Class: 13rd April 2018

Topics

1. Plotting Data
2. Working with datasets
3. Correlations and Covariance with plotting
4. Data frames accessing
5. Reading files
6. Gist about packages and installing packages.

Plotting operations in R

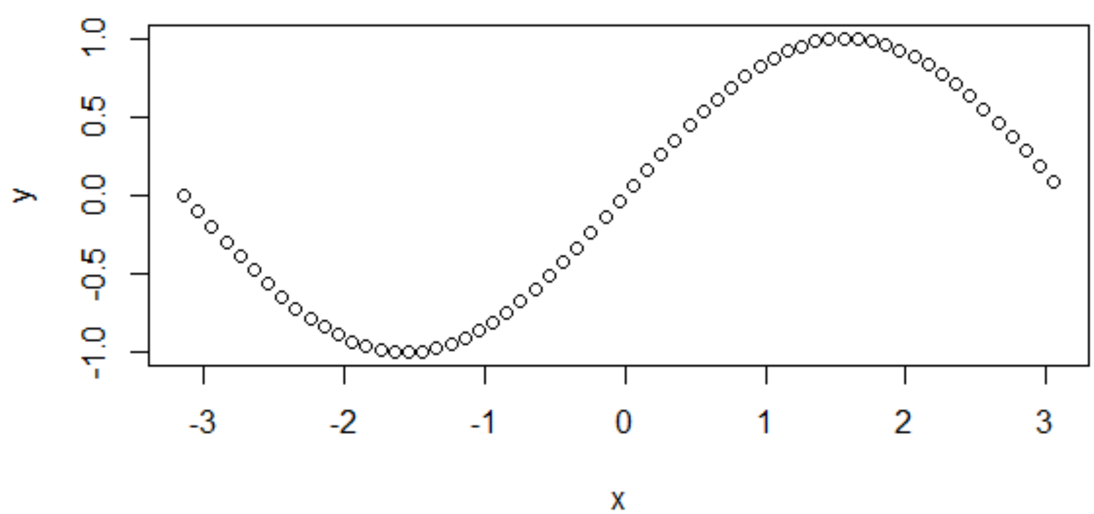
The most used plotting function in R programming is the plot() function. It is a generic function, meaning, it has many methods which are called according to the type of object passed to plot().

In the simplest case, we can pass in a vector and we will get a scatter plot of magnitude vs index. But generally, we pass in two vectors and a scatter plot of these points are plotted.

For example, the command plot(c(1,2),c(3,5)) would plot the points (1,3) and (2,5).

Here is a more concrete example where we plot a sine function form range -pi to pi.

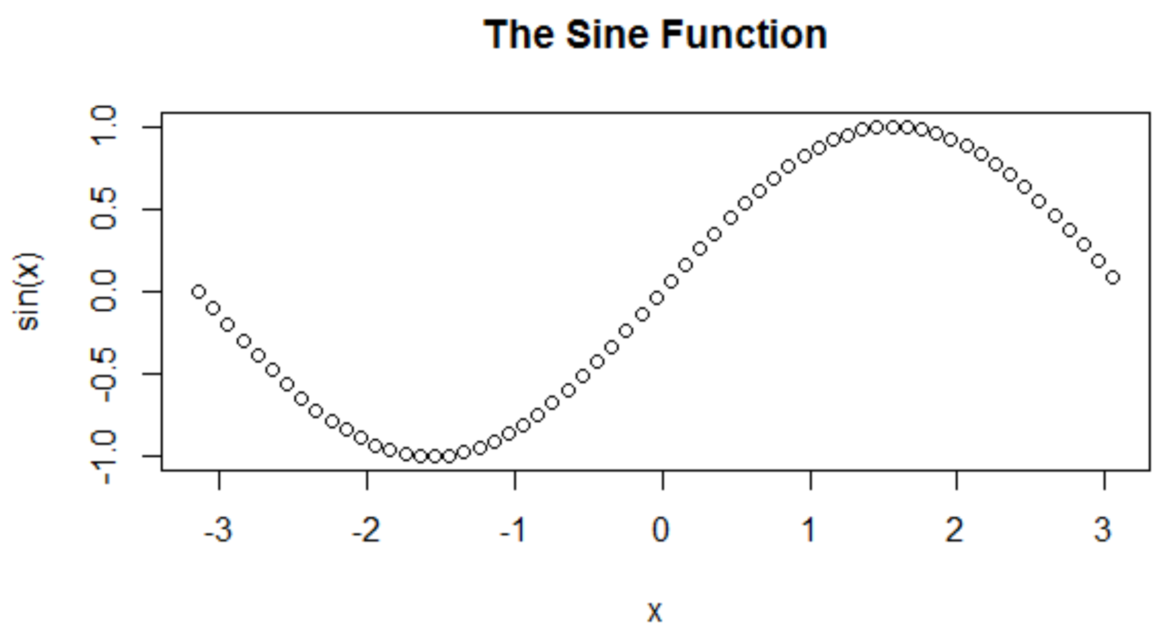
```
x <- seq(-pi,pi,0.1)

plot(x, sin(x))
```



Adding Titles and Labelling Axes

We can add a title to our plot with the parameter main. Similarly, xlab and ylab can be used to label the x-axis and y-axis respectively.

```
plot(x, sin(x),main="The Sine Function",ylab="sin(x)")
```



Changing Color and Plot Type

We can see above that the plot is of circular points and black in color. This is the default color.

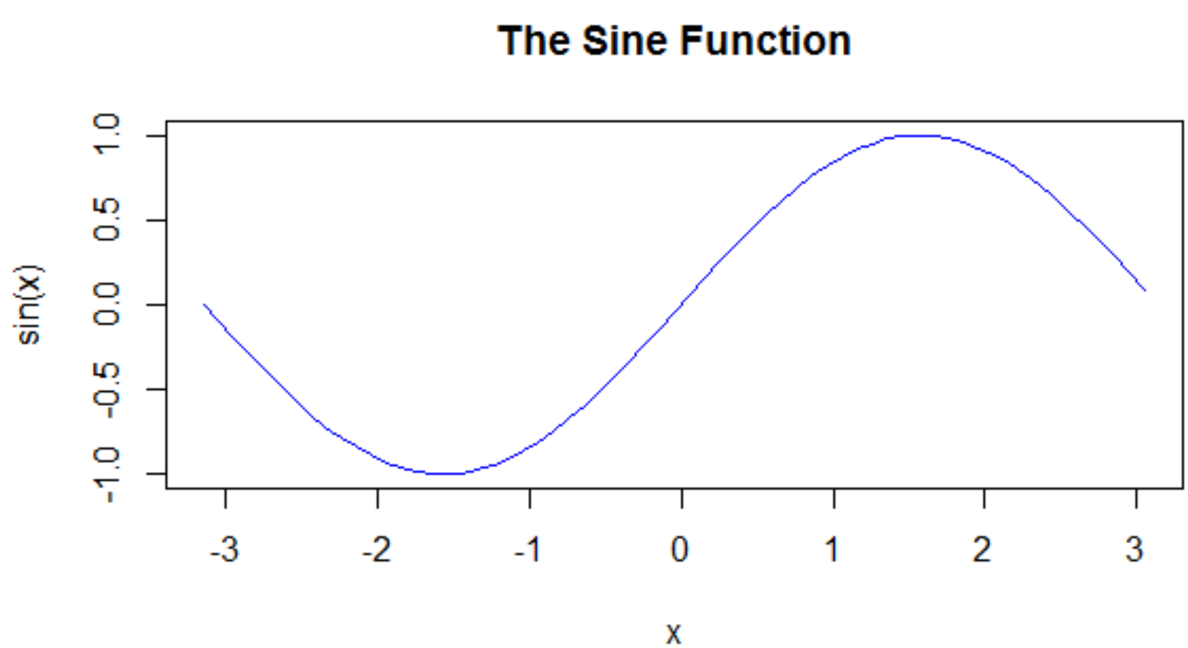
We can change the plot type with the argument type. It accepts the following strings and has the given effect.

```
"p" - points

"l" - lines

"b" - both points and lines
```

```
"c" - empty points joined by lines

"o" - overplotted points and lines

"s" and "S" - stair steps

"h" - histogram-like vertical lines

"n" - does not produce any points or lines
```

Similarly, we can define the color using `col`.

```
plot(x, sin(x),main="The Sine
Function",ylab="sin(x)",type="l",col="blue")
```



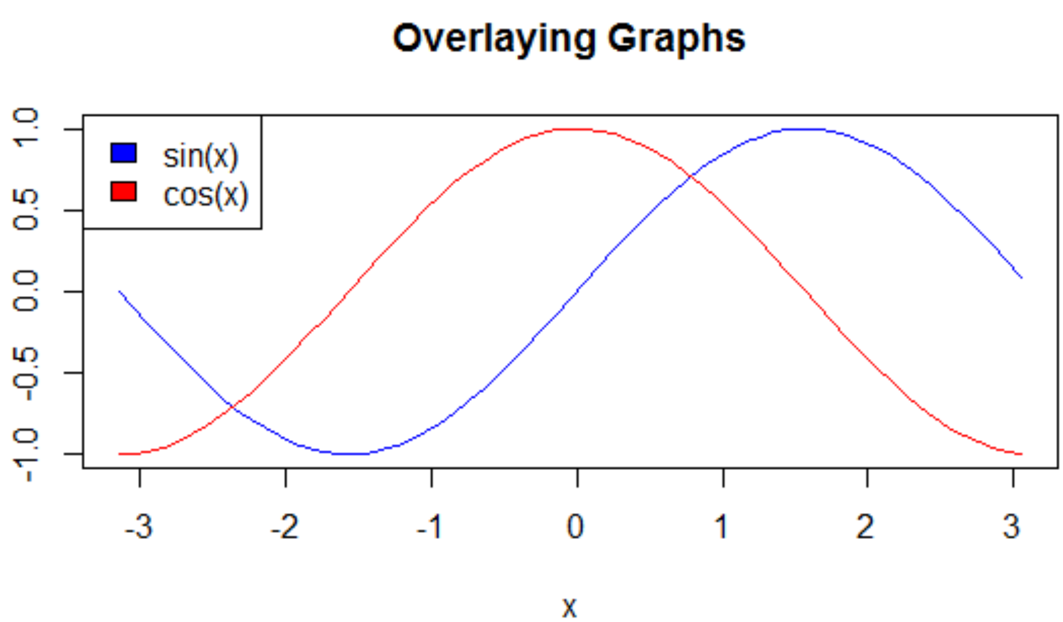
Overlaying Plots Using legend() function

Calling plot() multiple times will have the effect of plotting the current graph on the same window replacing the previous one.

However, sometimes we wish to overlay the plots in order to compare the results.

This is made possible with the functions lines() and points() to add lines and points respectively, to the existing plot.

```
plot(x, sin(x),main="Overlaying
Graphs",ylab="",type="l",col="blue")

lines(x,cos(x), col="red")

legend("topleft",c("sin(x)","cos(x)"),fill=c("blue","red"))
```



We have used the function legend() to appropriately display the legend. Visit legend() function to learn more.

Also visit plot() function to learn more about different arguments plot() function can take, and more examples.

Working with datasets

Datasets in R can be of csv or text files. You can access a dataset by using the following commands.
The default datasets files that come with R are as follow:

AirPassengers	Monthly Airline Passenger Numbers 1949-1960
BJsales	Sales Data with Leading Indicator
BJsales.lead (BJsales)	Sales Data with Leading Indicator
BOD	Biochemical Oxygen Demand
CO2	Carbon Dioxide Uptake in Grass Plants
ChickWeight	Weight versus age of chicks on different diets
DNase	Elisa assay of DNase
EuStockMarkets	Daily Closing Prices of Major European Stock Indices, 1991-1998
Formaldehyde	Determination of Formaldehyde
HairEyeColor	Hair and Eye Color of Statistics Students
Harman23.cor	Harman Example 2.3
Harman74.cor	Harman Example 7.4
Indometh	Pharmacokinetics of Indomethacin
InsectSprays	Effectiveness of Insect Sprays
JohnsonJohnson	Quarterly Earnings per Johnson & Johnson Share
LakeHuron	Level of Lake Huron 1875-1972
LifeCycleSavings	Intercountry Life-Cycle Savings Data
Loblolly	Growth of Loblolly pine trees
Nile	Flow of the River Nile
Orange	Growth of Orange Trees
OrchardSprays	Potency of Orchard Sprays
PlantGrowth	Results from an Experiment on Plant Growth
Puromycin	Reaction Velocity of an Enzymatic Reaction
Seatbelts	Road Casualties in Great Britain 1969-84
Theoph	Pharmacokinetics of Theophylline
Titanic	Survival of passengers on the Titanic
ToothGrowth	The Effect of Vitamin C on Tooth Growth in Guinea Pigs
UCBAdmissions	Student Admissions at UC Berkeley
UKDriverDeaths	Road Casualties in Great Britain 1969-84
UKgas	UK Quarterly Gas Consumption
USAccDeaths	Accidental Deaths in the US 1973-1978
USArrests	Violent Crime Rates by US State
USJudgeRatings	Lawyers' Ratings of State Judges in the US Superior Court
USPersonalExpenditure	Personal Expenditure Data
UScitiesD	Distances Between European Cities and Between US Cities
VADeaths	Death Rates in Virginia (1940)
WWWusage	Internet Usage per Minute
WorldPhones	The World's Telephones
ability.cov	Ability and Intelligence Tests
airmiles	Passenger Miles on Commercial US Airlines, 1937-1960
airquality	New York Air Quality Measurements
anscombe	Anscombe's Quartet of 'Identical' Simple Linear Regressions
attenu	The Joyner-Boore Attenuation Data

attitude	The Chatterjee-Price Attitude Data
austres	Quarterly Time Series of the Number of Australian Residents
beaver1 (beavers)	Body Temperature Series of Two Beavers
beaver2 (beavers)	Body Temperature Series of Two Beavers
cars	Speed and Stopping Distances of Cars
chickwts	Chicken Weights by Feed Type
co2	Mauna Loa Atmospheric CO2 Concentration
crimtab	Student's 3000 Criminals Data
discoveries	Yearly Numbers of Important Discoveries
esoph	Smoking, Alcohol and (O)esophageal Cancer
euro	Conversion Rates of Euro Currencies
euro.cross (euro)	Conversion Rates of Euro Currencies
eurodist	Distances Between European Cities and Between US Cities
faithful	Old Faithful Geyser Data
fdeaths (UKLungDeaths)	Monthly Deaths from Lung Diseases in the UK
freeny	Freeny's Revenue Data
freeny.x (freeny)	Freeny's Revenue Data
freeny.y (freeny)	Freeny's Revenue Data
infert	Infertility after Spontaneous and Induced Abortion
iris	Edgar Anderson's Iris Data
iris3	Edgar Anderson's Iris Data
islands	Areas of the World's Major Landmasses
ldeaths (UKLungDeaths)	Monthly Deaths from Lung Diseases in the UK
lh	Luteinizing Hormone in Blood Samples
longley	Longley's Economic Regression Data
lynx	Annual Canadian Lynx trappings 1821-1934
mdeaths (UKLungDeaths)	Monthly Deaths from Lung Diseases in the UK
morley	Michelson Speed of Light Data
mtcars	Motor Trend Car Road Tests
nhtemp	Average Yearly Temperatures in New Haven
nottem	Average Monthly Temperatures at Nottingham, 1920-1939
npk	Classical N, P, K Factorial Experiment
occupationalStatus	Occupational Status of Fathers and their Sons
precip	Annual Precipitation in US Cities
presidents	Quarterly Approval Ratings of US Presidents
pressure	Vapor Pressure of Mercury as a Function of Temperature
quakes	Locations of Earthquakes off Fiji
randu	Random Numbers from Congruential Generator RANDU
rivers	Lengths of Major North American Rivers
rock	Measurements on Petroleum Rock Samples
sleep	Student's Sleep Data
stack.loss (stackloss)	Brownlee's Stack Loss Plant Data
stack.x (stackloss)	Brownlee's Stack Loss Plant Data

```
stackloss                           Brownlee's Stack Loss Plant Data
state.abb (state)                   US State Facts and Figures
state.area (state)                  US State Facts and Figures
state.center (state)                US State Facts and Figures
state.division (state)              US State Facts and Figures
state.name (state)                  US State Facts and Figures
state.region (state)                US State Facts and Figures
state.x77 (state)                   US State Facts and Figures
sunspot.month                       Monthly Sunspot Data, from 1749 to
"Present"
sunspot.year                        Yearly Sunspot Data, 1700-1988
sunspots                            Monthly Sunspot Numbers, 1749-1983
swiss                               Swiss Fertility and Socioeconomic
Indicators (1888) Data
treering                            Yearly Treering Data, -6000-1979
trees                               Girth, Height and Volume for Black
Cherry Trees
uspop                               Populations Recorded by the US Census
volcano                             Topographic Information on Auckland's
Maunga Whau Volcano
warpbreaks                          The Number of Breaks in Yarn during
Weaving
women                               Average Heights and Weights for
American Women
```

Example:

```
> Titanic
, , Age = Child, Survived = No

      Sex
Class  Male Female
  1st     0      0
  2nd     0      0
  3rd    35     17
  Crew    0      0

, , Age = Adult, Survived = No

      Sex
Class  Male Female
  1st   118      4
  2nd   154     13
  3rd   387     89
  Crew  670      3

, , Age = Child, Survived = Yes

      Sex
Class  Male Female
  1st     5      1
  2nd    11     13
```

```
  3rd    13     14
  Crew    0      0

, , Age = Adult, Survived = Yes

      Sex
Class  Male Female
  1st    57    140
  2nd    14     80
  3rd    75     76
  Crew  192     20
```

Assignments:
Check some datasets to the R console just by typing the names.
NB: you can see all the data types just by typing `data()` in the console.

