Data Visualization Using R

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Outline

Introduction

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- Data in spreadsheets is hard to visualize.
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- Data visualization makes interpretation easier.

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- The current R is the result of a collaborative effort with contributions from all over the world.
- Developed by Ross Ihaka and Robert Gentelman at University of Auckland.
- Highly extensible and flexible.
- Implementation of modern statistical methods.

Graphics in R

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- Huge number of R packages for graphics are available
- R Graphs can be viewed on screen
- R graphs can be saved in various formats like pdf/png/jpg/wmf/tiff/ps etc.

Graphical Environments in R

Graphical Environments in R

Core - Overview

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Low-Level Graphics

Graphical Environments in R

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Low-Level Graphics

- Base graphics

Graphical Environments in R

Cytel

Low-Level Graphics

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- Grid graphics

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Graphical Environments in R

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- lattice

Graphical Environments in R

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High-Level Graphics

- lattice
- ggplot2

Base graphics

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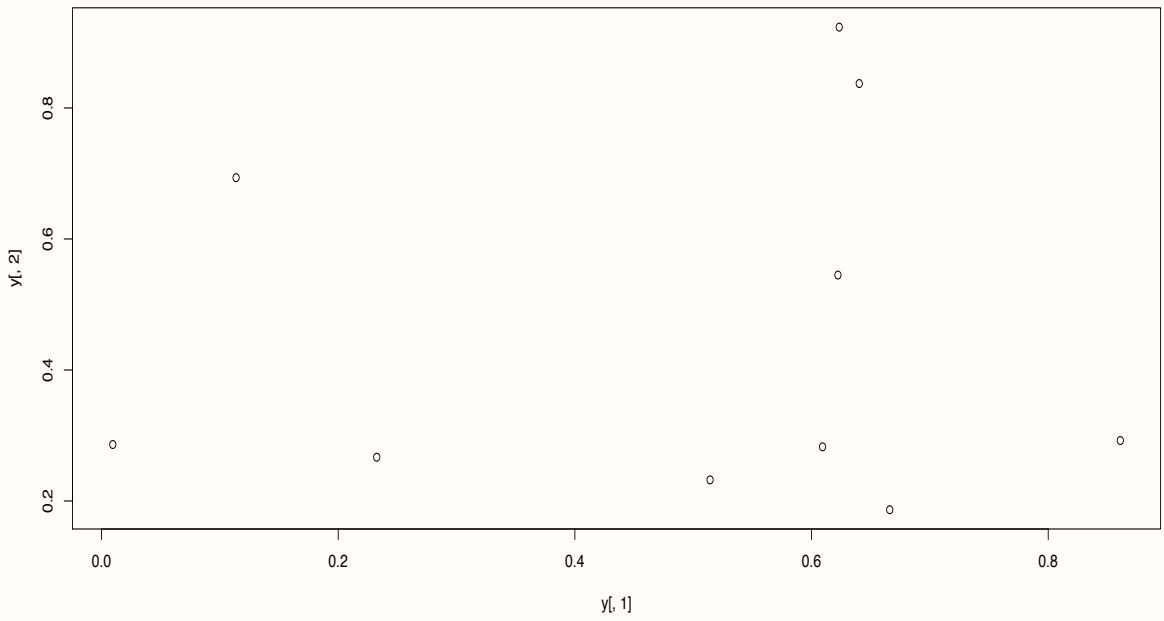
Plotting functions:

- plot - x-y plotting
- barplot - bar plots
- boxplot - box & whisker plot
- hist - histogram
- pie - pie charts
- dotchart - dot plots
- image, heatmap, contour, persp - functions to generate image like plots
- qqnorm, qqline, qqplot - distribution comparison plots
- pairs, coplot - display of multivariate data

Scatter plot: Basic

R code

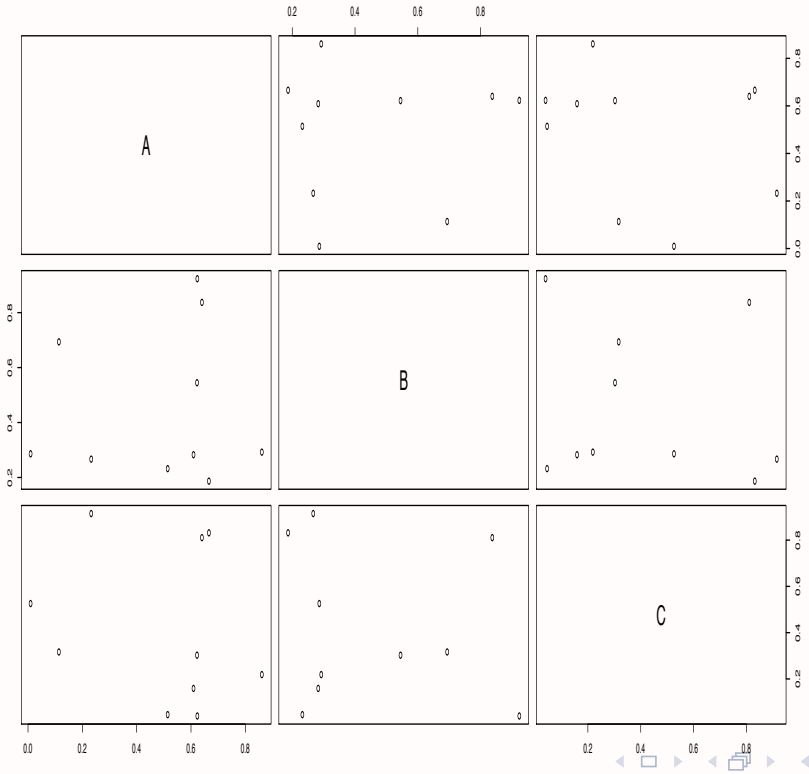
```
>  set.seed(1234)
> y <- matrix(runif(30), ncol=3, dimnames=list(letters[1:10], LETTERS[1:3]))
> plot(y[,1], y[,2])
```



