Chapter 26: Base Plotting

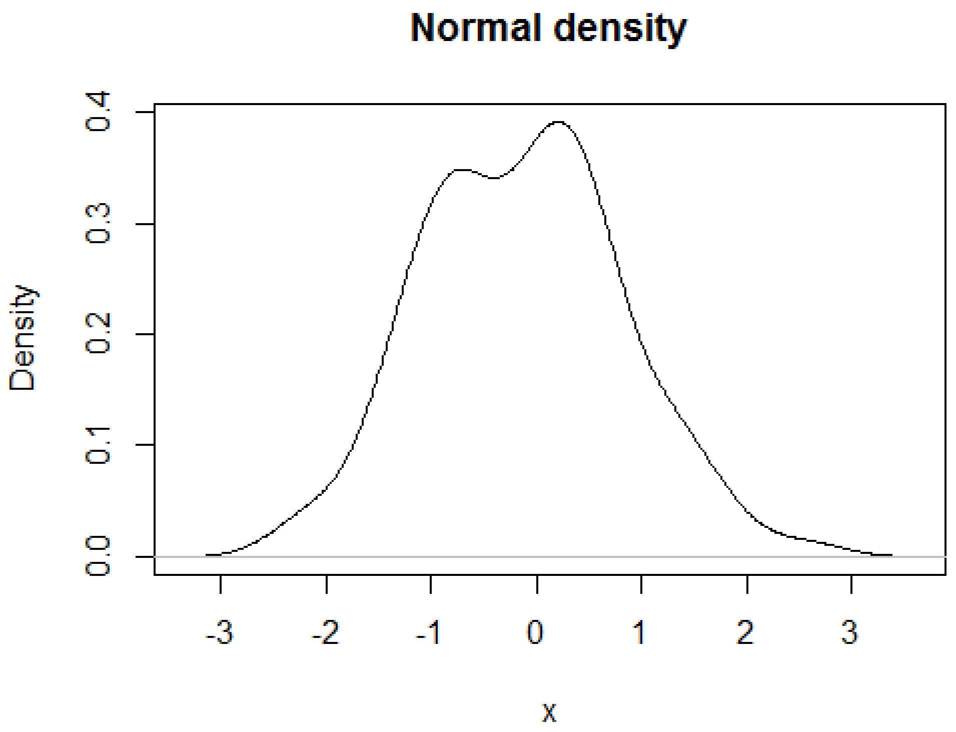
Parameter	Details
x	x-axis variable. May supply either `data$variablex` or `data[,x]`
y	y-axis variable. May supply either `data$variabley` or `data[,y]`
main	Main title of plot
sub	Optional subtitle of plot
xlab	Label for x-axis
ylab	Label for y-axis
pch	Integer or character indicating plotting symbol
col	Integer or string indicating color
type	Type of plot. `"p"` for points, `"l"` for lines, `"b"` for both, `"c"` for the lines part alone of `"b"`, `"o"` for both 'overplotted', `"h"` for 'histogram'-like (or 'high-density') vertical lines, `"s"` for stair steps, `"S"` for other steps, `"n"` for no plotting

Section 26.1: Density plot

A very useful and logical follow-up to histograms would be to plot the smoothed density function of a random variable. A basic plot produced by the command

```
plot(density(rnorm(100)),main="Normal density",xlab="x")
```