If you want to print a certain amount of data(here 5 columns), you can do like the following thing.

```
> head(CO2, 5)
  Plant   Type  Treatment conc uptake
1   Qn1 Quebec nonchilled   95   16.0
2   Qn1 Quebec nonchilled  175   30.4
3   Qn1 Quebec nonchilled  250   34.8
4   Qn1 Quebec nonchilled  350   37.2
5   Qn1 Quebec nonchilled  500   35.3
```

Here `5` is the number of rows of the dataset.
To get how many columns and rows are there in the dataset, you can use the `ncol(Dataset_name)` and `nrow(Dataset_name)` functions respectively.
Only `head()` return 5/6 rows.

Example:

```
> nrow(CO2)
[1] 84
> ncol(CO2)
[1] 5
```

Loading a dataframe

To load a dataframe with .Rda extension or .Rdata extension, we can use the following command.
`load(data_frame_name.Rda)`
If you use the .Rda dataframe a lot in R, you can also save the data file into R as follow.

```
save(list='mydata',file="data_frame_name.Rda")
```

after this command, you will have a dataframe `mydata` in R.

Building a dataframe

We can build a dataframe using vector.

```
N <- 100
u <- rnorm(N)
x1 <- rnorm(N)
x2 <- rnorm(N)
y <- 1 + x1 + x2 + u
mydat <- data.frame(y,x1,x2)
```

here `rnorm(n, mean = , sd = )` is used to generate `n` normal random numbers with arguments `mean` and `sd`; while `runif(n, min = , max = )` is used to generate `n` uniform random numbers lie in the interval `(min, max)`.

Assignment:

Create a dtaframe using the following data. (hint: use `data.frame()` function)

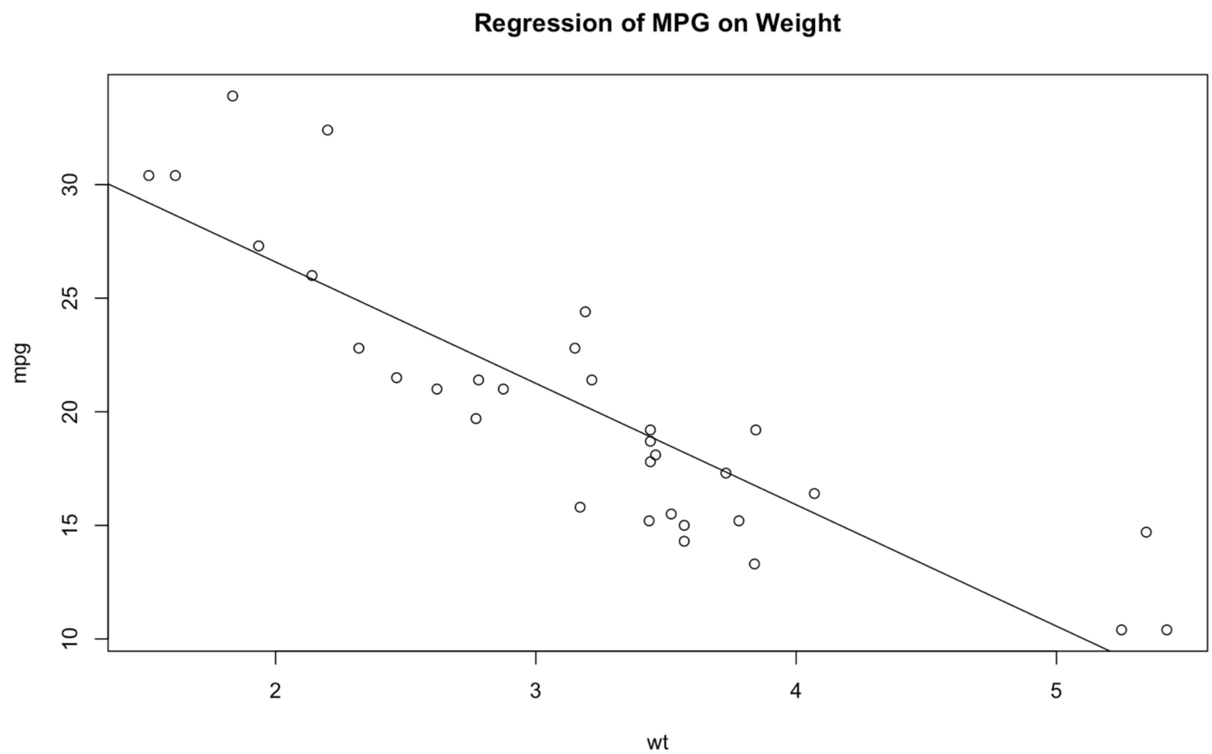
```
> employee <- c('John Doe','Peter Gynn','Jolie Hope')
> salary <- c(21000, 23400, 26800)
> startdate <- as.Date(c('2010-11-1','2008-3-25','2007-3-14'))
```

Plot a graph for salary. Find the average salary, maximum and minimum salary.

Types of Graphs in R

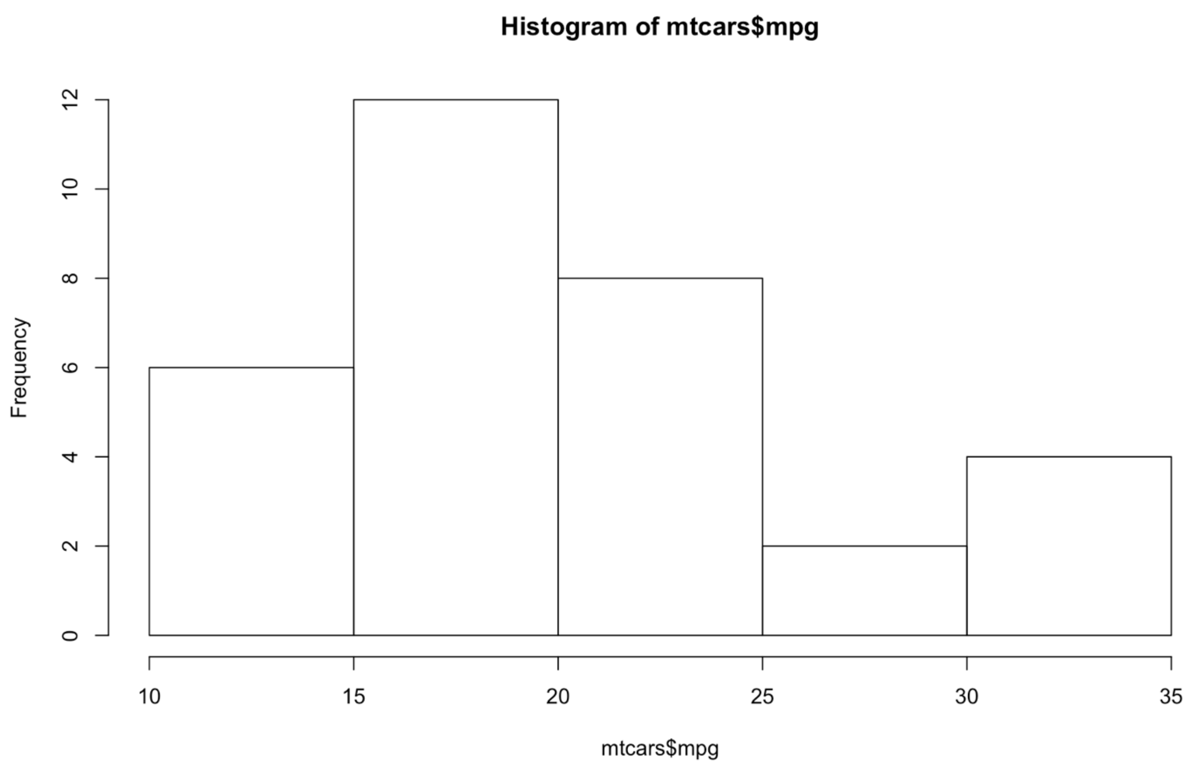
1. Simple plotting

```
> attach(mtcars) // setting latest/real time dataframe
> plot(wt, mpg)   //form the same dataset
> abline(lm(mpg~wt))  //y and x axix respectively
> title("Regression of MPG on Weight") //top title.
```

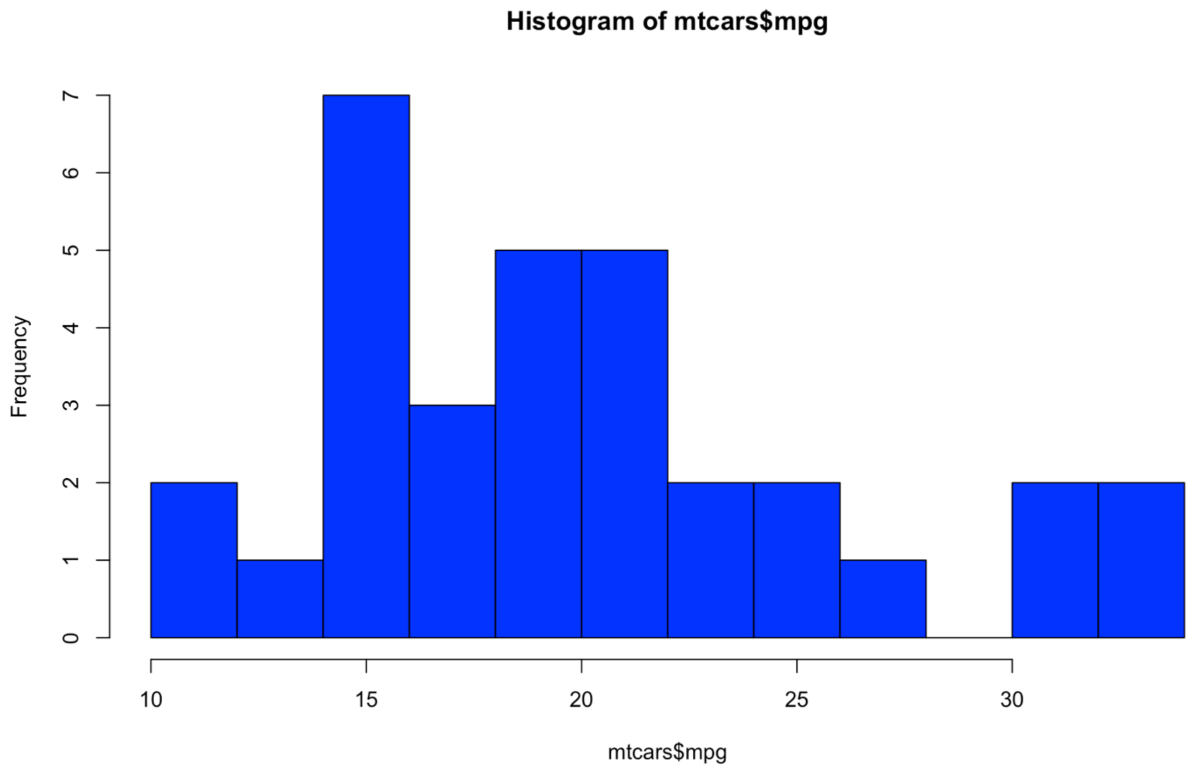


2. Histogram

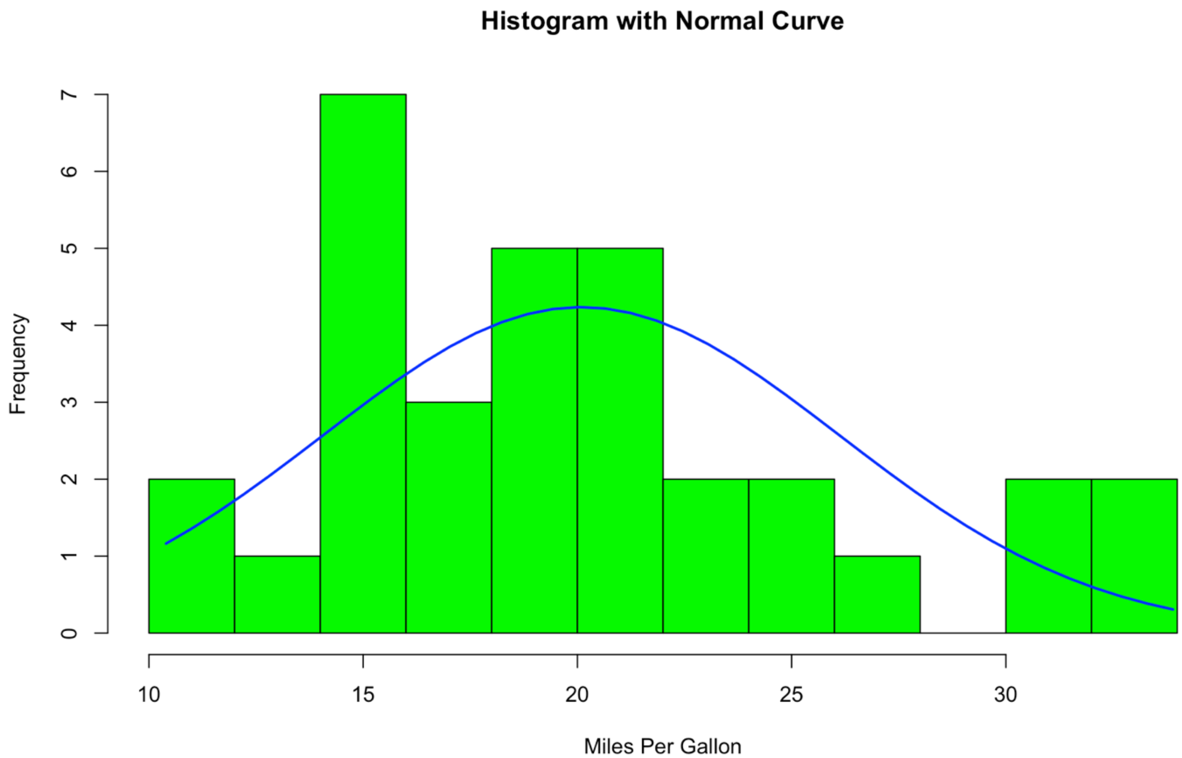
```
hist(mtcars$mpg)  //from mtcars dataframe, mpg's histogram
```



