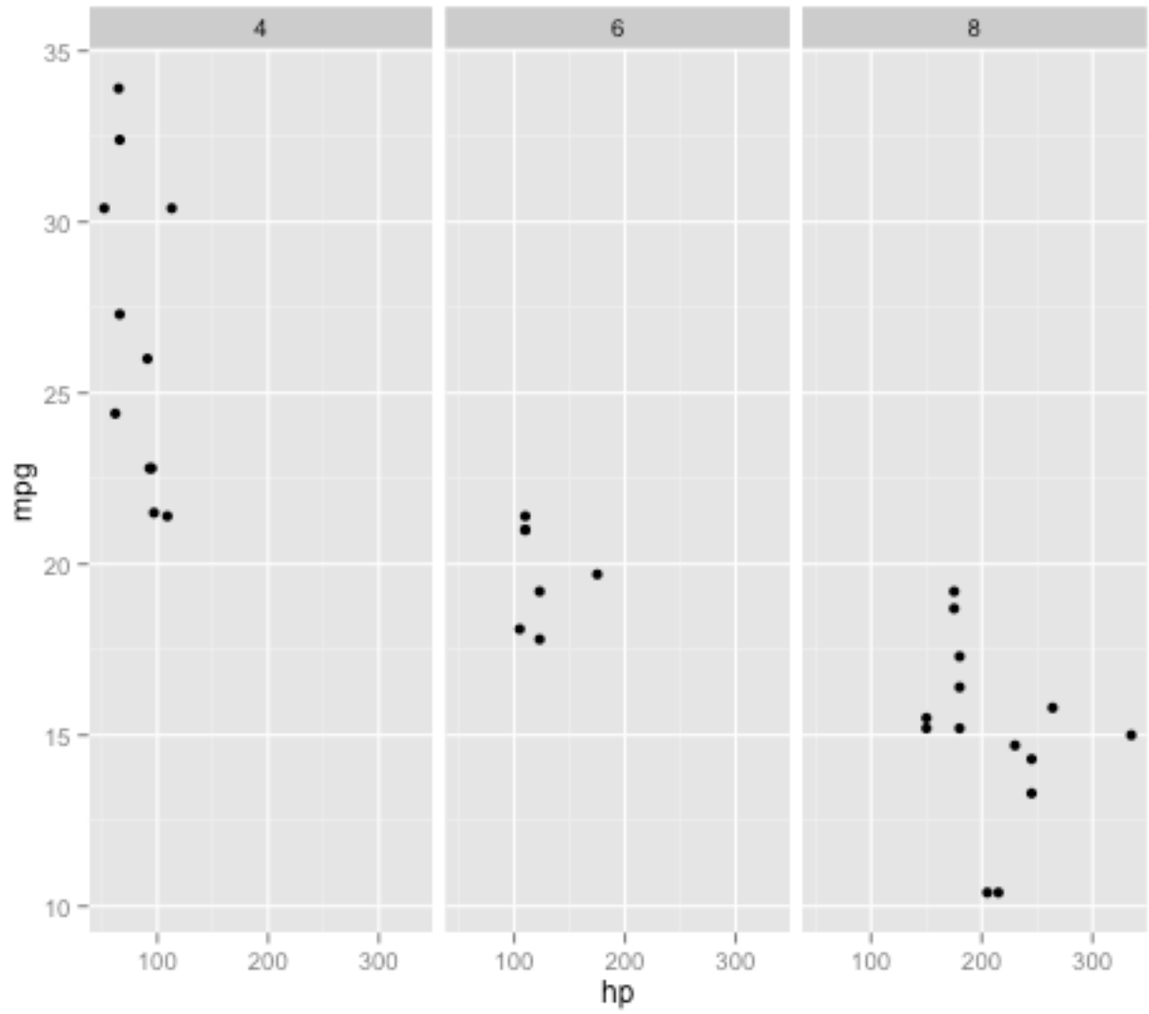
Example

```
# Faceting
mtcars$cyl <- factor(mtcars$cyl)
ggplot(data=mtcars, aes(hp, mpg)) + geom_point() + facet_grid(~ cyl)
```