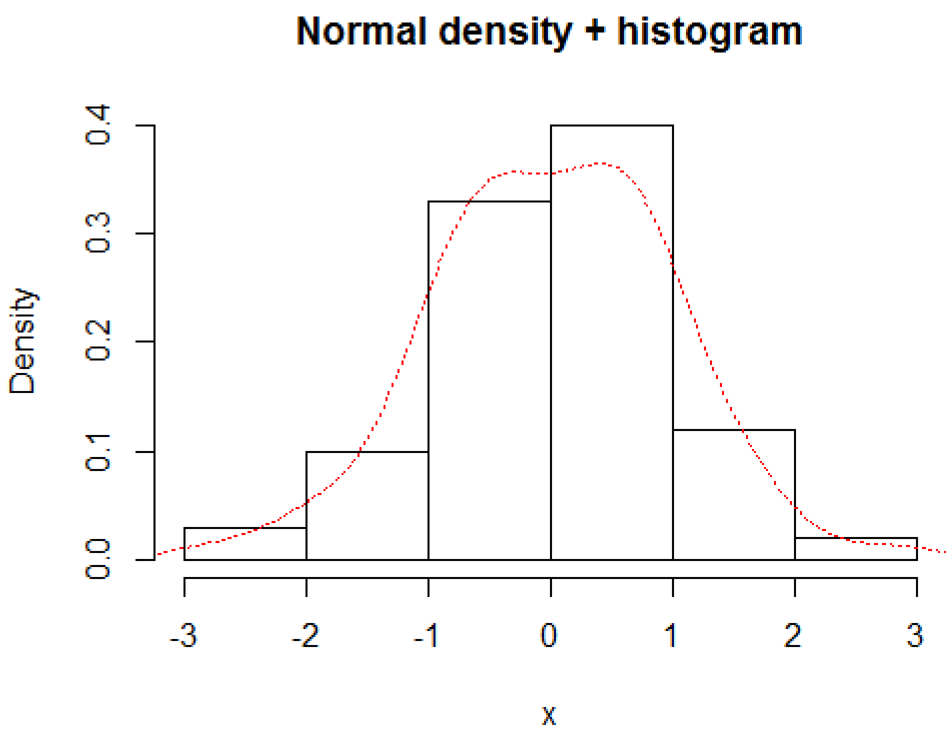
would look like



You can overlay a histogram and a density curve with

```
x=rnorm(100)
hist(x,prob=TRUE,main="Normal density + histogram")
lines(density(x),lty="dotted",col="red")
```