Scatter plot: Pairs

R code

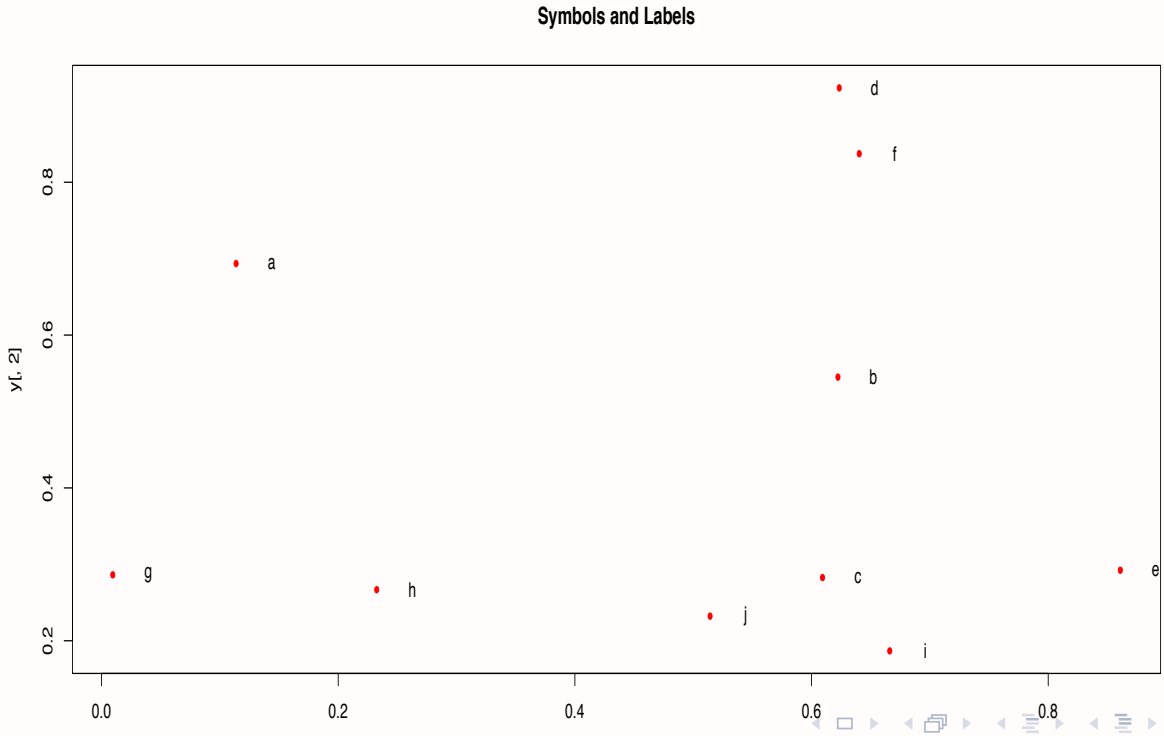
```
> pairs(y)
```



Scatter plot: with label

R code

```
> plot(y[,1], y[,2], pch=20, col="red", main="Symbols and Labels")
> text(y[,1]+0.03, y[,2], rownames(y))
```



Scatter plot: More Examples

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Using important plotting parameters

```
> grid(5, 5, lwd = 2)
> op <- par(mar=c(8,8,8,8), bg="lightblue")
> plot(y[,1], y[,2], type="p", col="red", cex.lab=1.2, cex.axis=1.2,
+ cex.main=1.2, cex.sub=1, lwd=4, pch=20, xlab="x label",
+ ylab="y label", main="My Main", sub="My Sub")
> par(op)
```

Used arguments

```
mar- species the margin sizes around the plotting area: c(bottom,left, top, right)
col- color of symbols
pch- type of symbols, samples: example(points)
lwd- size of symbols
cex.- control font sizes
```

Scatter plot: More examples

Adding a regression line

```
> plot(y[,1], y[,2])
> myline <- lm(y[,2]~y[,1]); abline(myline, lwd=2)
> summary(myline)
```

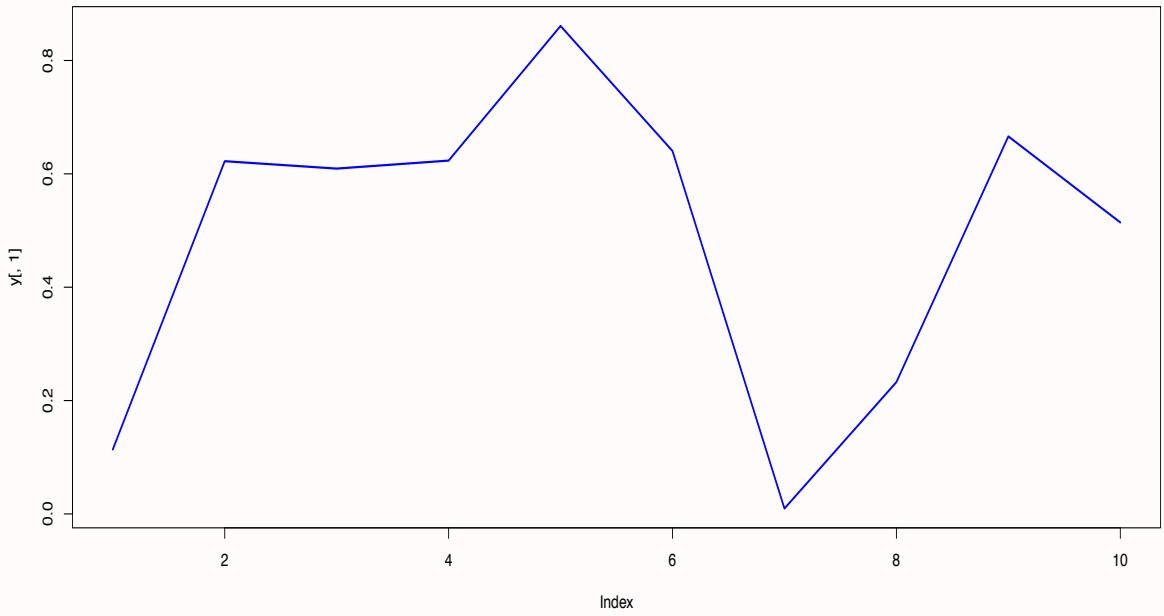
Plot on log scale

```
> plot(y[,1], y[,2], log="xy")
```