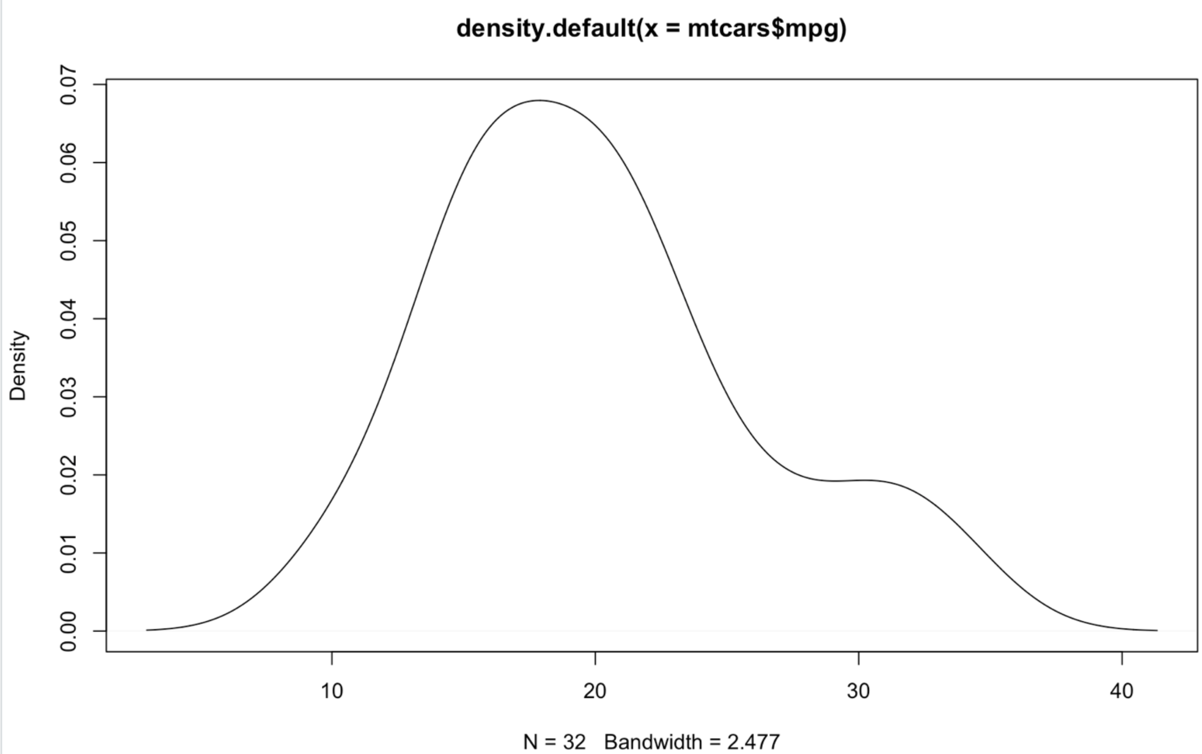
```
# Colored Histogram with Different Number of Bins
hist(mtcars$mpg, breaks=12, col="blue")
```



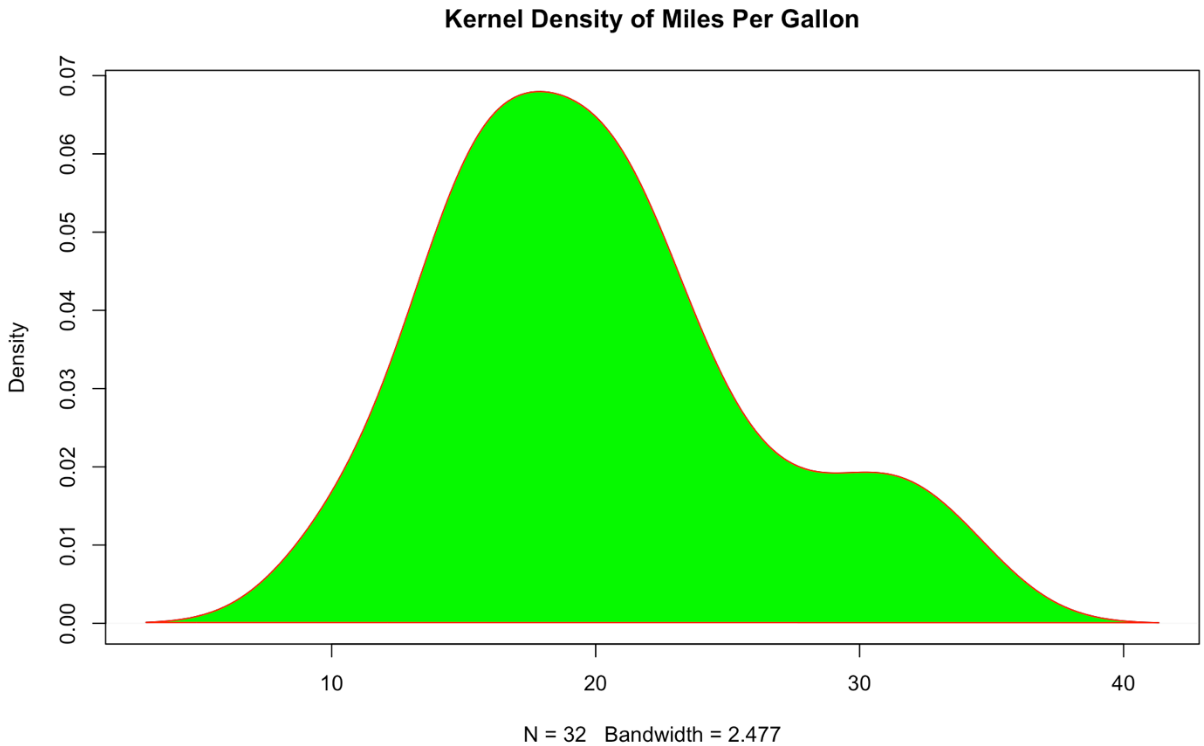

```
# Add a Normal Curve
x <- mtcars$mpg
h<-hist(x, breaks=10, col="green", xlab="Miles Per Gallon",
   main="Histogram with Normal Curve")
xfit<-seq(min(x),max(x),length=40)
yfit<-dnorm(xfit,mean=mean(x),sd=sd(x))
yfit <- yfit*diff(h$mids[1:2])*length(x)
lines(xfit, yfit, col="blue", lwd=2)
```




```
# Kernel Density Plot
d <- density(mtcars$mpg) # returns the density data
plot(d) # plots the results
```

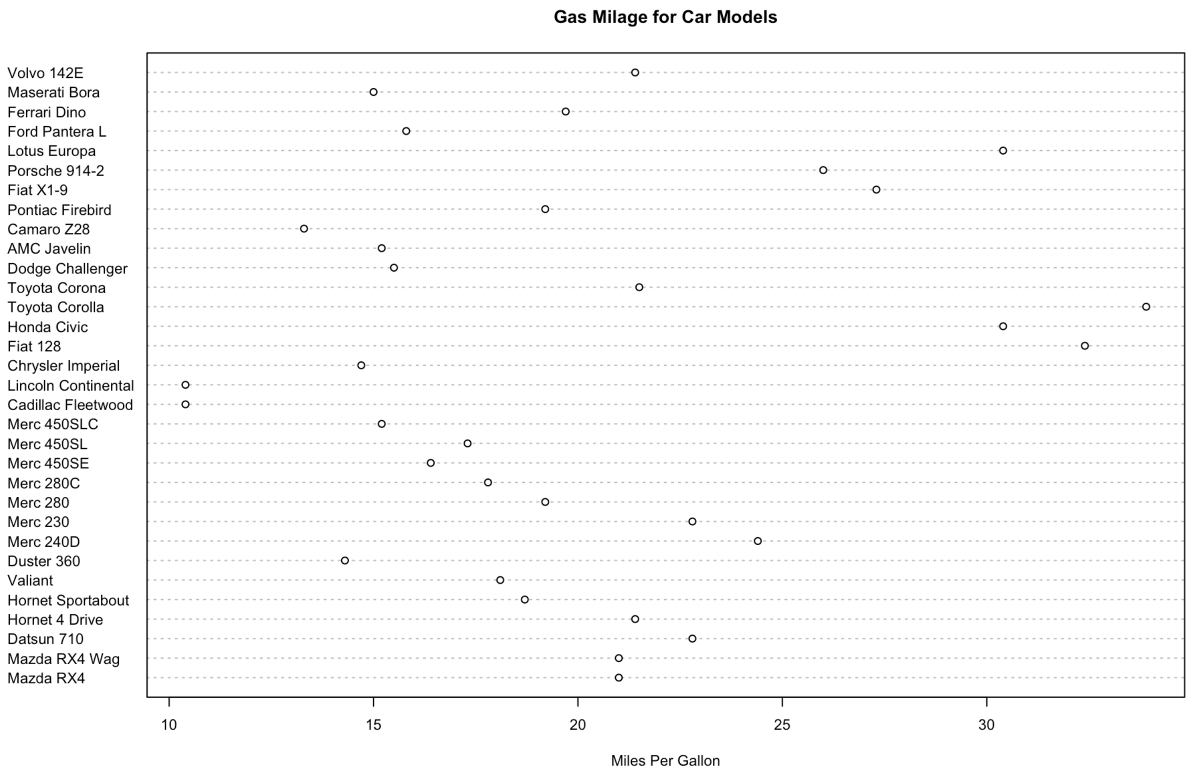


```
# Filled Density Plot
d <- density(mtcars$mpg)
plot(d, main="Kernel Density of Miles Per Gallon")
polygon(d, col="green", border="red")
```

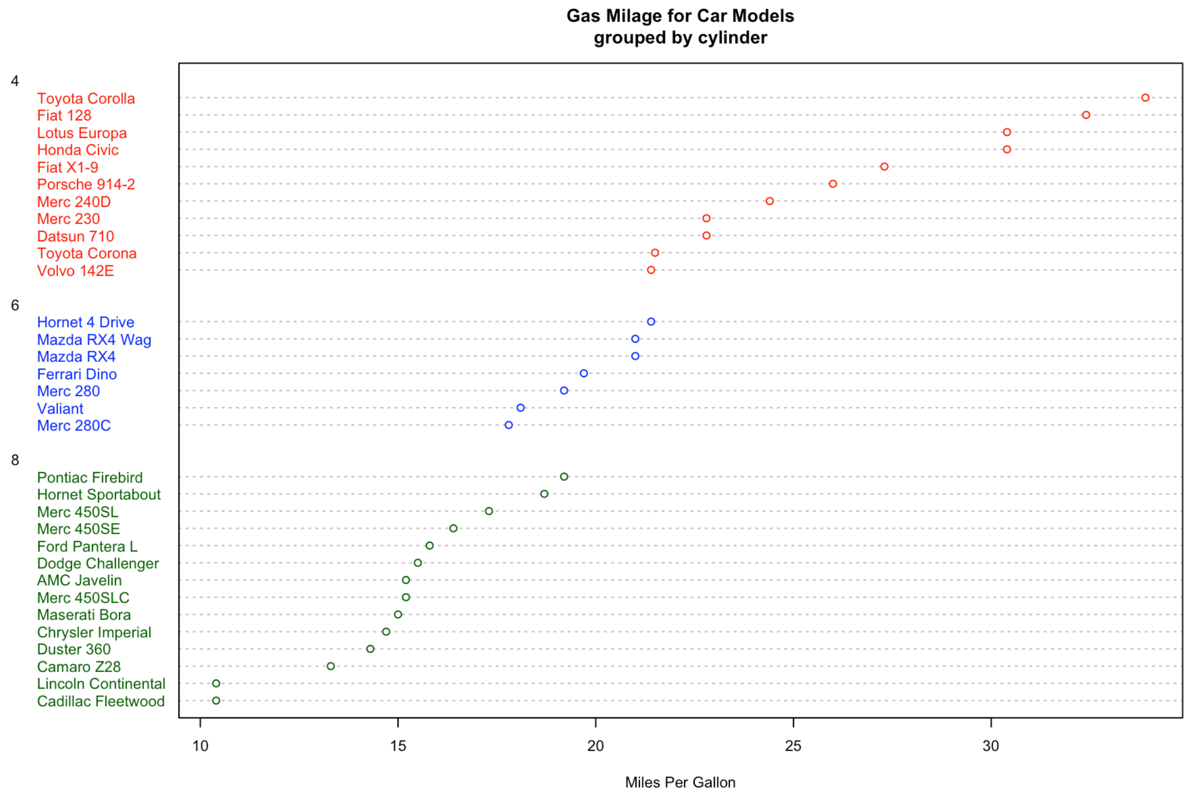


3. Dot Plot

```
# Simple Dotplot
dotchart(mtcars$mpg,labels=row.names(mtcars),cex=.7,
   main="Gas Milage for Car Models",
   xlab="Miles Per Gallon")
```

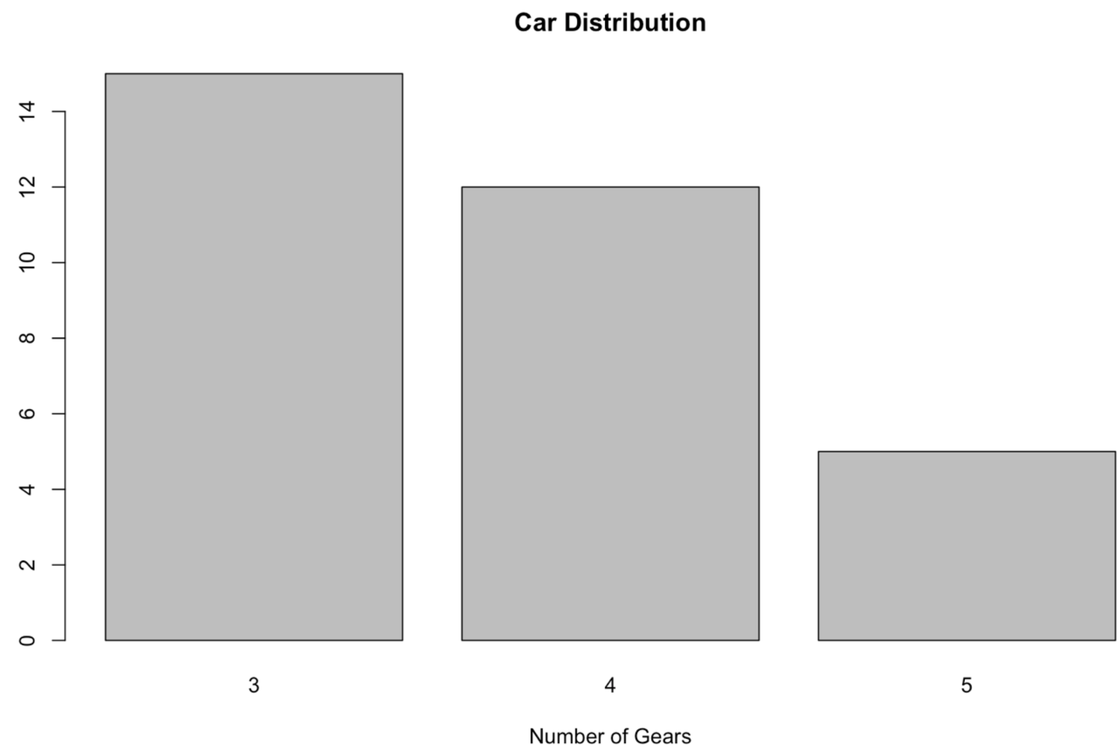



```
# Dotplot: Grouped Sorted and Colored
# Sort by mpg, group and color by cylinder
x <- mtcars[order(mtcars$mpg),] # sort by mpg
x$cyl <- factor(x$cyl) # it must be a factor
x$color[x$cyl==4] <- "red"
x$color[x$cyl==6] <- "blue"
x$color[x$cyl==8] <- "darkgreen"
dotchart(x$mpg,labels=row.names(x),cex=.7,groups= x$cyl,
   main="Gas Milage for Car Models\ngrouped by cylinder",
   xlab="Miles Per Gallon", gcolor="black", color=x$color)
```