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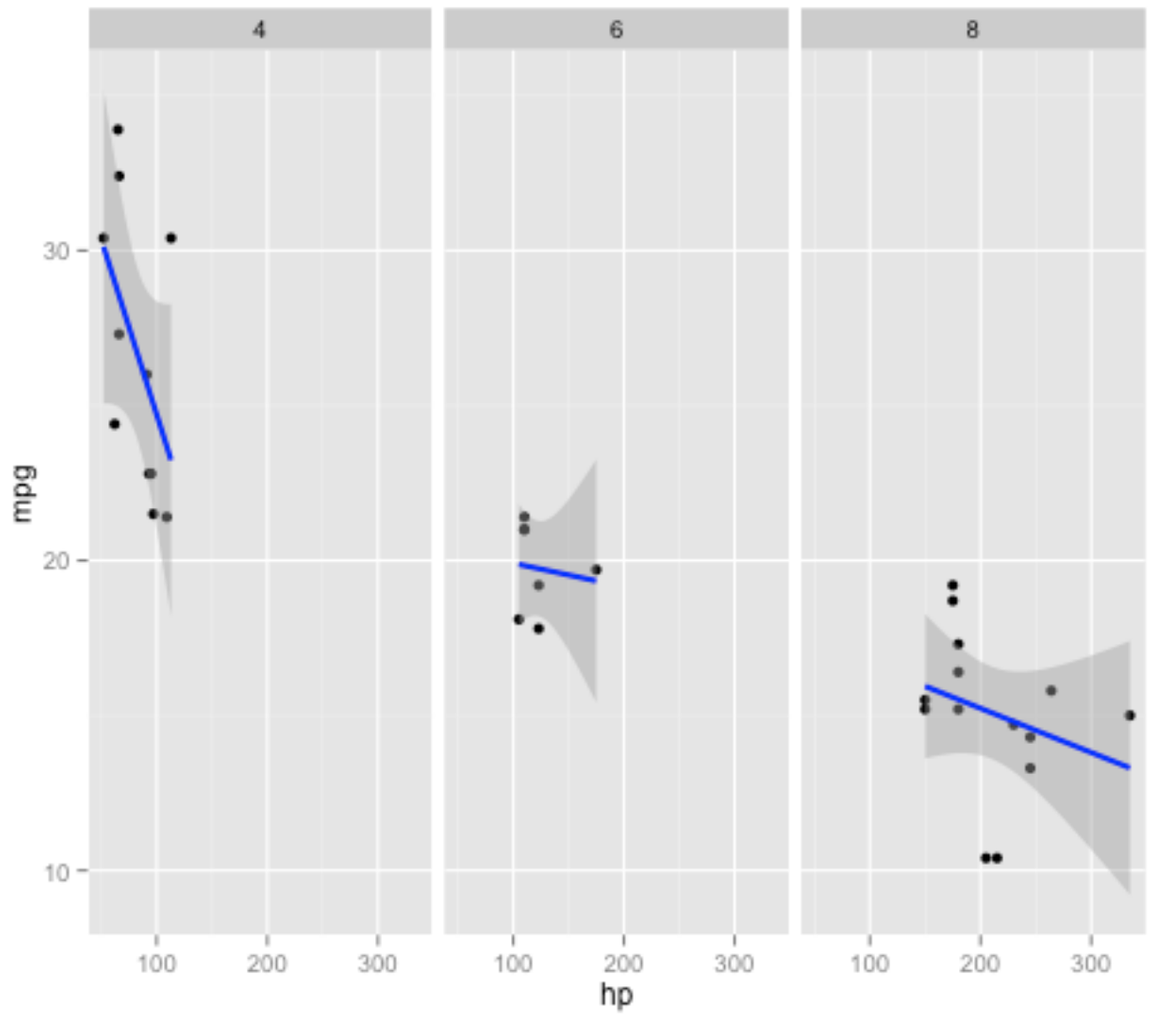
Example

```
ggplot(data=mtcars, aes(hp, mpg)) + geom_point() + facet_grid(~ cyl) +
  geom_smooth(colour = "blue", size = 1, method=lm)
```



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Resources

- http://www.r-bloggers.com
- http://revolutionanalytics.com
- http://www.statmethods.net (Quick-R)
- Coursera (Data Science Specialisation)