Line plot

R code

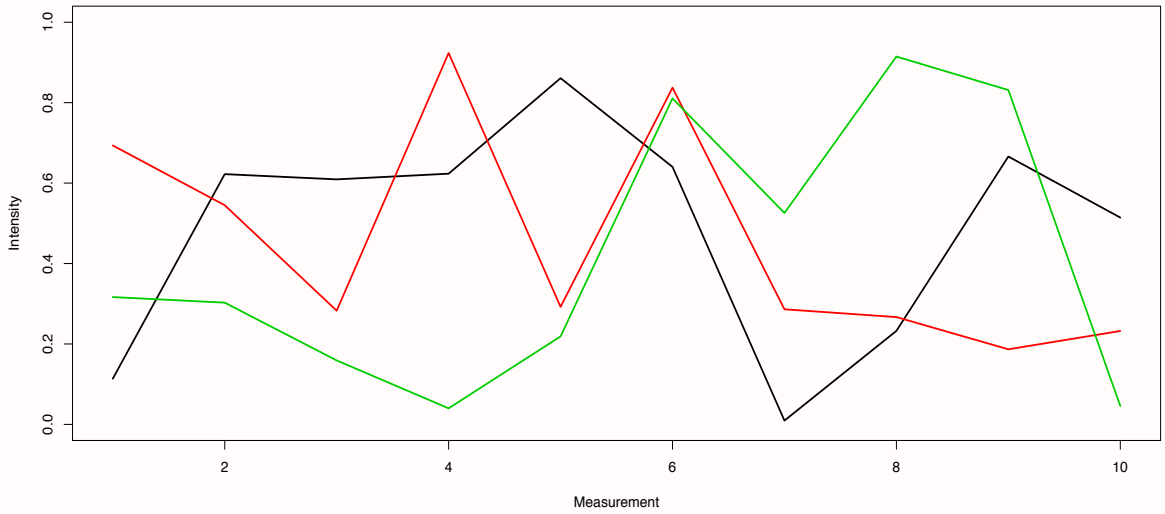
```
> plot(y[,1], type="l", lwd=2, col="blue")
```



Line plot with multiple variables

R code

```
> plot(y[,1], ylim=c(0,1),xlab="Measurement",ylab="Intensity",type="l",lwd=2,col=1)
> for(i in 2:length(y[1,])) {
+ screen(1, new=FALSE)
+ plot(y[,i], ylim=c(0,1), type="l", lwd=2, col=i, xaxt="n", yaxt="n", ylab="",
+ xlab="", main="", bty="n")
+ }
```



More Functions in Base graphics

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Graph Type	R function

More Functions in Base graphics

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Graph Type	R function
• Barplot	• barplot

More Functions in Base graphics

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Barplot	barplot
Histogram	hist

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Graph Type	R function
Barplot	barplot
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Graph Type	R function
Barplot	barplot
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Pie Chart	pie

Grid Graphics Environment

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What is grid?

- Low-level graphics system
- Highly exible and controllable system
- Does not provide high-level functions
- Intended as development environment for custom plotting functions
- Pre-installed on new R distributions

Lattice

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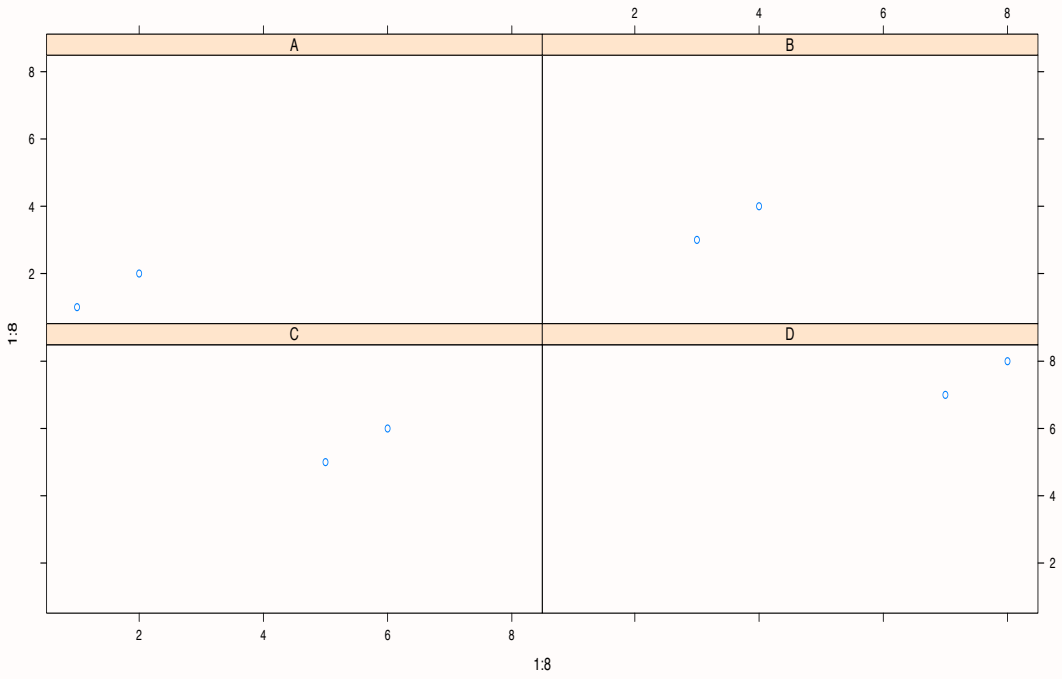
What is lattice?

- High-level graphics system
- Developed by Deepayan Sarkar
- Implements Trellis graphics system from S-Plus
- Simplies high-level plotting tasks, arranging complex graphical features
- Syntax similar to R's base graphics

Lattice plot example

R code

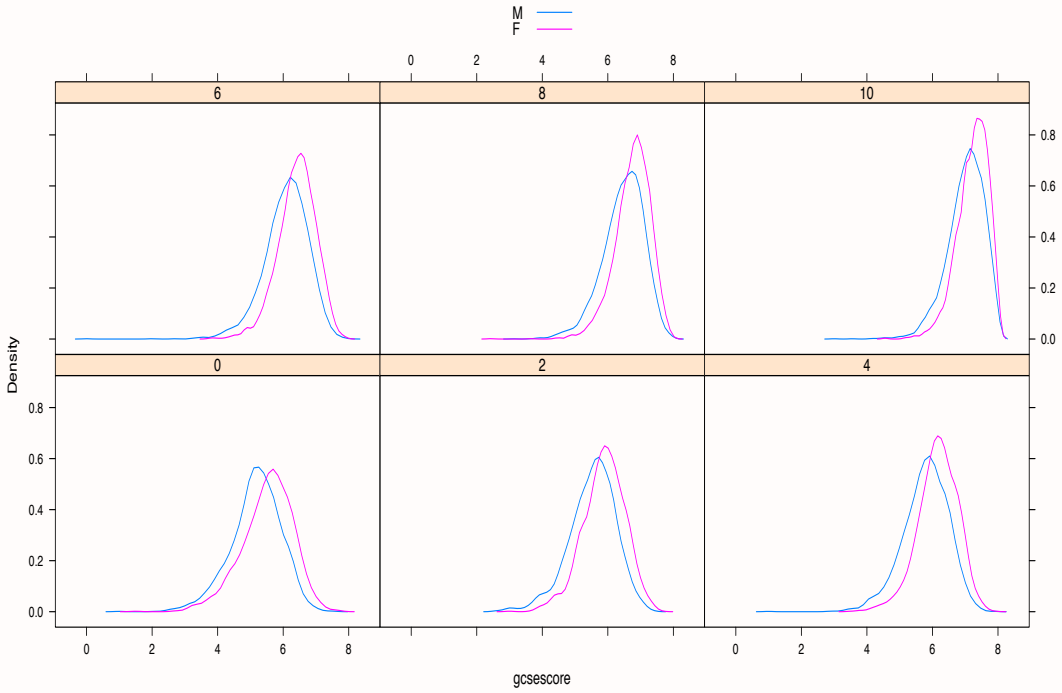
```
> library(lattice)
> p1 <- xyplot(1:8 ~ 1:8 | rep(LETTERS[1:4], each=2), as.table=TRUE)
> plot(p1)
```



Lattice plot: Density plot

R code

```
> data(Chem97, package = "mlmRev")
> densityplot(~ gcsescore | factor(score),data= Chem97, groups = gender,
+ plot.points = FALSE, auto.key = TRUE)
```



ggplot2

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What is ggplot2?