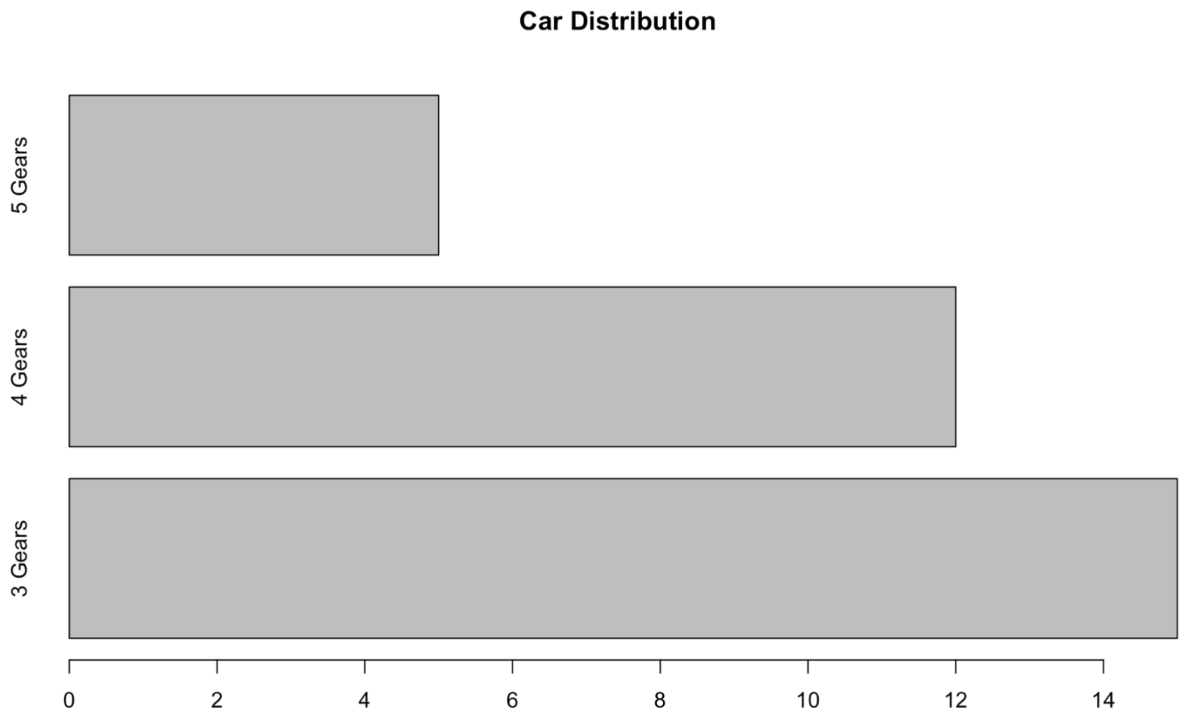


4. Bar Plot

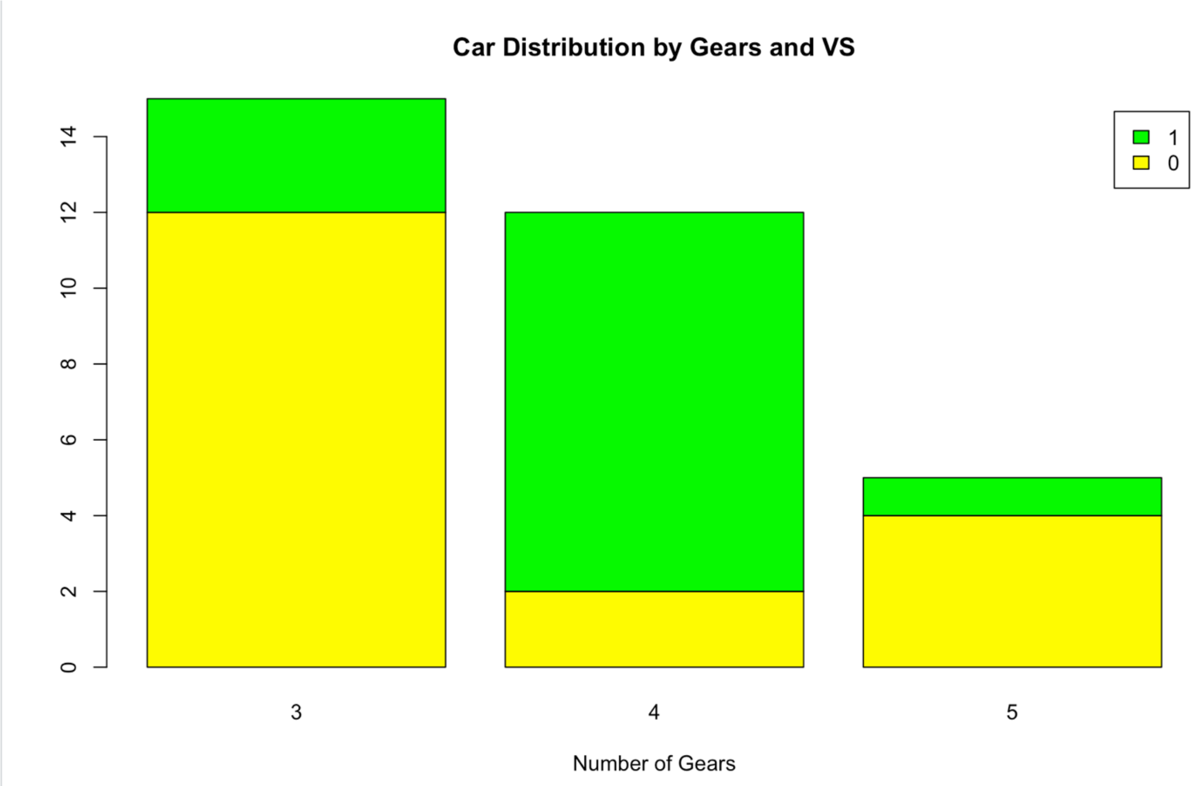
```
# Simple Bar Plot
counts <- table(mtcars$gear)
barplot(counts, main="Car Distribution",
   xlab="Number of Gears")
```



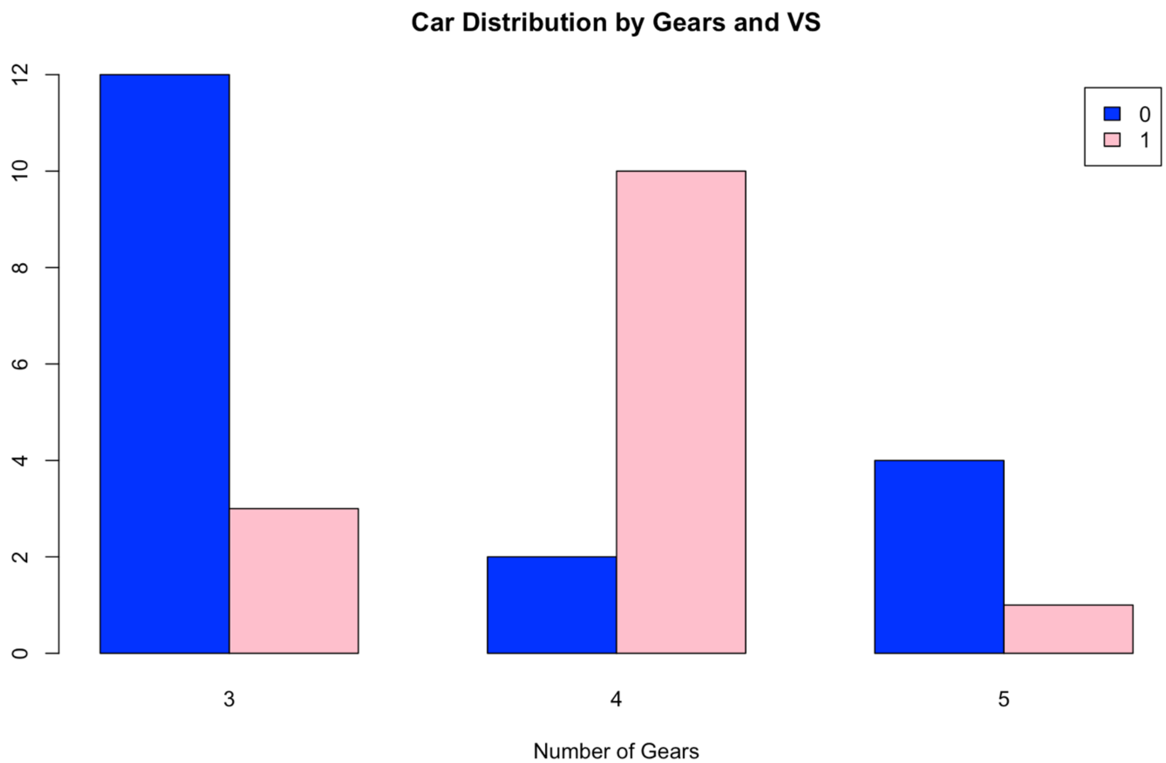

```
# Simple Horizontal Bar Plot with Added Labels
counts <- table(mtcars$gear)
barplot(counts, main="Car Distribution", horiz=TRUE,
  names.arg=c("3 Gears", "4 Gears", "5 Gears"))
```



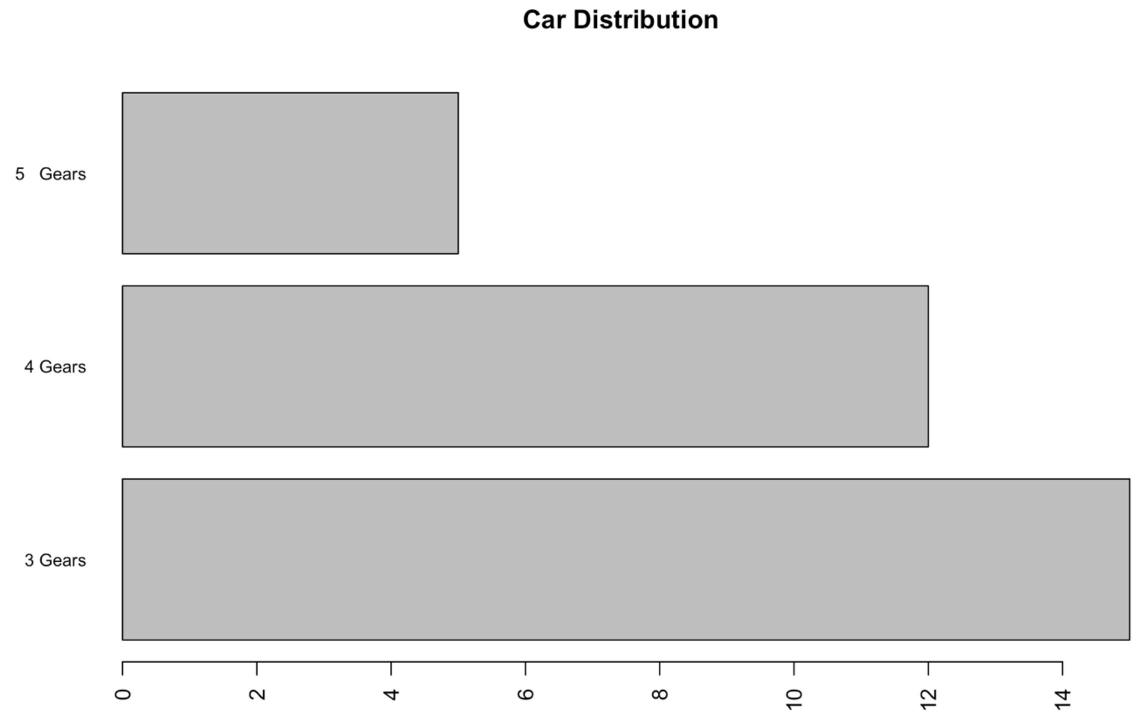

```
# Stacked Bar Plot with Colors and Legend
counts <- table(mtcars$vs, mtcars$gear)
barplot(counts, main="Car Distribution by Gears and VS",
  xlab="Number of Gears", col=c("yellow","green"),
  legend = rownames(counts))
```




```
# Grouped Bar Plot
counts <- table(mtcars$vs, mtcars$gear)
barplot(counts, main="Car Distribution by Gears and VS",
  xlab="Number of Gears", col=c("blue","pink"),
  legend = rownames(counts), beside=TRUE)
```




```
# Fitting Labels
par(las=2) # make label text perpendicular to axis
par(mar=c(5,8,4,2)) # increase y-axis margin.

counts <- table(mtcars$gear)
barplot(counts, main="Car Distribution", horiz=TRUE,
names.arg=c("3 Gears", "4 Gears", "5   Gears"), cex.names=0.8)
```



5. Line Chart

Line charts are created with the function `lines(x, y,type=)` where *x* and *y* are numeric vectors of `(x,y)` points to connect. `type=` can take the following values:

type	description
p	points
l	lines
o	overplotted points and lines
b, c	points (empty if "c") joined by lines
s, S	stair steps
h	histogram-like vertical lines
n	does not produce any points or lines

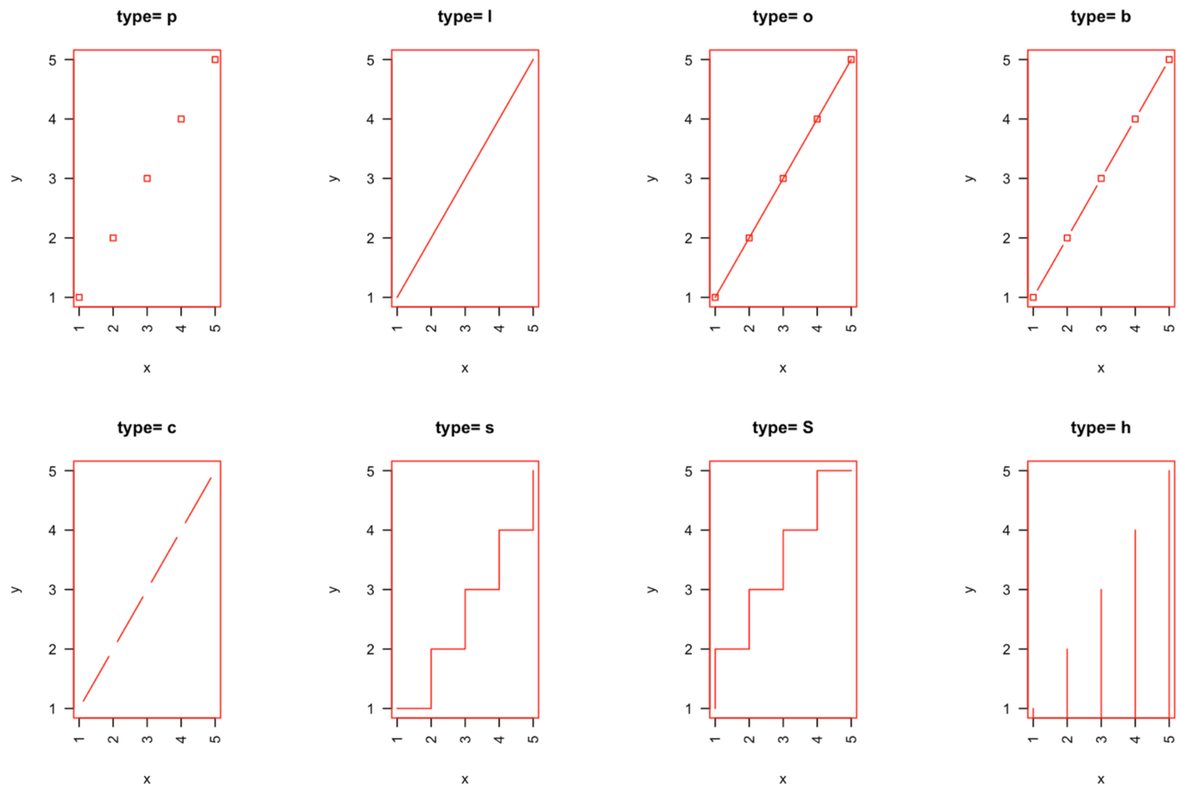
The `lines()` function *adds* information to a graph. It cannot produce a graph on its own. Usually it follows a `plot(x,y)` command that produces a graph.