which gives



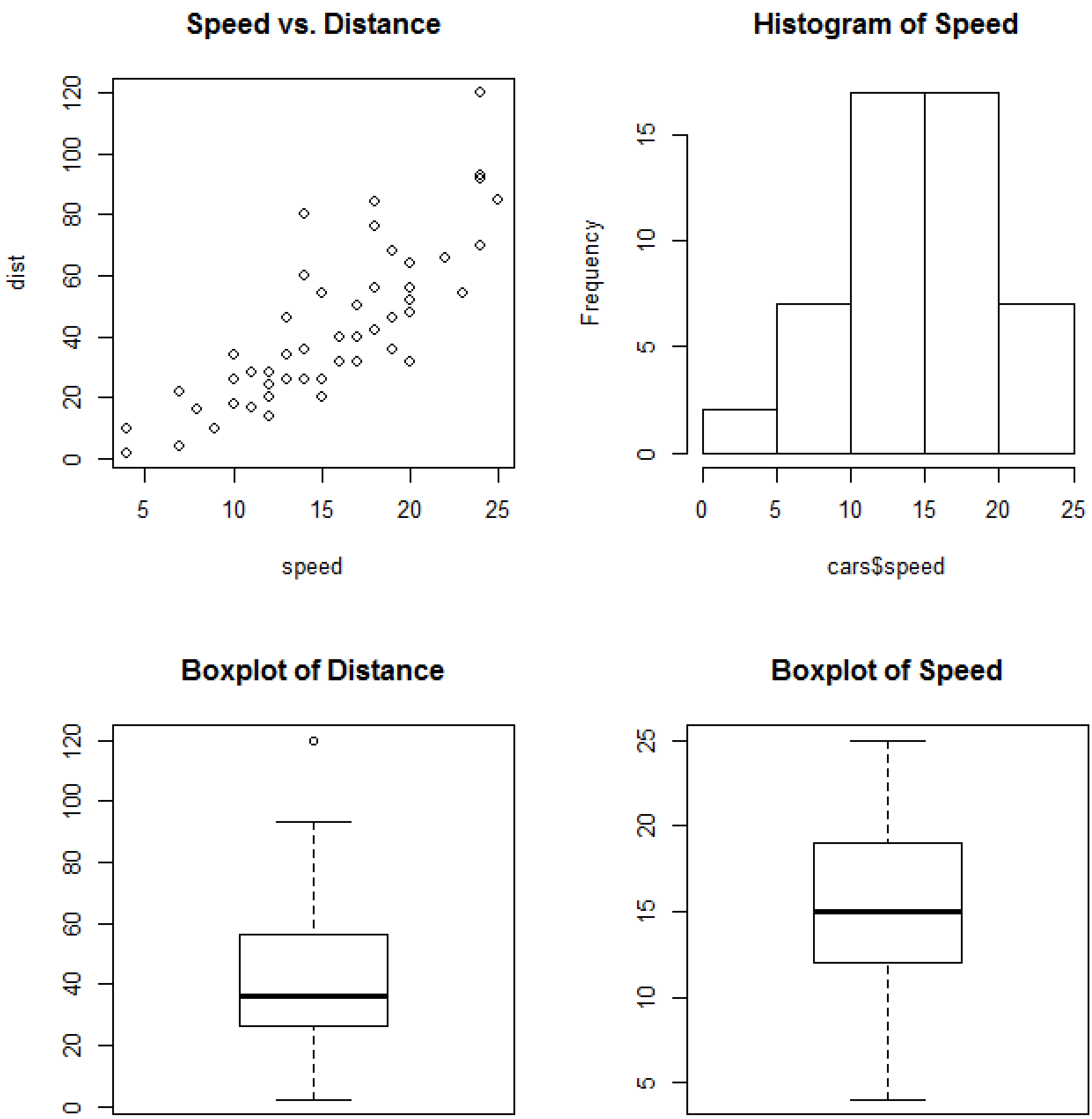
Section 26.2: Combining Plots

It's often useful to combine multiple plot types in one graph (for example a Barplot next to a Scatterplot.) R makes this easy with the help of the functions `par()` and `layout()`.

`par()`

`par` uses the arguments `mfrow` or `mfcol` to create a matrix of nrows and ncols `c(nrows, ncols)` which will serve as a grid for your plots. The following example shows how to combine four plots in one graph:

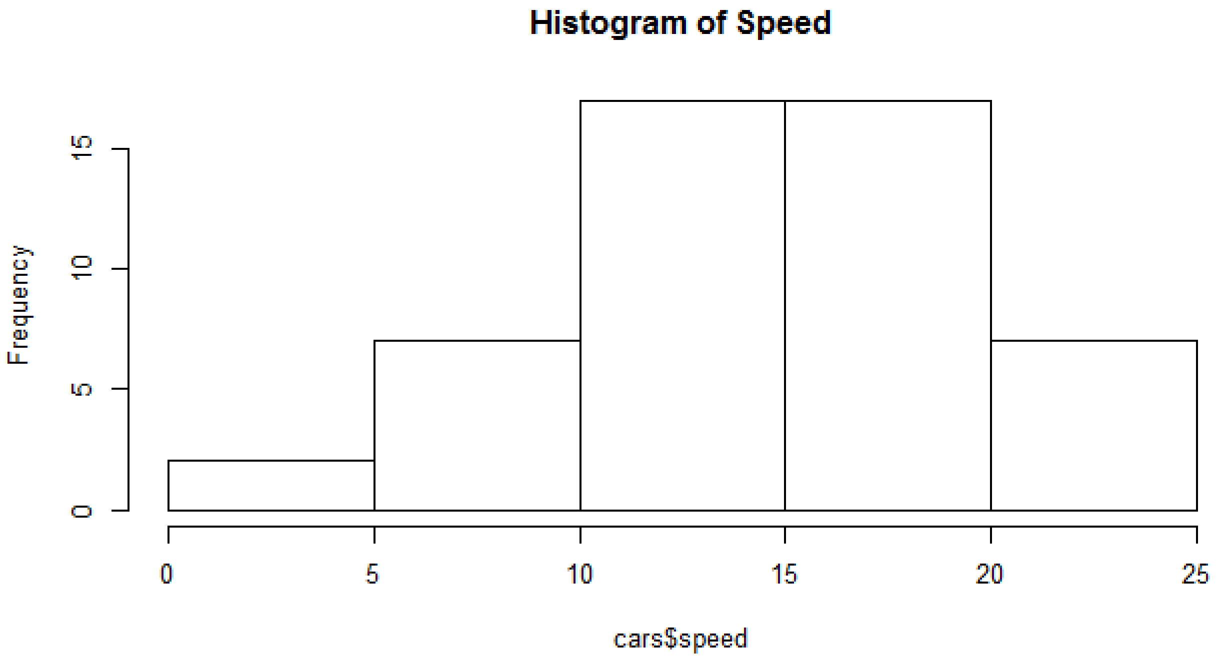
```
par(mfrow=c(2,2))
plot(cars, main="Speed vs. Distance")
hist(cars$speed, main="Histogram of Speed")
boxplot(cars$dist, main="Boxplot of Distance")
boxplot(cars$speed, main="Boxplot of Speed")
```

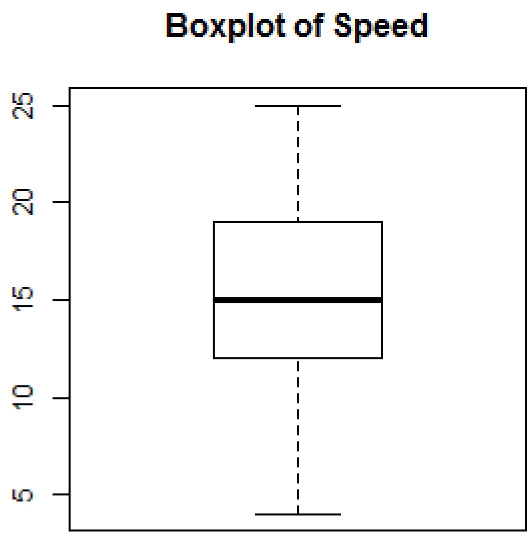


layout()