- High-level graphics system
- Implements grammar of graphics from Leland Wilkinson
- Streamlines many graphics workows for complex plots
- Syntax centered around main ggplot function
- Simpler qplot function provides many shortcuts
- ggplot function accepts two arguments (1)Data set to be plotted (2)Aesthetic mappings provided by aes function

qplot function

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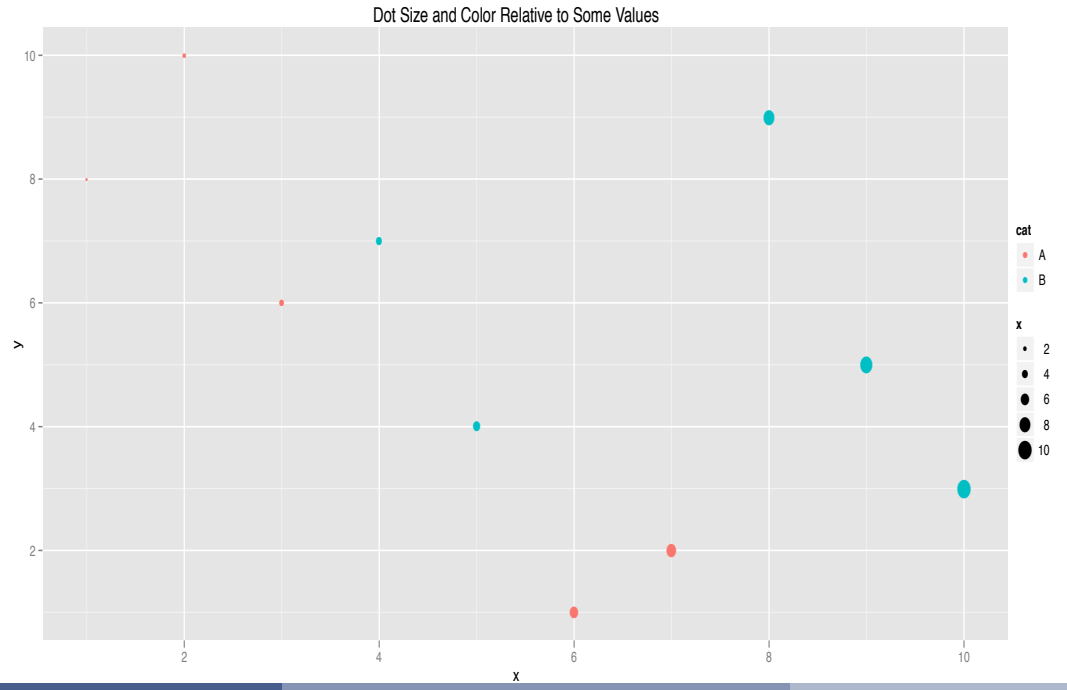
- qplot syntax is similar to R's basic plot function
- Arguments:
  - x: x-coordinates (e.g. col1)
  - y: y-coordinates (e.g. col2)
  - data: data frame with corresponding column names
  - xlim, ylim: e.g. xlim=c(0,10)
  - log: e.g. log="x" or log="xy"
  - main: main title; see ?plotmath for mathematical formula
  - xlab, ylab: labels for the x- and y-axes
  - color, shape, size
  - ...: many arguments accepted by plot function

qplot: Scatterplot

R code

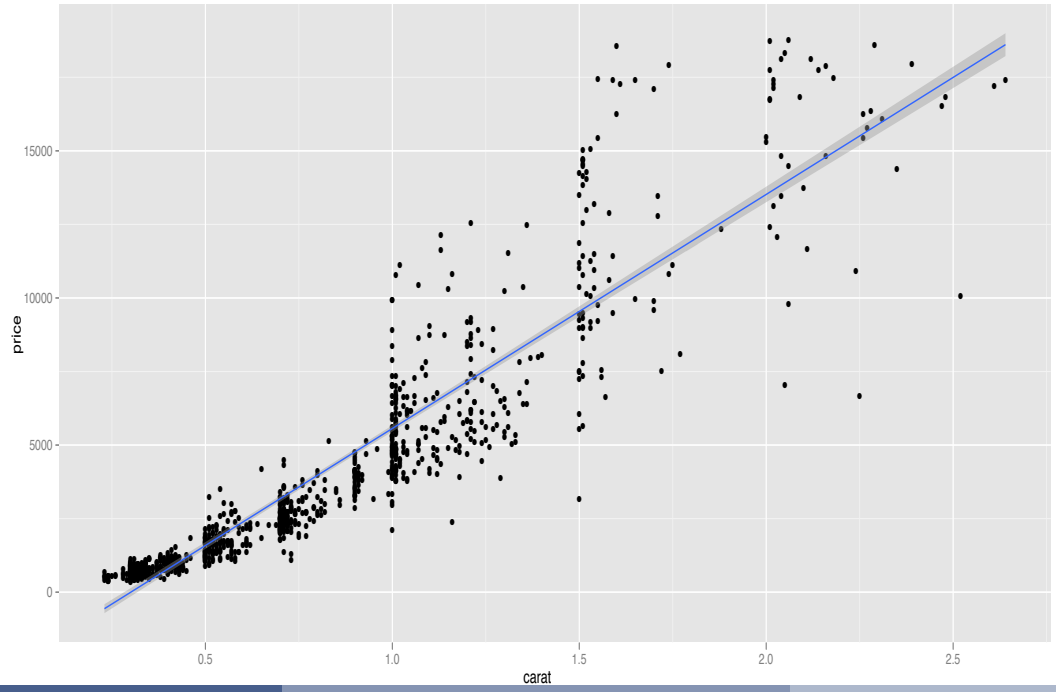
```
> p <- qplot(x, y, geom="point", size=x, color=cat,
+ main="Dot Size and Color Relative to Some Values") +
+ theme(legend.position = "none")
> print(p)
```