By default, `plot()` plots the (x,y) points. Use the `type="n"` option in the `plot()` command, to create the graph with axes, titles, etc., but *without* plotting the points.

Example

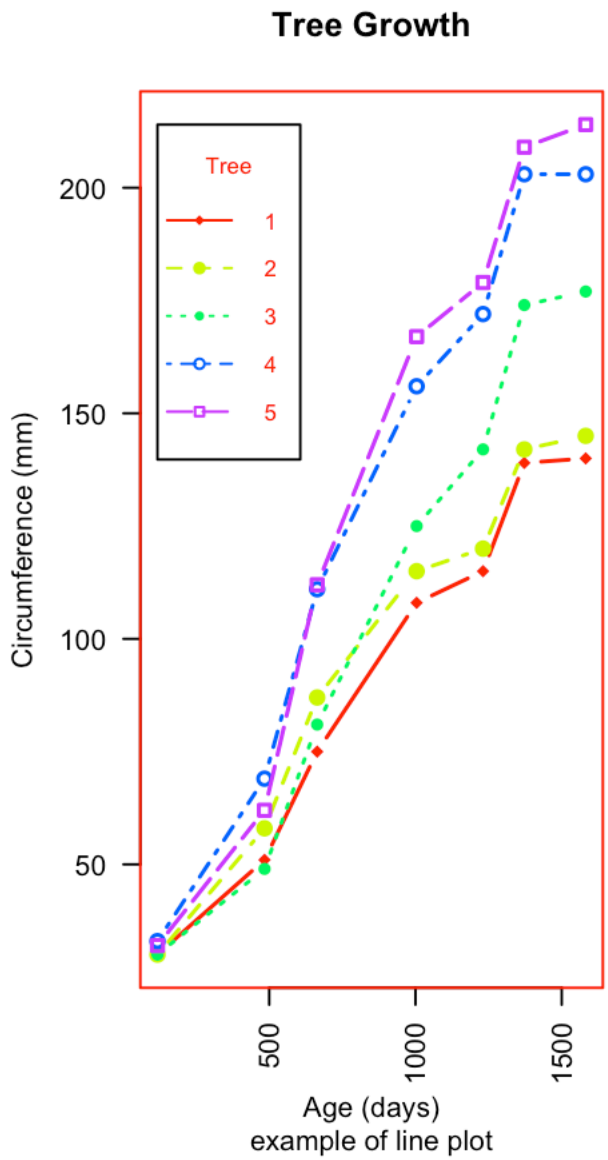
```
x <- c(1:5); y <- x # create some data
par(pch=22, col="red") # plotting symbol and color
par(mfrow=c(2,4)) # all plots on one page
```

```
opts = c("p","l","o","b","c","s","S","h")
for(i in 1:length(opts)){
  heading = paste("type=",opts[i])
  plot(x, y, type="n", main=heading)
  lines(x, y, type=opts[i])
}
```



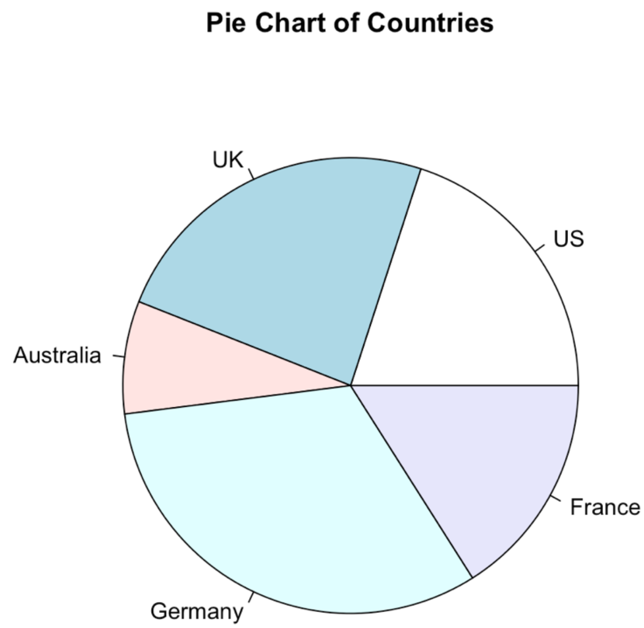

```
# Create Line Chart

# convert factor to numeric for convenience
Orange$Tree <- as.numeric(Orange$Tree)
ntrees <- max(Orange$Tree)

# get the range for the x and y axis
xrange <- range(Orange$age)
yrange <- range(Orange$circumference)

# set up the plot
plot(xrange, yrange, type="n", xlab="Age (days)",
   ylab="Circumference (mm)" )
colors <- rainbow(ntrees)
linetype <- c(1:ntrees)
plotchar <- seq(18,18+ntrees,1)

# add lines
for (i in 1:ntrees) {
```

```
  tree <- subset(Orange, Tree==i)
  lines(tree$age, tree$circumference, type="b", lwd=1.5,
    lty=linetype[i], col=colors[i], pch=plotchar[i])
}

# add a title and subtitle
title("Tree Growth", "example of line plot")

# add a legend
legend(xrange[1], yrange[2], 1:ntrees, cex=0.8, col=colors,
   pch=plotchar, lty=linetype, title="Tree")
```

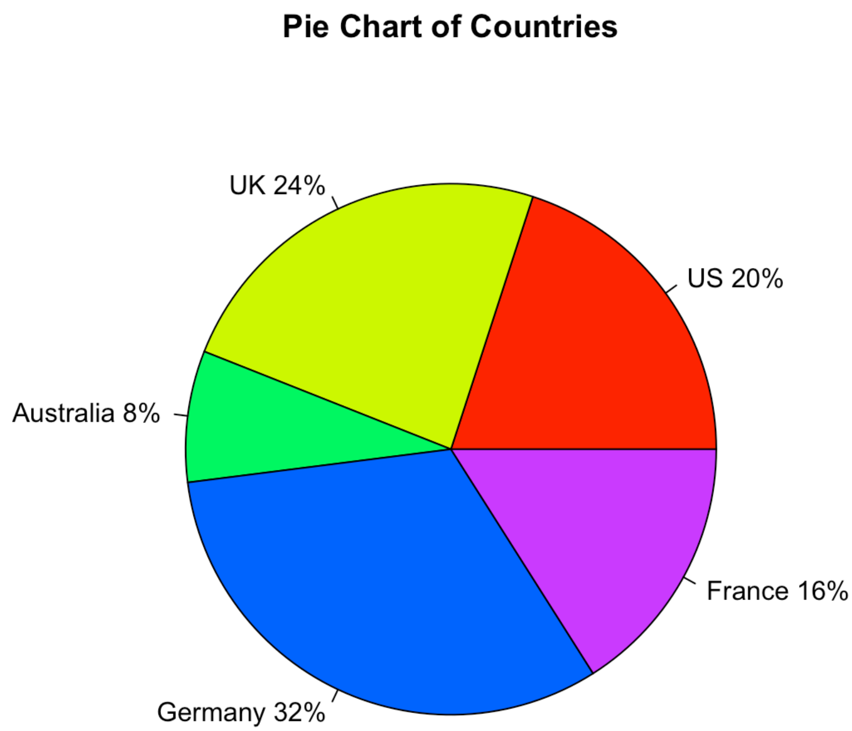


7. Pie Chart

```
# Simple Pie Chart
slices <- c(10, 12,4, 16, 8)
lbls <- c("US", "UK", "Australia", "Germany", "France")
pie(slices, labels = lbls, main="Pie Chart of Countries")
```

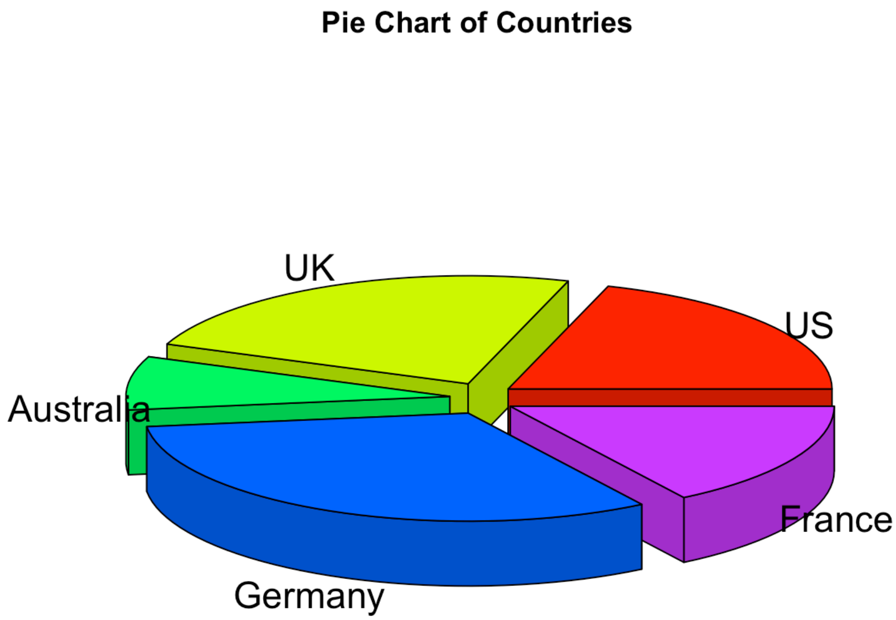



```
# Pie Chart with Percentages
slices <- c(10, 12, 4, 16, 8)
lbls <- c("US", "UK", "Australia", "Germany", "France")
pct <- round(slices/sum(slices)*100)
lbls <- paste(lbls, pct) # add percents to labels
lbls <- paste(lbls,"%",sep="") # ad % to labels
pie(slices,labels = lbls, col=rainbow(length(lbls)),
   main="Pie Chart of Countries")
```

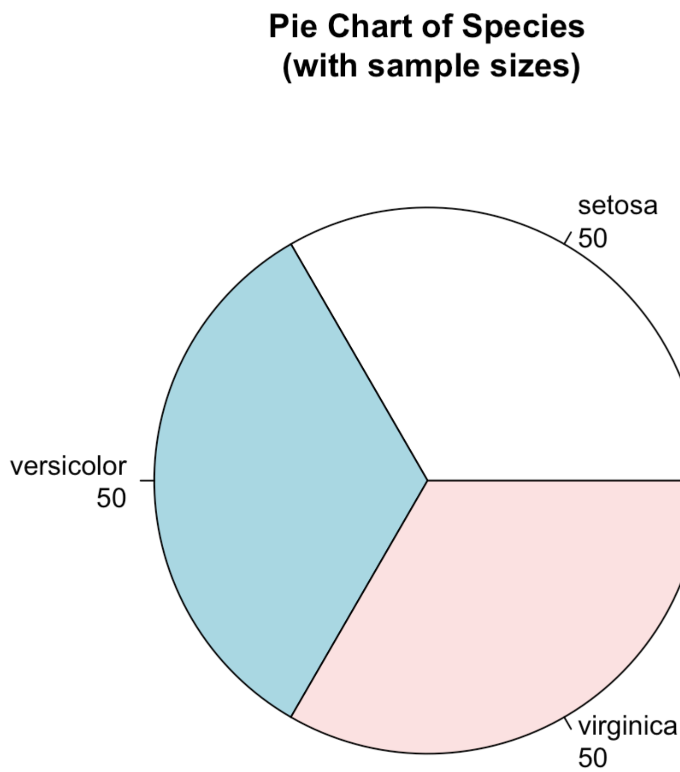


3D Exploded Pie Chart

```
>install.packages("plotrix")
> library(plotrix)
> slices <- c(10, 12, 4, 16, 8)
> lbls <- c("US", "UK", "Australia", "Germany", "France")
> pie3D(slices,labels=lbls,explode=0.1,
+       main="Pie Chart of Countries ")
```

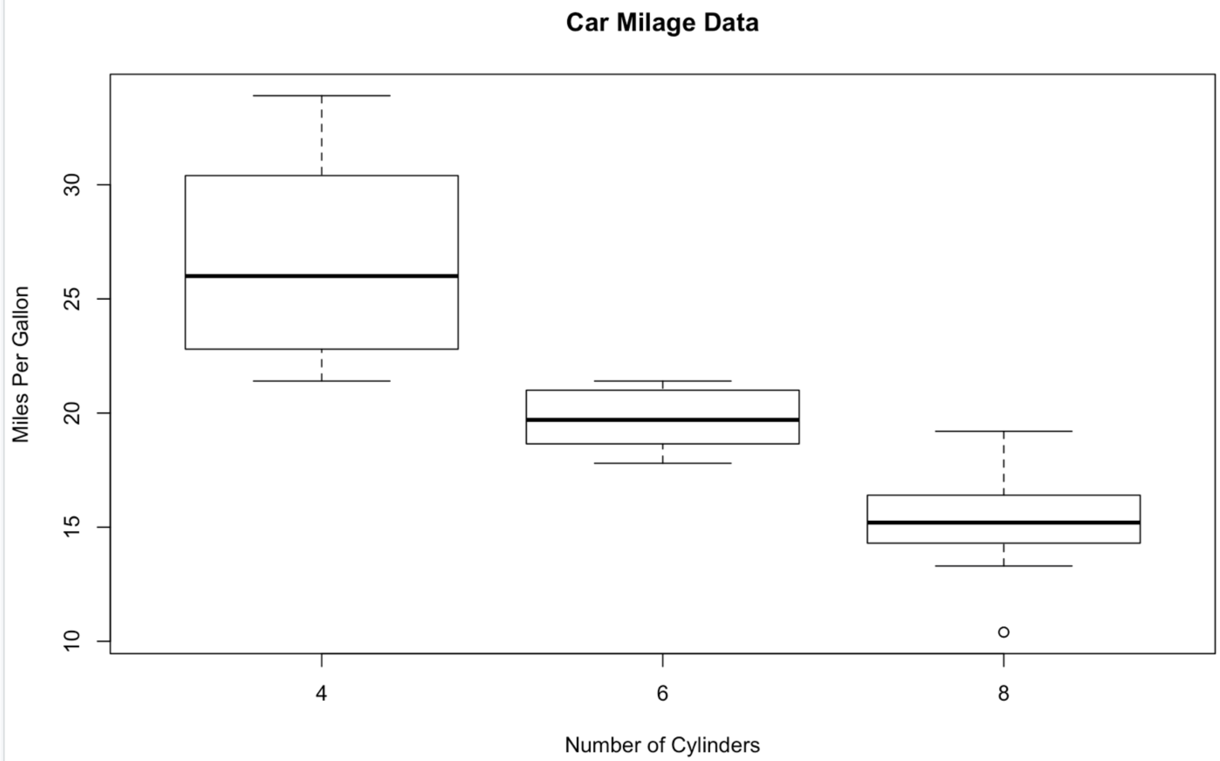



```
# Pie Chart from data frame with Appended Sample Sizes
mytable <- table(iris$Species)
lbls <- paste(names(mytable), "\n", mytable, sep="")
pie(mytable, labels = lbls,
   main="Pie Chart of Species\n (with sample sizes)")
```