The `layout()` is more flexible and allows you to specify the location and the extent of each plot within the final combined graph. This function expects a matrix object as an input:

```
layout(matrix(c(1,1,2,3), 2,2, byrow=T))
hist(cars$speed, main="Histogram of Speed")
boxplot(cars$dist, main="Boxplot of Distance")
boxplot(cars$speed, main="Boxplot of Speed")
```





Section 26.3: Getting Started with R_Plots

- **Scatterplot**

You have two vectors and you want to plot them.

```
x_values <- rnorm(n = 20 , mean = 5 , sd = 8) #20 values generated from Normal(5,8)
y_values <- rbeta(n = 20 , shape1 = 500 , shape2 = 10) #20 values generated from Beta(500,10)
```

If you want to make a plot which has the `y_values` in vertical axis and the `x_values`in horizontal axis, you can use the following commands:

```
plot(x = x_values, y = y_values, type = "p") #standard scatter-plot
plot(x = x_values, y = y_values, type = "l") # plot with lines
```

```
plot(x = x_values, y = y_values, type = "n") # empty plot
```

You can type `?plot()` in the console to read about more options.

- **Boxplot**

You have some variables and you want to examine their Distributions

```
#boxplot is an easy way to see if we have some outliers in the data.

z<- rbeta(20 , 500 , 10) #generating values from beta distribution
z[c(19 , 20)] <- c(0.97 , 1.05) # replace the two last values with outliers
boxplot(z) # the two points are the outliers of variable z.
```

- **Histograms**

Easy way to draw histograms

```
hist(x = x_values) # Histogram for x vector
hist(x = x_values, breaks = 3) #use breaks to set the numbers of bars you want
```

- **Pie_charts**

If you want to visualize the frequencies of a variable just draw pie

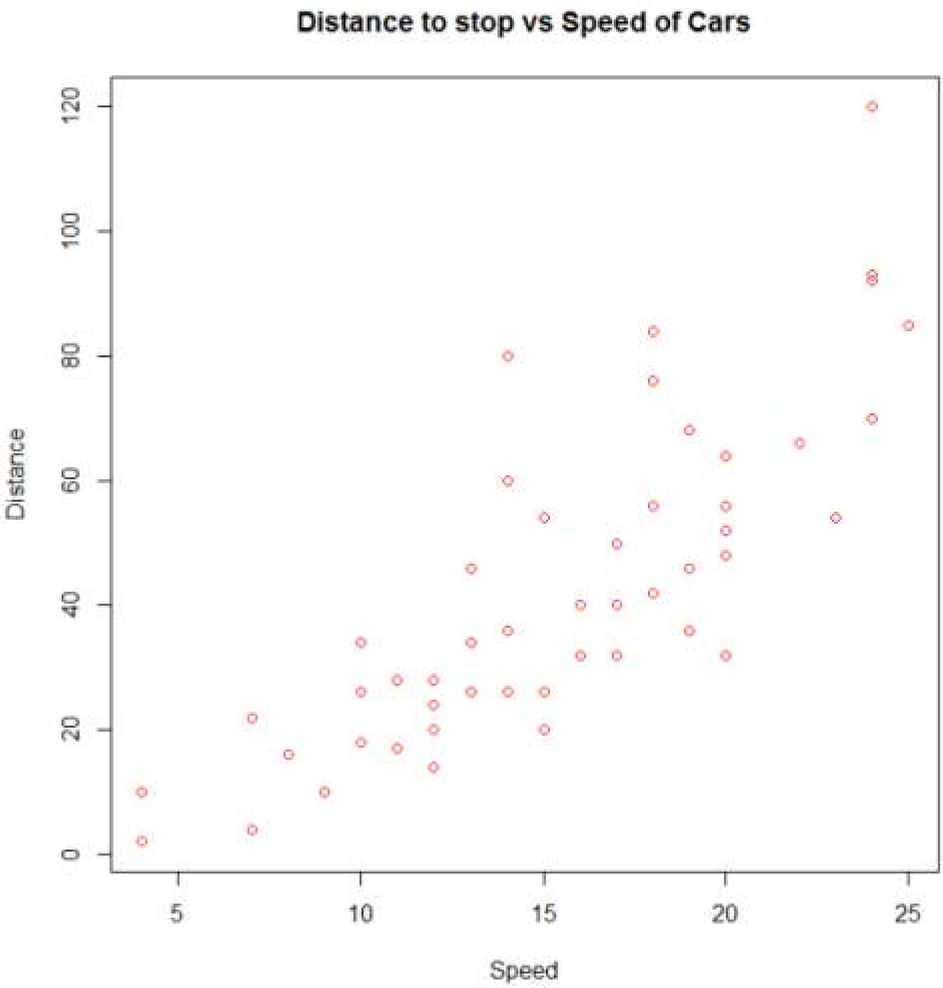
First we have to generate data with frequencies, for example :

```
P <- c(rep('A' , 3) , rep('B' , 10) , rep('C' , 7) )
t <- table(P) # this is a frequency matrix of variable P
pie(t) # And this is a visual version of the matrix above
```