qplot:Scatterplot with Regression Line

R code

```
> set.seed(1234)
> dsmall <- diamonds[sample(nrow(diamonds), 1000), ]
> p <- qplot(carat, price,data = dsmall,geom = c("point", "smooth"),method= "lm")
> print(p)
```



ggplot: Scatterplot

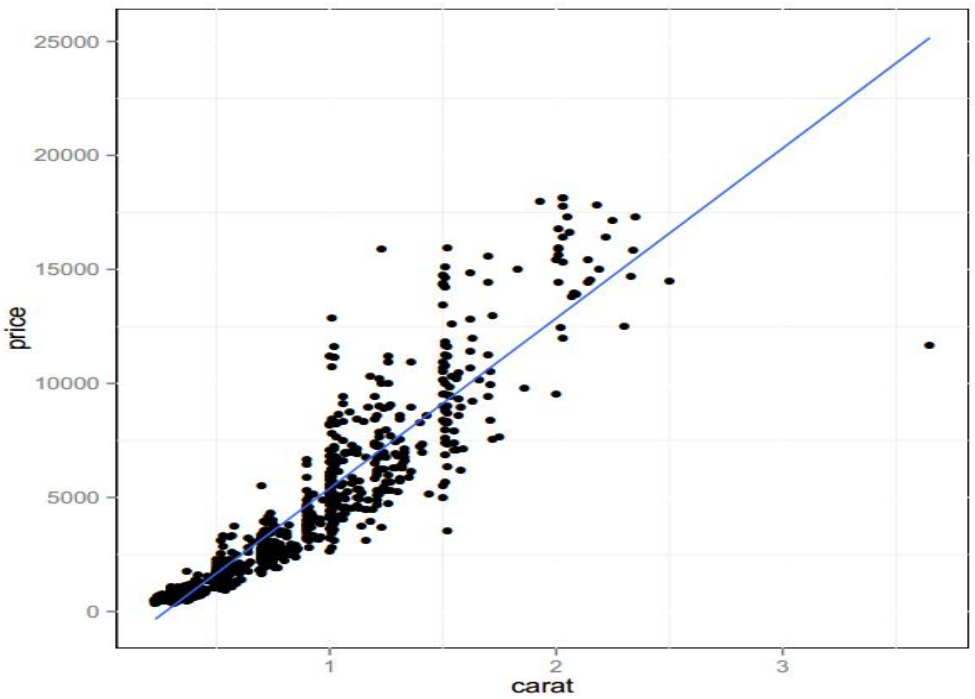
R code

```
> p <- ggplot(dsmall, aes(carat, price, color=color)) + geom_point(size=4)
> print(p)
```

ggplot: Scatterplot with Regression Line

R code

```
> p <- ggplot(dsmall, aes(carat, price, color=color)) + geom_point(size=4)
> print(p)
```



ggplot: Jitter Plot

R code

```
> p <- ggplot(dsmall, aes(color, price/carat)) +
+ geom_jitter(alpha = I(1 / 2), aes(color=color))
>  print(p)
```

Multiple Figures in Single Panel

- Requirement - Multiple figures in a single panel

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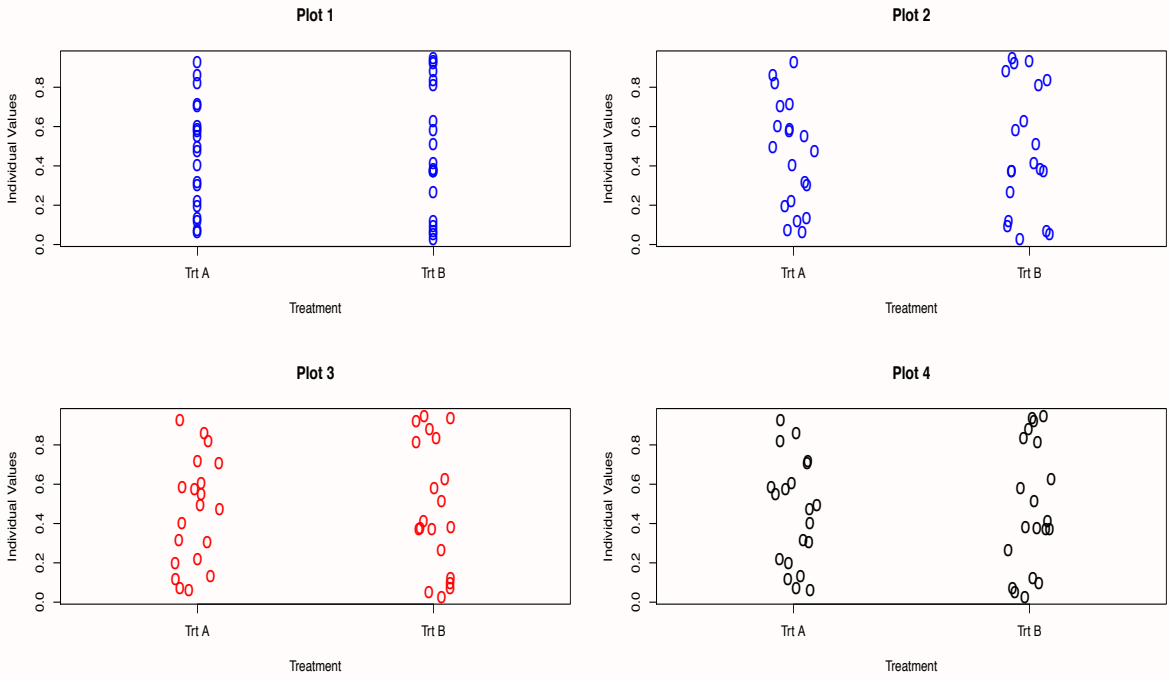