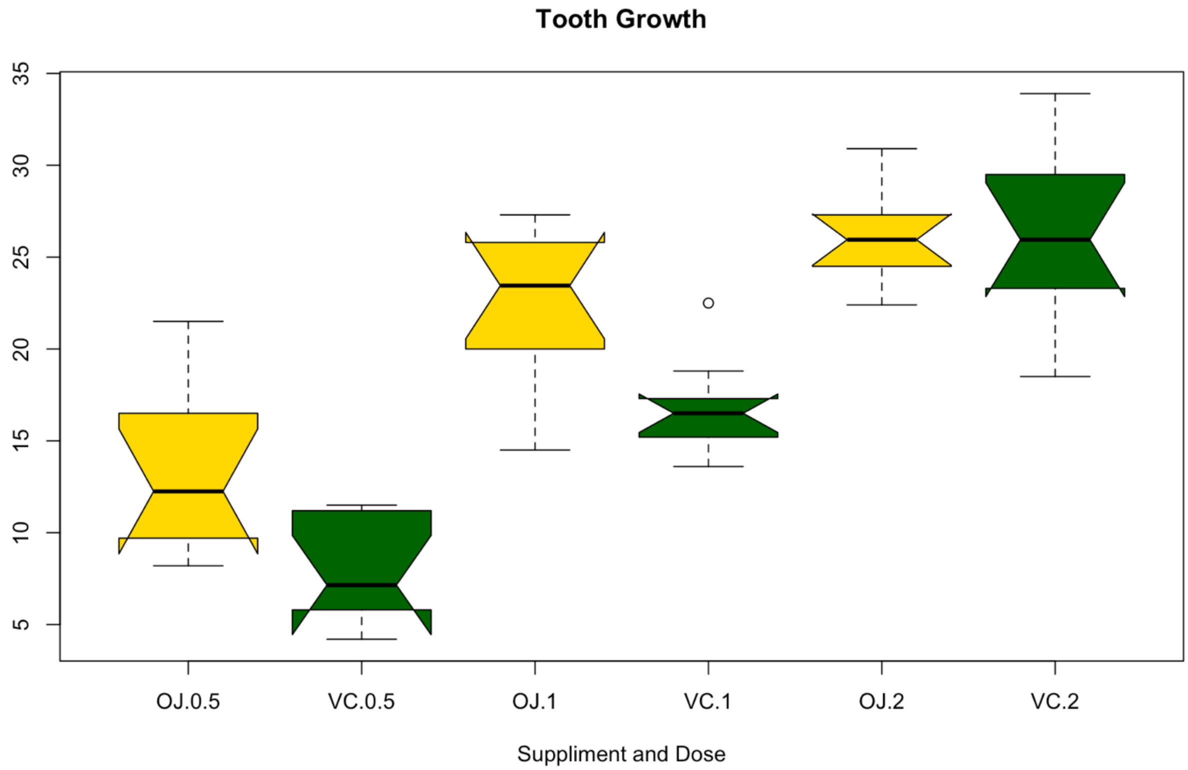


8. BoxPlot

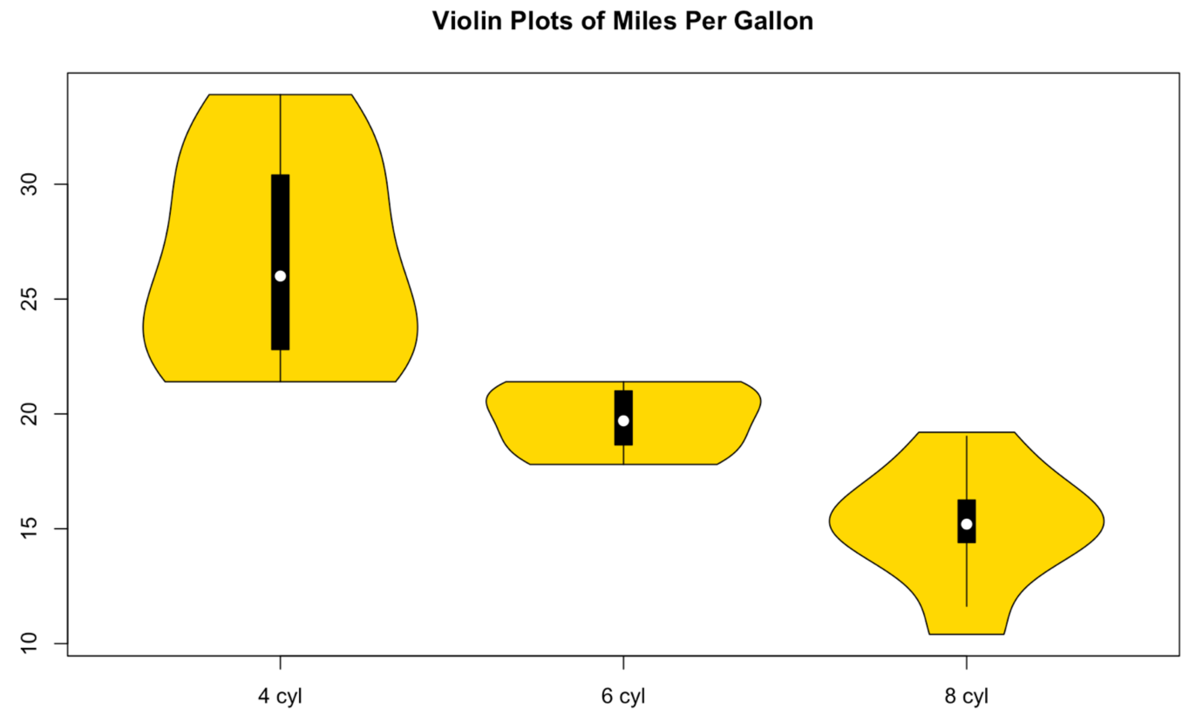
```
# Boxplot of MPG by Car Cylinders
boxplot(mpg~cyl,data=mtcars, main="Car Milage Data",
   xlab="Number of Cylinders", ylab="Miles Per Gallon")
```



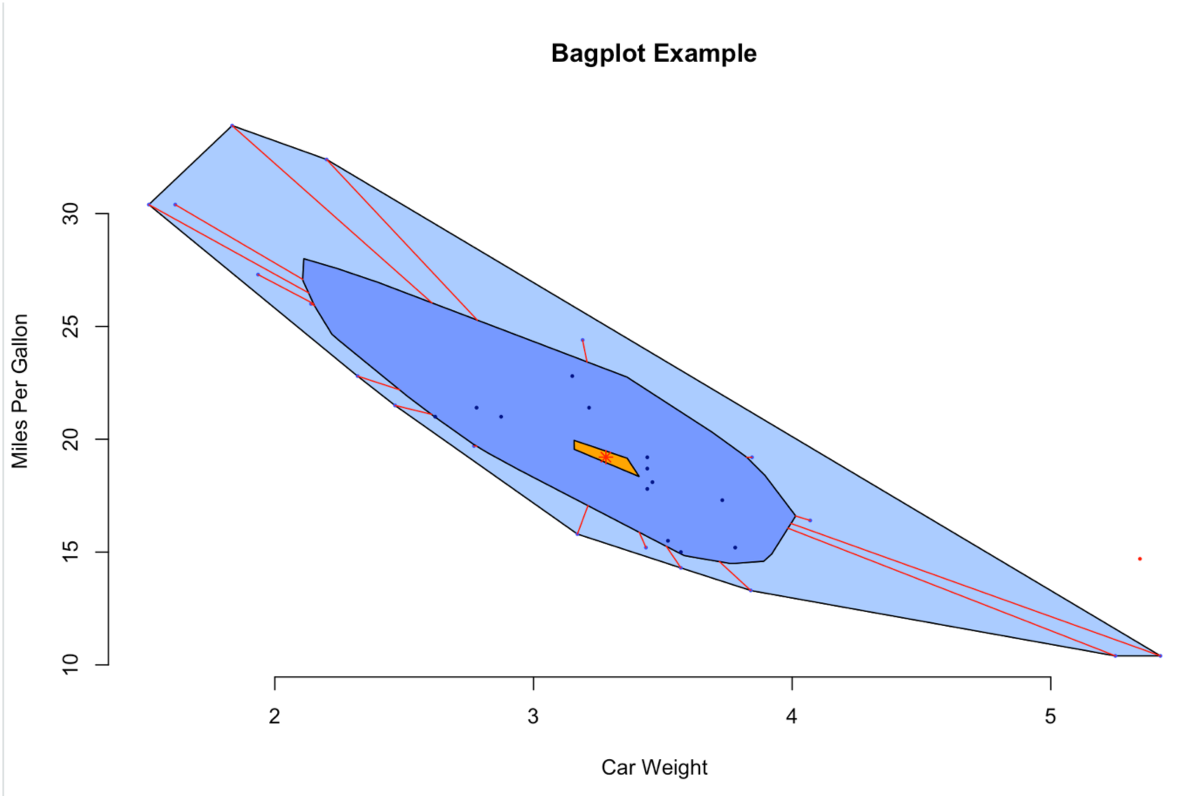

```
# Notched Boxplot of Tooth Growth Against 2 Crossed Factors
# boxes colored for ease of interpretation
boxplot(len~supp*dose, data=ToothGrowth, notch=TRUE,
  col=(c("gold","darkgreen")),
  main="Tooth Growth", xlab="Suppliment and Dose")
```




```
# Violin Plots
install.packages("vioplot")
library(vioplot)
x1 <- mtcars$mpg[mtcars$cyl==4]
x2 <- mtcars$mpg[mtcars$cyl==6]
x3 <- mtcars$mpg[mtcars$cyl==8]
vioplot(x1, x2, x3, names=c("4 cyl", "6 cyl", "8 cyl"),
   col="gold")
title("Violin Plots of Miles Per Gallon")
```

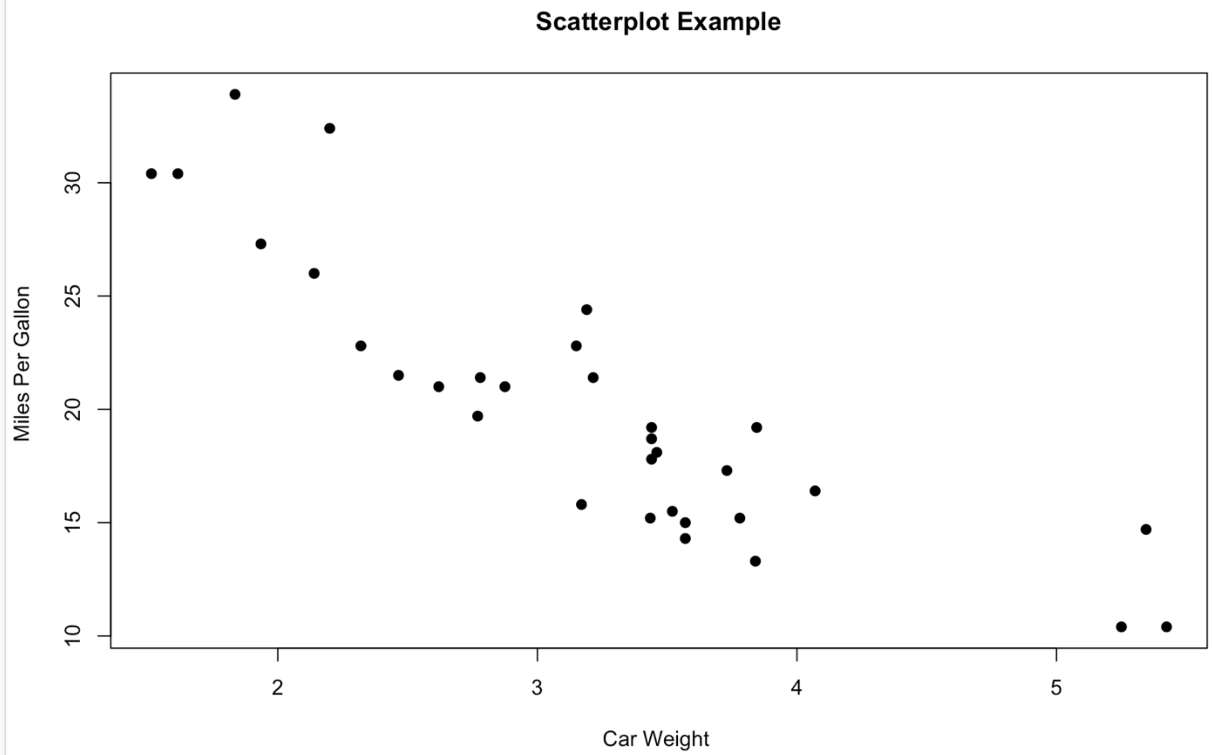



```
# Example of a Bagplot
  install.packages("aplpack")
  library(aplpack)
  attach(mtcars)
  bagplot(wt,mpg, xlab="Car Weight", ylab="Miles Per Gallon",
    main="Bagplot Example")
```