Multiple graphs in Single Panel

R Code

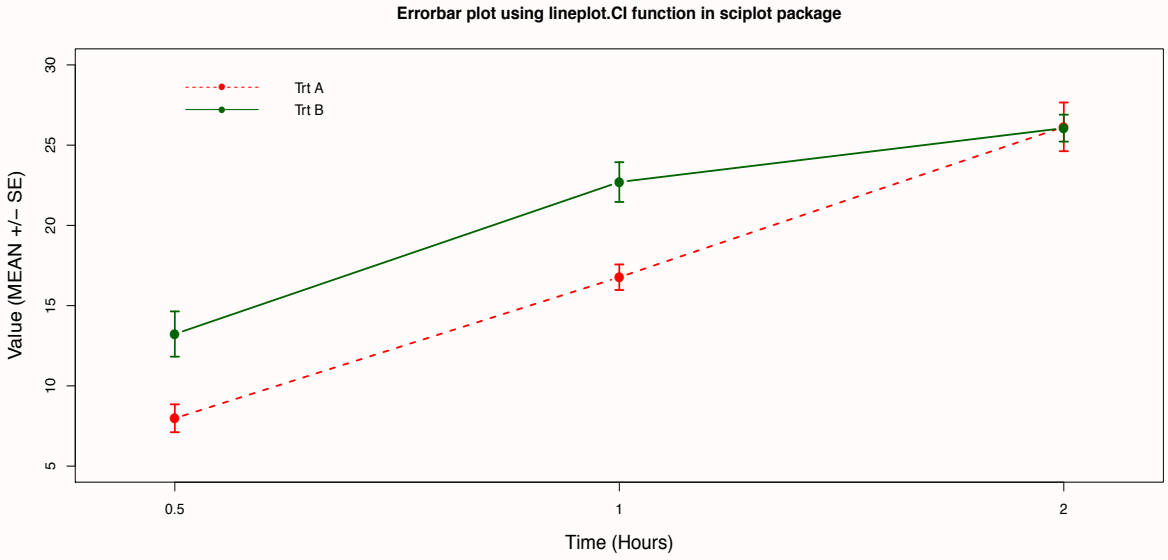
```
pdf("D:/Example1.pdf")
par(mfrow=c(2,2)) # Divide the plotting area

#<Code for Plot 1>
plot(b,a, xaxt = 'n', xlab = 'Treatment',ylab = 'Individual Values',
xlim=c(1,5),main = "Plot 1",cex=1.5,col='blue', pch = 'o')
axis(1,at=c(2,4),labels = c('Trt A', 'Trt B'))
#<Code for Plot 2>
plot(jitter(b,amount=0.2),a, xaxt = 'n', xlab = 'Treatment',ylab =
'Individual Values', xlim=c(1,5),main = "Plot 2", cex=1.5,col='blue',
pch = 'o')
axis(1,at=c(2,4),labels = c('Trt A', 'Trt B'))
# <Code for Plot 3>
# <Code for Plot 4>

dev.off()
```

Errorbar Plot

- Using an inbuilt data in R named 'ToothGrowth' whose variables are renamed as rep, trt and time.
- Errorbar plot using 'lineplot.CI' from 'sciplot' package in R



Errorbar plot using sciplot package

R Code

```
lineplot.CI(time, rep, group = trt, data = tg, cex = 1.5,
  xlab = "Time (Hours)", ylab = "Value (MEAN +/- SE)",
  cex.lab = 1.3, x.leg = 1,y.leg=30,col = c("red","dark green"),
  pch = c(16,16),ylim=c(5,30), err.width = 0.05, xaxt = 'n',lwd=2)

axis(1,at=c(1,2,3),labels=c(0.5, 1, 2))

title("Errorbar plot using 'lineplot.CI' function in sciplot package")
```

Errorbar plot using ggplot2 package

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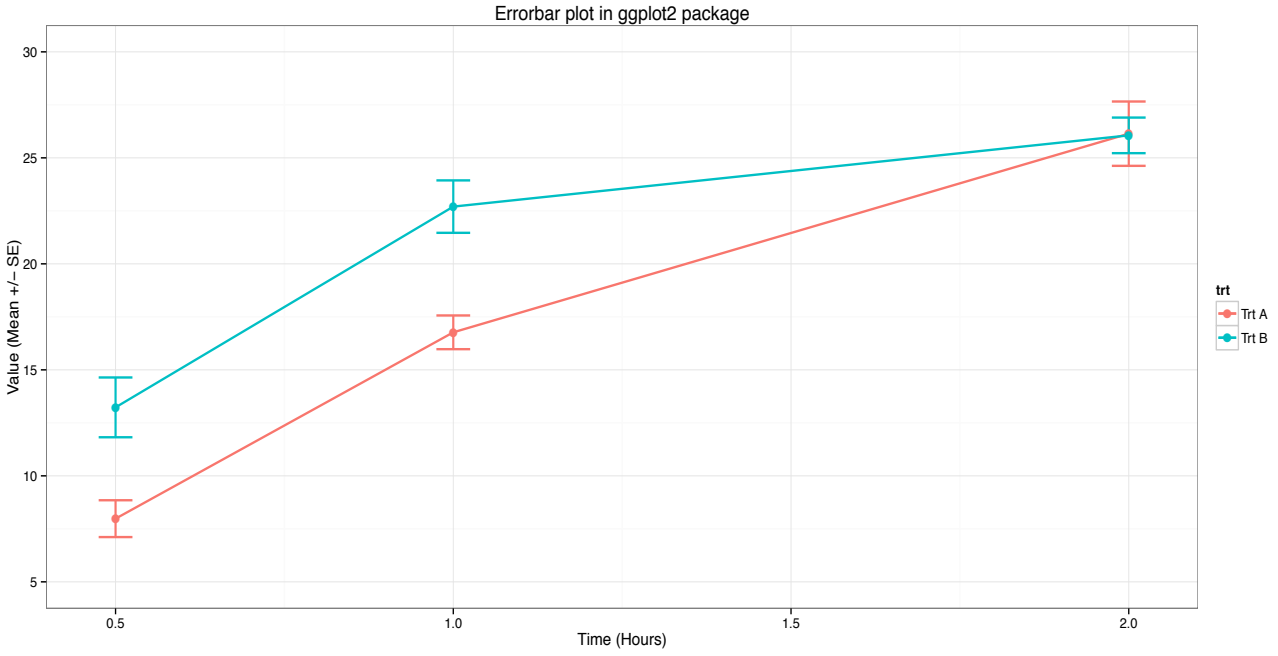
- Errorbar plot using 'ggplot2' package in R

Errorbar plot using ggplot2 package

- Errorbar plot using 'ggplot2' package in R



Errorbar plot using ggplot2 package

R Code

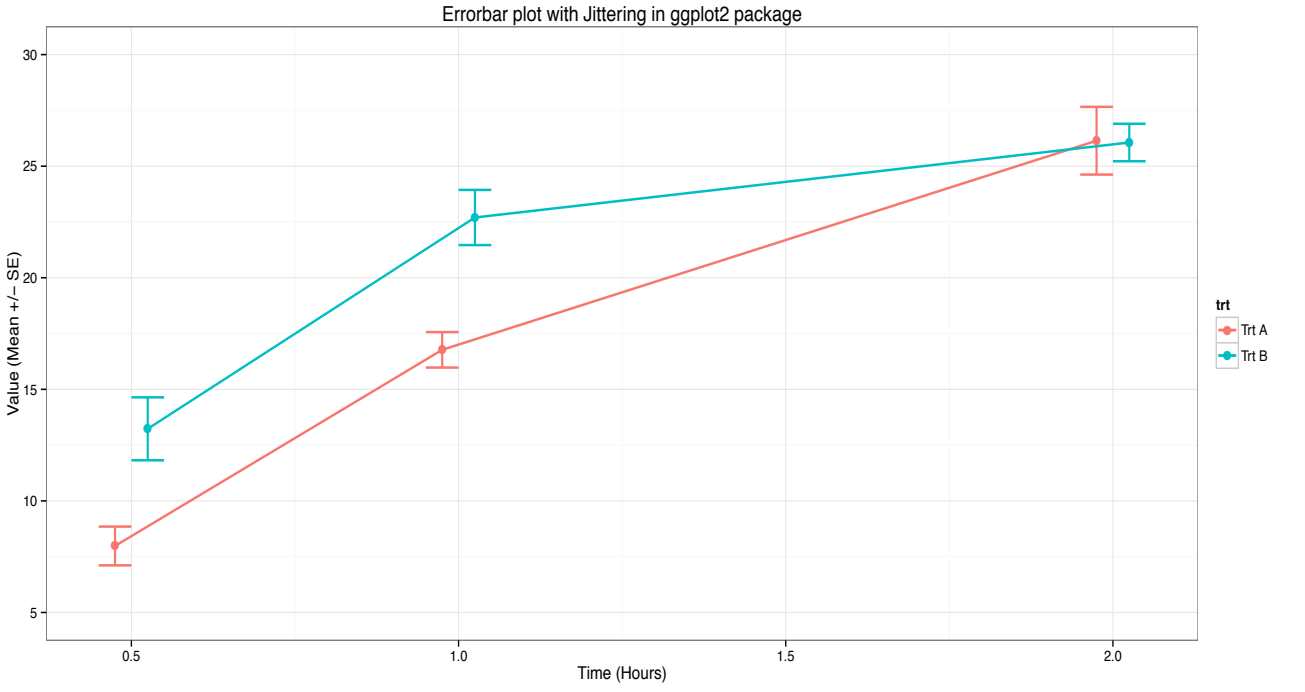
```
ggplot(summary, aes(x=time, y=rep, colour=trt)) +
 geom_errorbar(aes(ymin=rep-se, ymax=rep+se), width=.05, lwd = 0.8) +
 geom_line(lwd=0.8) +
 geom_point(cex=3) + xlab("Time (Hours)") + ylab ("Value (Mean +/- SE)")+
 ggtitle("Errorbar plot in ggplot2 package")+
 theme_bw()+
 scale_y_continuous(limits=c(5,30), breaks=0:30*5)
```

Errorbar plot using ggplot2 package

R Code

```
pd <- position_dodge(.1)
ggplot(summary, aes(x=time, y=rep, colour=trt)) +
 geom_errorbar(aes(ymin=rep-se, ymax=rep+se), width=.1, position=pd,
 lwd =0.8) + geom_line(position=pd,lwd =0.8) + geom_point(position=pd,
 cex = 3) + xlab ("Time (Hours)") + ylab ("Value (Mean +/- SE)")+ ...
```