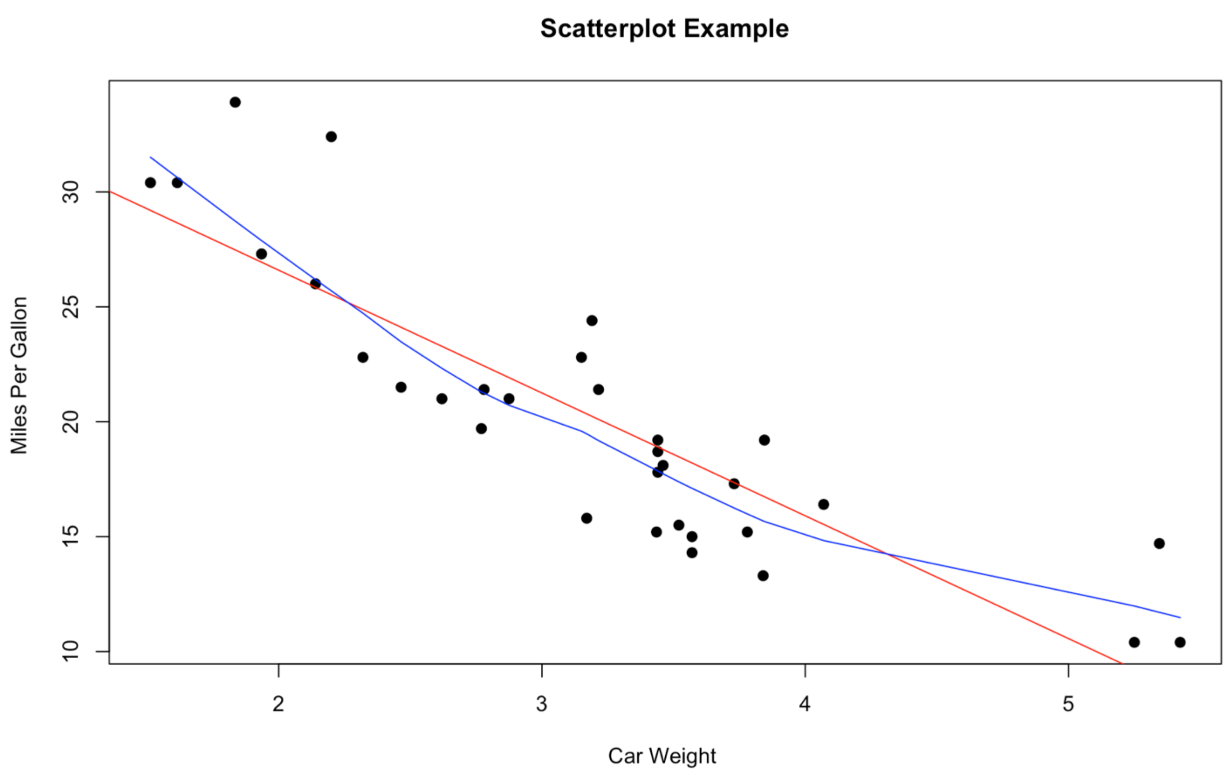


9. Scatterplot

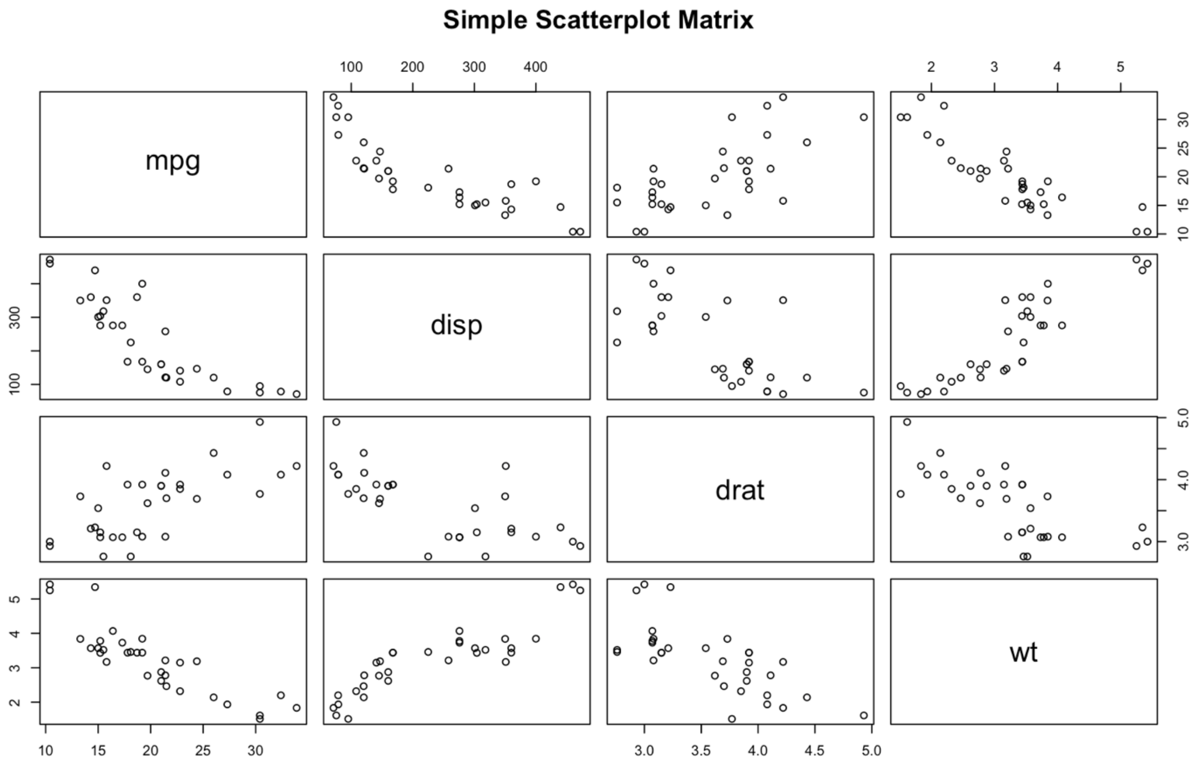
```
# Simple Scatterplot
attach(mtcars)
plot(wt, mpg, main="Scatterplot Example",
   xlab="Car Weight ", ylab="Miles Per Gallon ", pch=19)
```



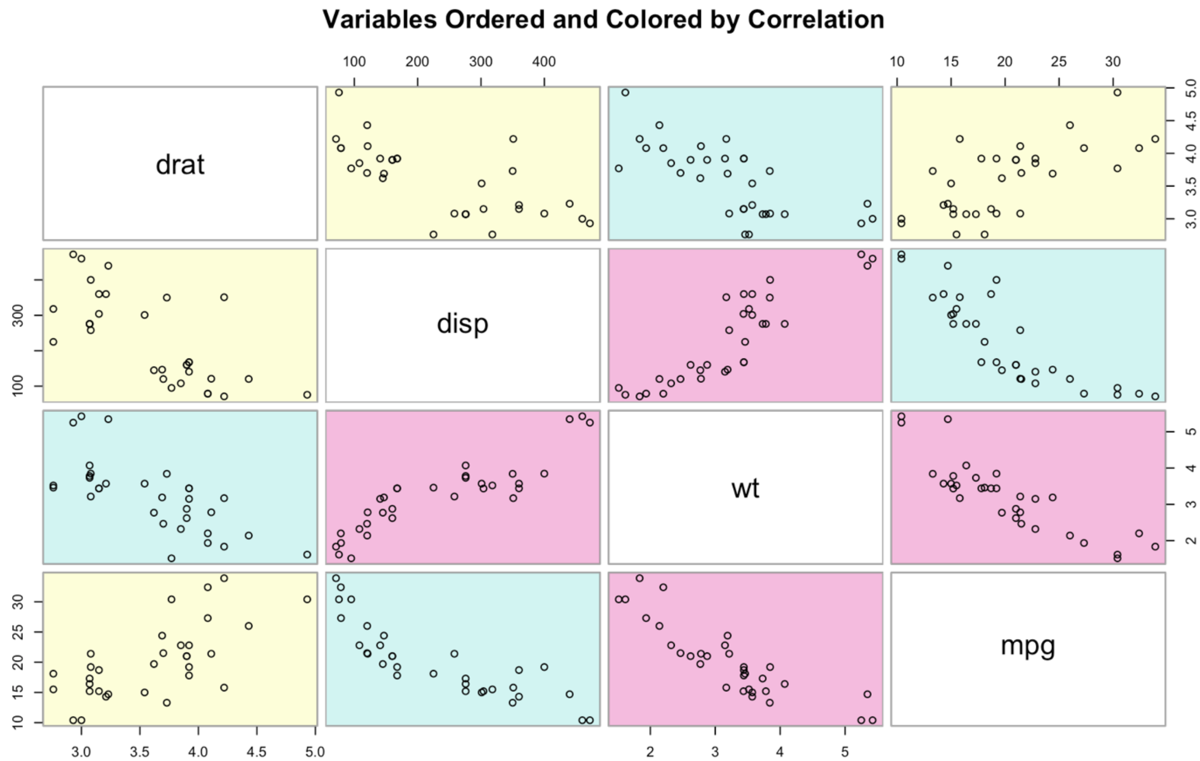

```
# Add fit lines
abline(lm(mpg~wt), col="red") # regression line (y~x)
lines(lowess(wt,mpg), col="blue") # lowess line (x,y)
```



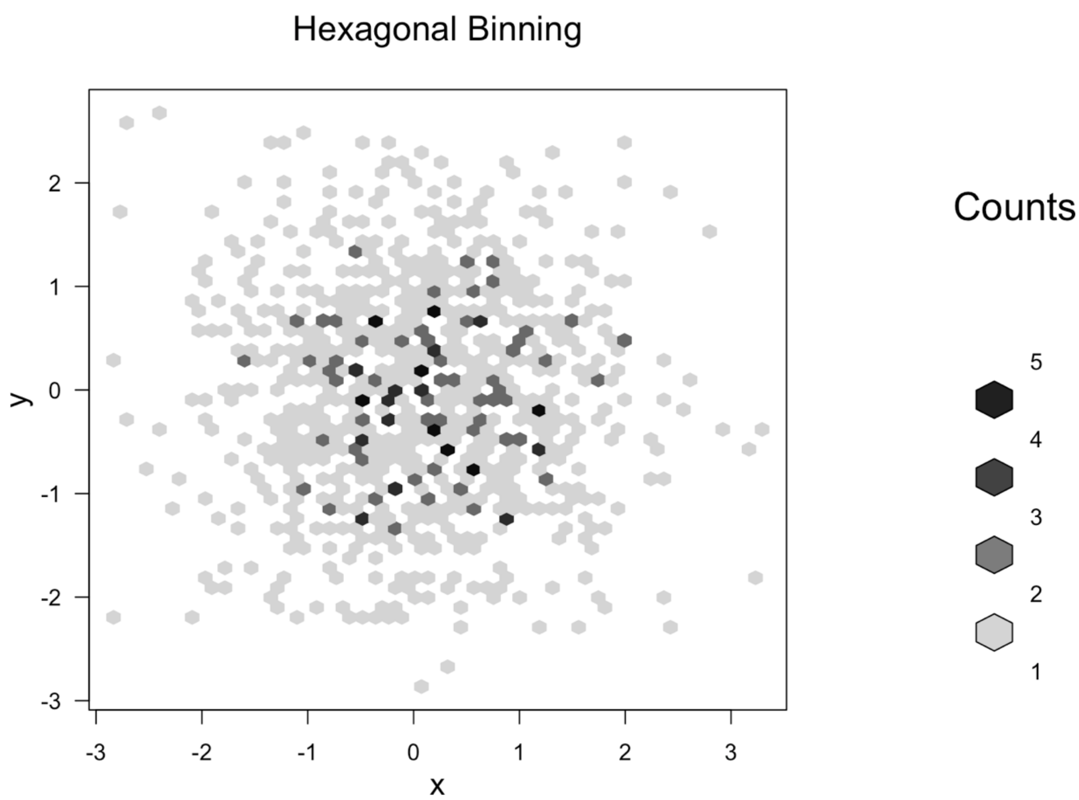
```
# Basic Scatterplot Matrix
pairs(~mpg+disp+drat+wt,data=mtcars,
   main="Simple Scatterplot Matrix")
```



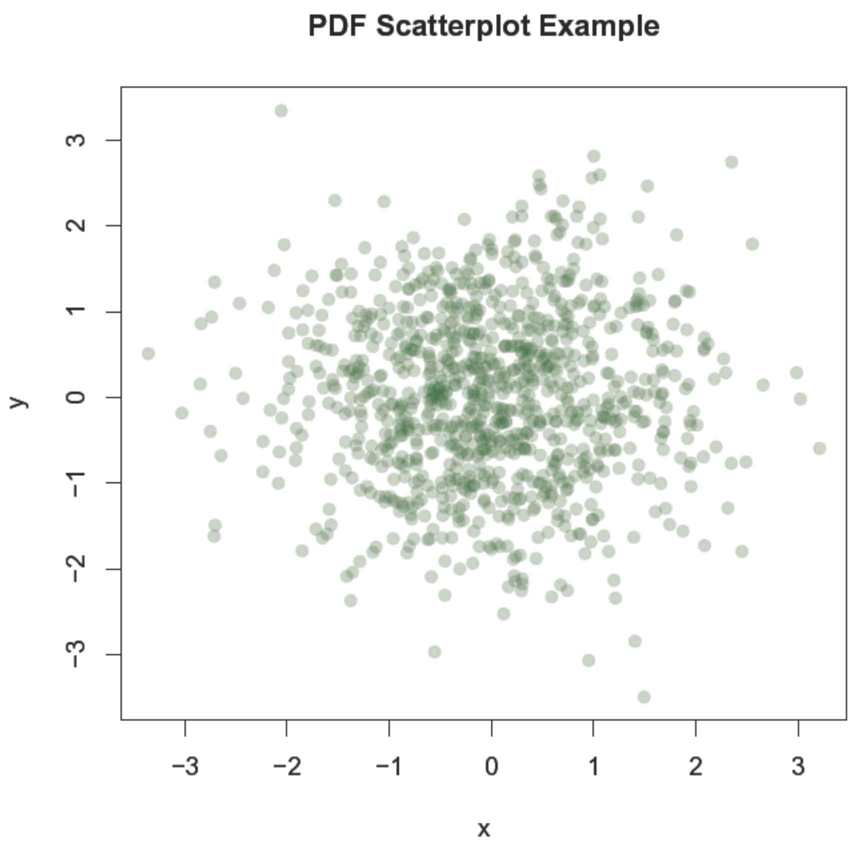

```
# Scatterplot Matrices from the glus Package
install.packages("gclus")
library(gclus)
dta <- mtcars[c(1,3,5,6)] # get data
dta.r <- abs(cor(dta)) # get correlations
dta.col <- dmat.color(dta.r) # get colors
# reorder variables so those with highest correlation
# are closest to the diagonal
dta.o <- order.single(dta.r)
cpairs(dta, dta.o, panel.colors=dta.col, gap=.5,
main="Variables Ordered and Colored by Correlation" )
```



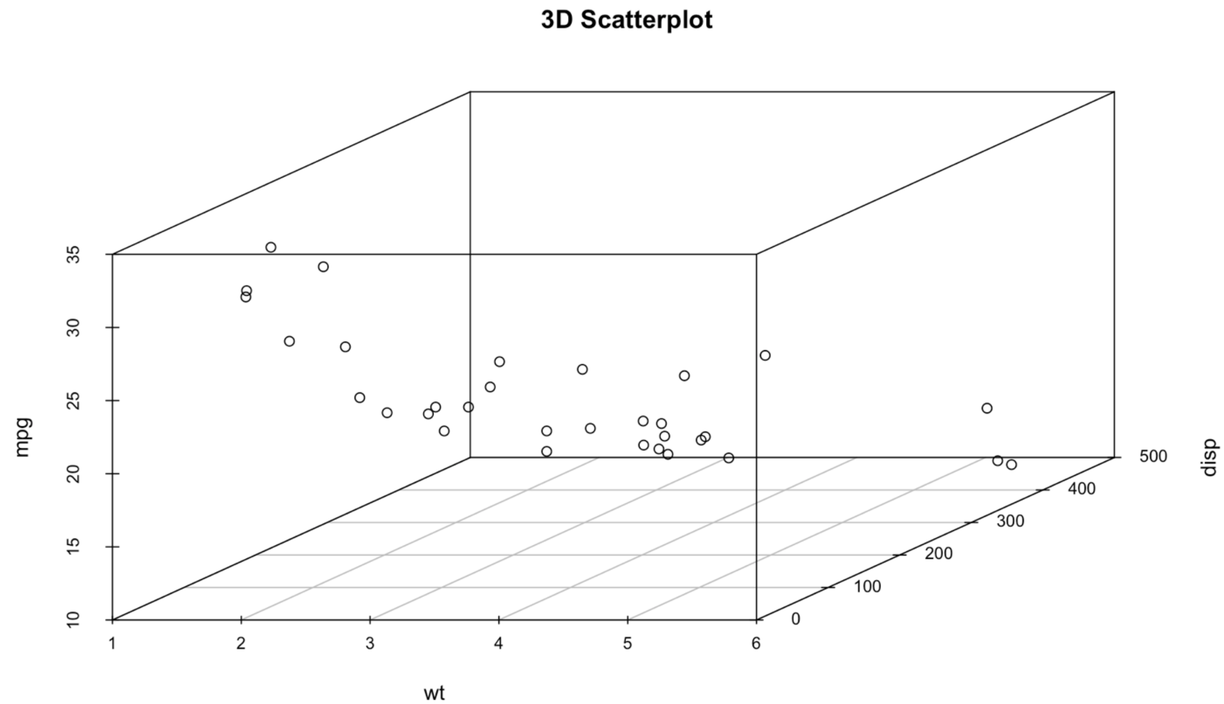

```
# High Density Scatterplot with Binning
install.packages("hexbin")
library(hexbin)
x <- rnorm(1000)
y <- rnorm(1000)
bin<-hexbin(x, y, xbins=50)
plot(bin, main="Hexagonal Binning")
```