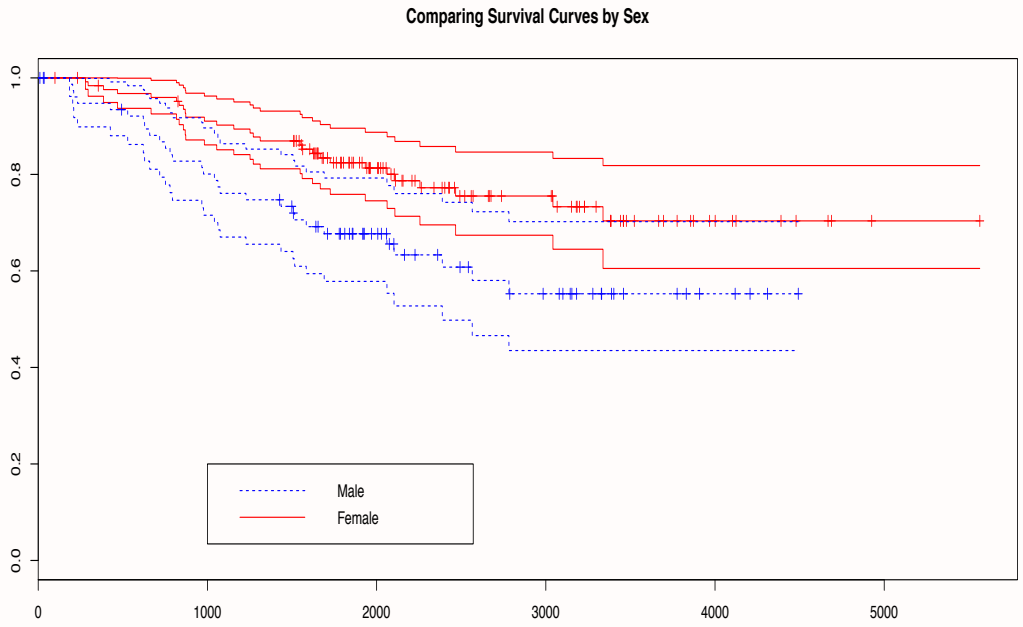
Errorbar plot using ggplot2 package



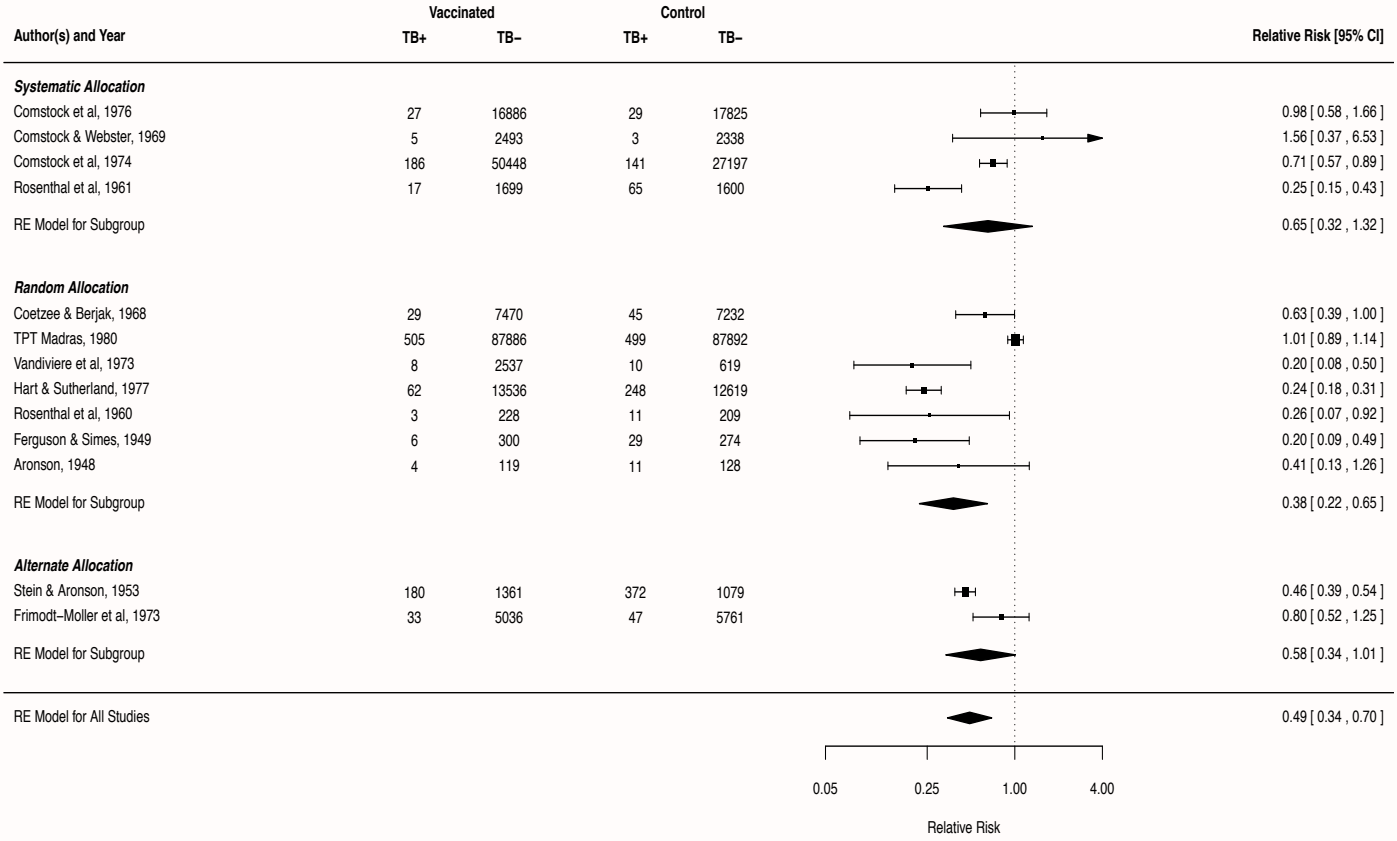
Comparison of Kaplan Meier Survival Curves

R Code

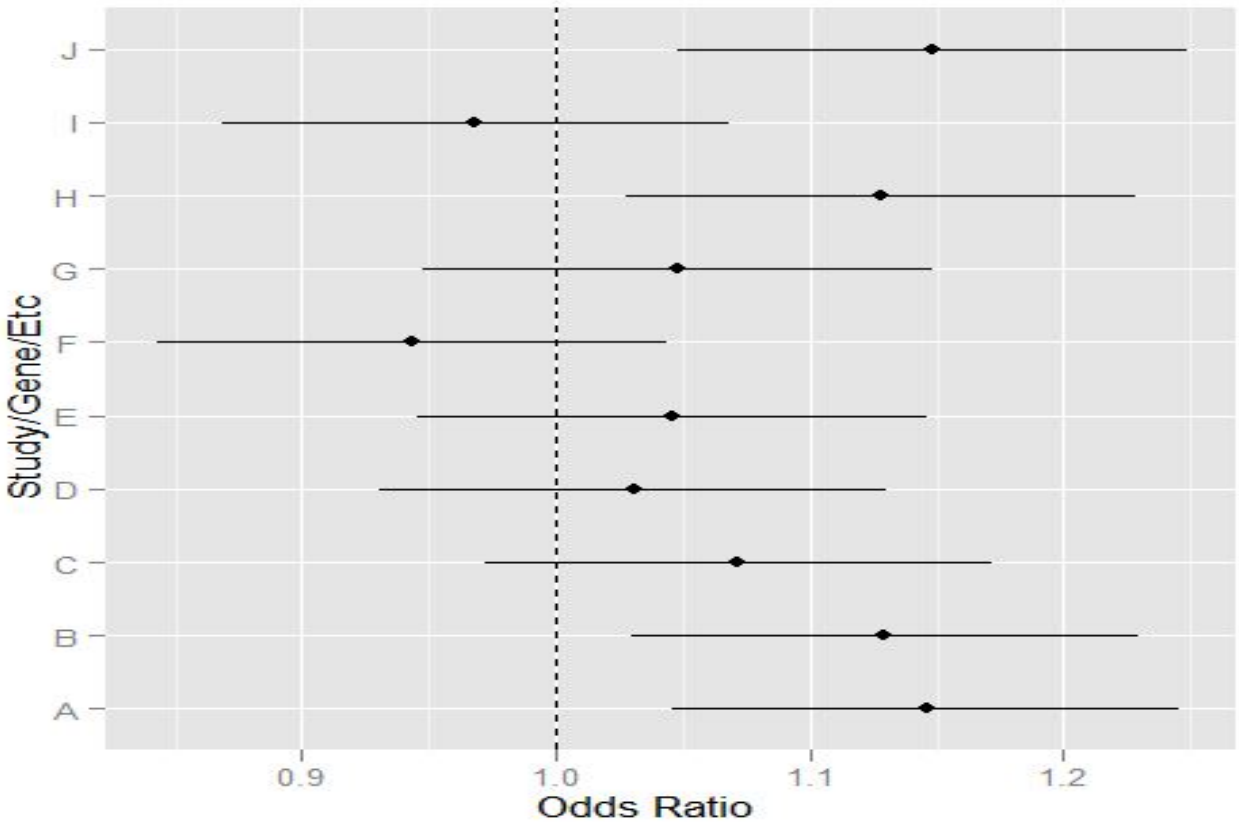
```
> library(ISwR)
> fit.bysex <- survfit(Surv(days, status == 1)~ sex, data=melanom)
> plot(fit.bysex,conf.int=TRUE,col=c("red","blue"),lty=1:2,main ='Comparing Sur ...
> legend(1000,0.2,  c("Male","Female"),lty=c(2,1),lwd=c(1,1),col=c("blue","red"))
```



Forest plot using R package 'metafor'



Forest plot using R package 'ggplot2'



Summary

- R is useful in Data visualization
- Various graphics environment in R
- R can be used to explore data and create various graphics
- Various R functions from various packages for same purpose

Conclusion

From examples we have seen, how graphs generated in R are good – in terms of appearance, time taken for coding and overall quality of the graph. So, R can be an ideal choice for data visualization (exploring) and creating graphs.

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Thanks for your attention!