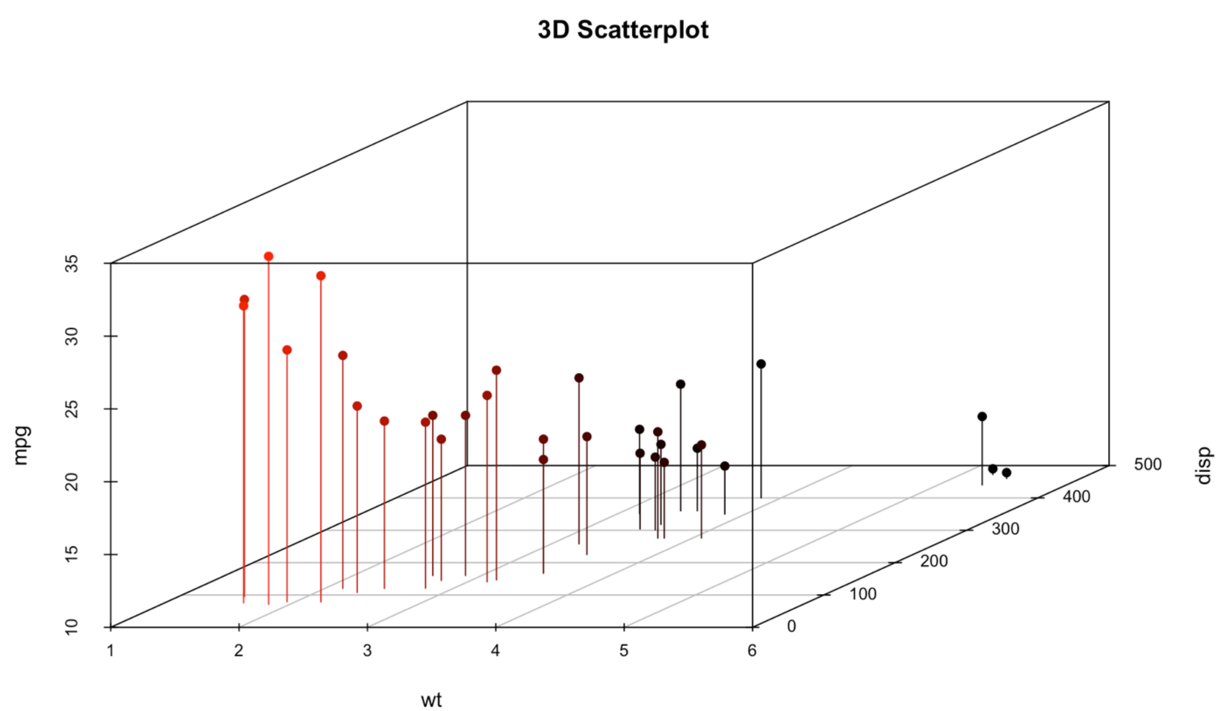

```
# High Density Scatterplot with Color Transparency

pdf("c:/scatterplot.pdf") //file location

x <- rnorm(1000)

y <- rnorm(1000)

plot(x,y, main="PDF Scatterplot Example",

col=rgb(0,100,0,50,maxColorValue=255), pch=16)
```



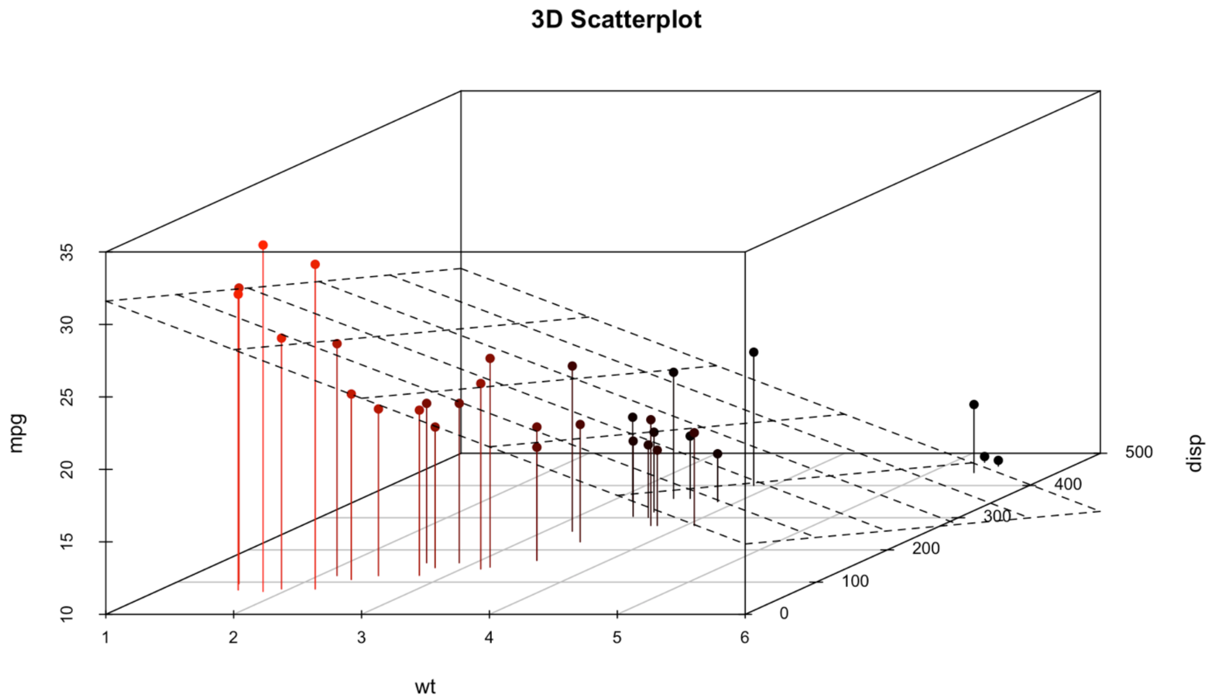

```
# 3D Scatterplot
install.packages("scatterplot3d")
library(scatterplot3d)
attach(mtcars)
scatterplot3d(wt,disp,mpg, main="3D Scatterplot")
```



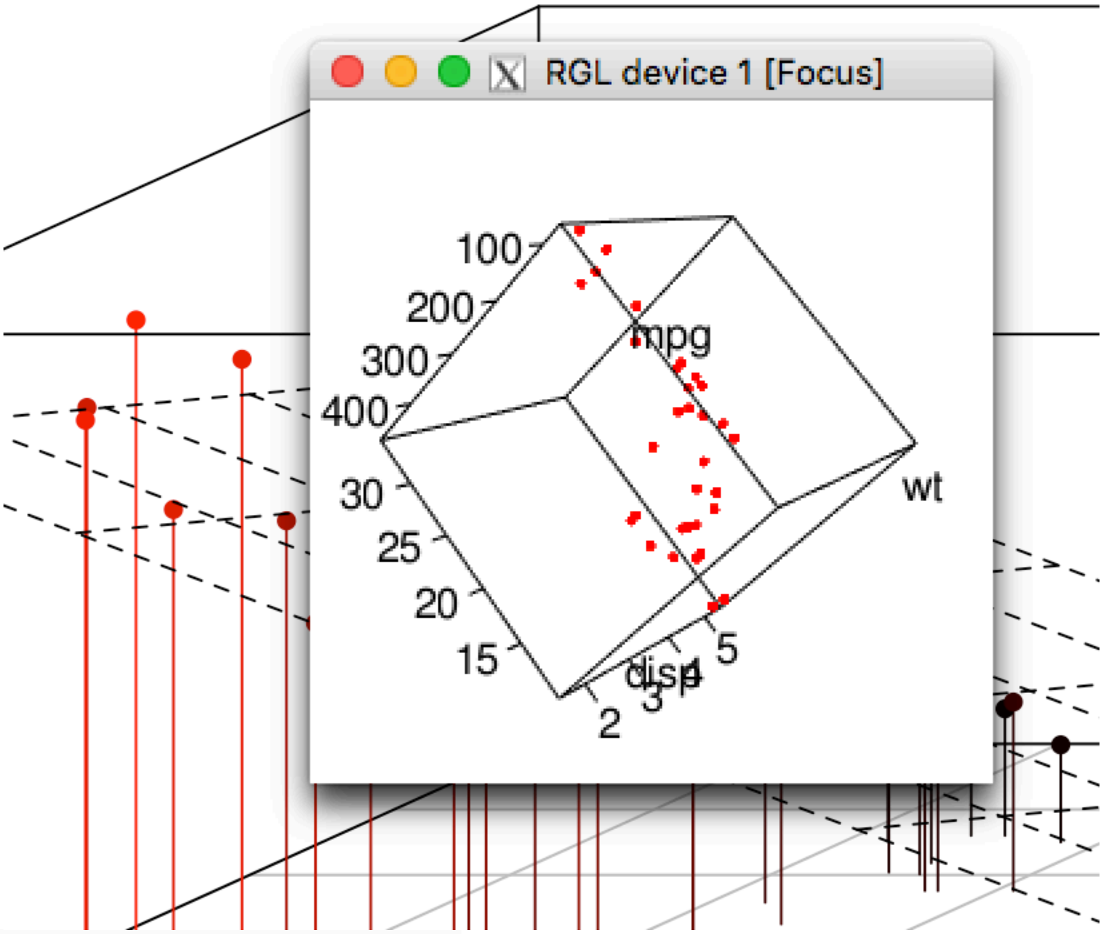

```
# 3D Scatterplot with Coloring and Vertical Drop Lines
library(scatterplot3d)
attach(mtcars)
scatterplot3d(wt,disp,mpg, pch=16, highlight.3d=TRUE,
  type="h", main="3D Scatterplot")
```



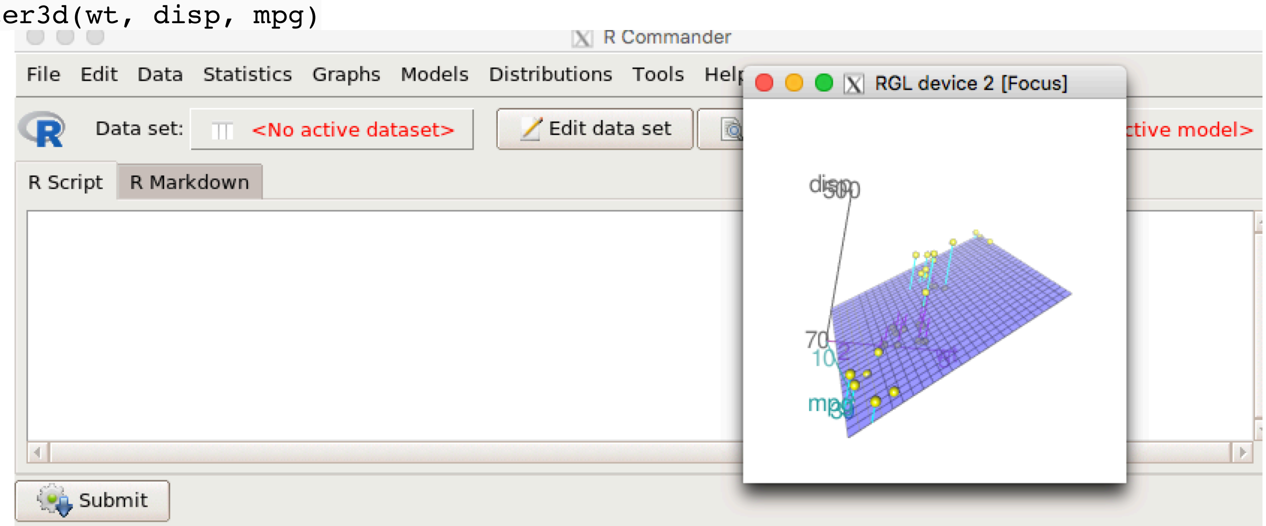
```
# 3D Scatterplot with Coloring and Vertical Lines
# and Regression Plane
library(scatterplot3d)
attach(mtcars)
s3d <-scatterplot3d(wt,disp,mpg, pch=16, highlight.3d=TRUE,
  type="h", main="3D Scatterplot")
fit <- lm(mpg ~ wt+disp)
s3d$plane3d(fit)
```




```
# Spinning 3d Scatterplot
Install.packages("rgl")
library(rgl)
plot3d(wt, disp, mpg, col="red", size=3)
```




```
# Another Spinning 3d Scatterplot
install.packages("Rcmdr")
library(Rcmdr)
attach(mtcars)
scatter3d(wt, disp, mpg)
```



Reading files in R

Importing data into R is fairly simple. For Stata and Systat, use the foreign package. For SPSS and SAS I would recommend the Hmisc package for ease and functionality. See the Quick-R section on packages, for information on obtaining and installing the these packages. Example of importing data are provided below.

CSV

```
# first row contains variable names, comma is separator
# assign the variable id to row names
# note the / instead of \ on mswindows systems

mydata <- read.table("c:/mydata.csv", header=TRUE,
   sep=",", row.names="id")
```

Excel

One of the best ways to read an Excel file is to export it to a comma delimited file and import it using the method above. Alternatively you can use the **xlsx** package to access Excel files. The first row should contain variable/column names.

```
# read in the first worksheet from the workbook myexcel.xlsx
# first row contains variable names
library(xlsx)
mydata <- read.xlsx("c:/myexcel.xlsx", 1)

# read in the worksheet named mysheet
mydata <- read.xlsx("c:/myexcel.xlsx", sheetName = "mysheet")
```

SPSS

```
# save SPSS dataset in trasport format
get file='c:\mydata.sav'.
export outfile='c:\mydata.por'.

# in R
library(Hmisc)
mydata <- spss.get("c:/mydata.por", use.value.labels=TRUE)
# last option converts value labels to R factors
```

SAS

```
# save SAS dataset in trasport format
libname out xport 'c:/mydata.xpt';
data out.mydata;
set sasuser.mydata;
run;

# in R
library(Hmisc)
mydata <- sasxport.get("c:/mydata.xpt")
# character variables are converted to R factors
```

Stata

```
# input Stata file
library(foreign)
mydata <- read.dta("c:/mydata.dta")
```

systat

```
# input Systat file
library(foreign)
mydata <- read.systat("c:/mydata.dta")
```

END OF CLASS

Next Class:

1. Descriptive Statistics
2. Frequencies and Crosstabs
3. Correlations
4. t-tests
5. Nonparametric Tests of Group Differences
6. Multiple (Linear) Regression

7. Regression Diagnostics
8. ANOVA/MANOVA
9. (M)ANOVA Assumption
10. Resampling Statistics
11. Power analysis
12. Using with() and by()