Section 26.4: Basic Plot

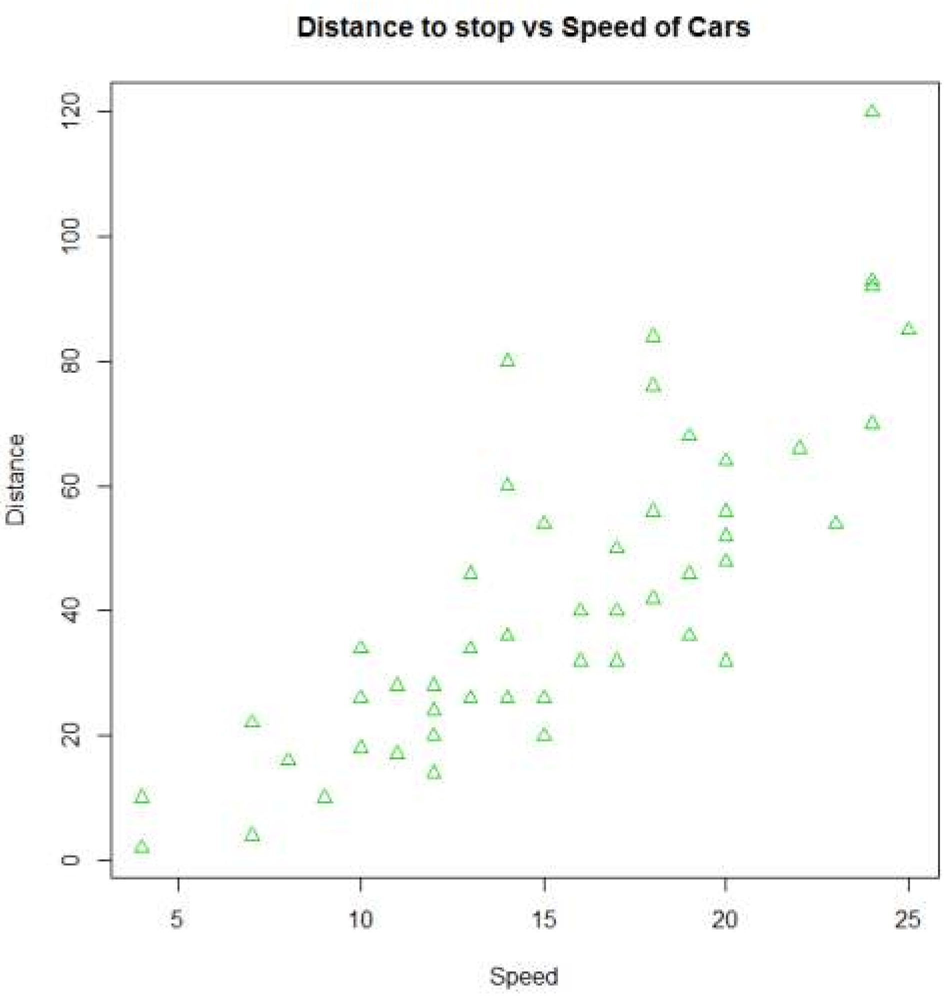
A basic plot is created by calling `plot()`. Here we use the built-in `cars` data frame that contains the speed of cars and the distances taken to stop in the 1920s. (To find out more about the dataset, use help(cars)).

```
plot(x = cars$speed, y = cars$dist, pch = 1, col = 1,
     main = "Distance vs Speed of Cars",
     xlab = "Speed", ylab = "Distance")
```



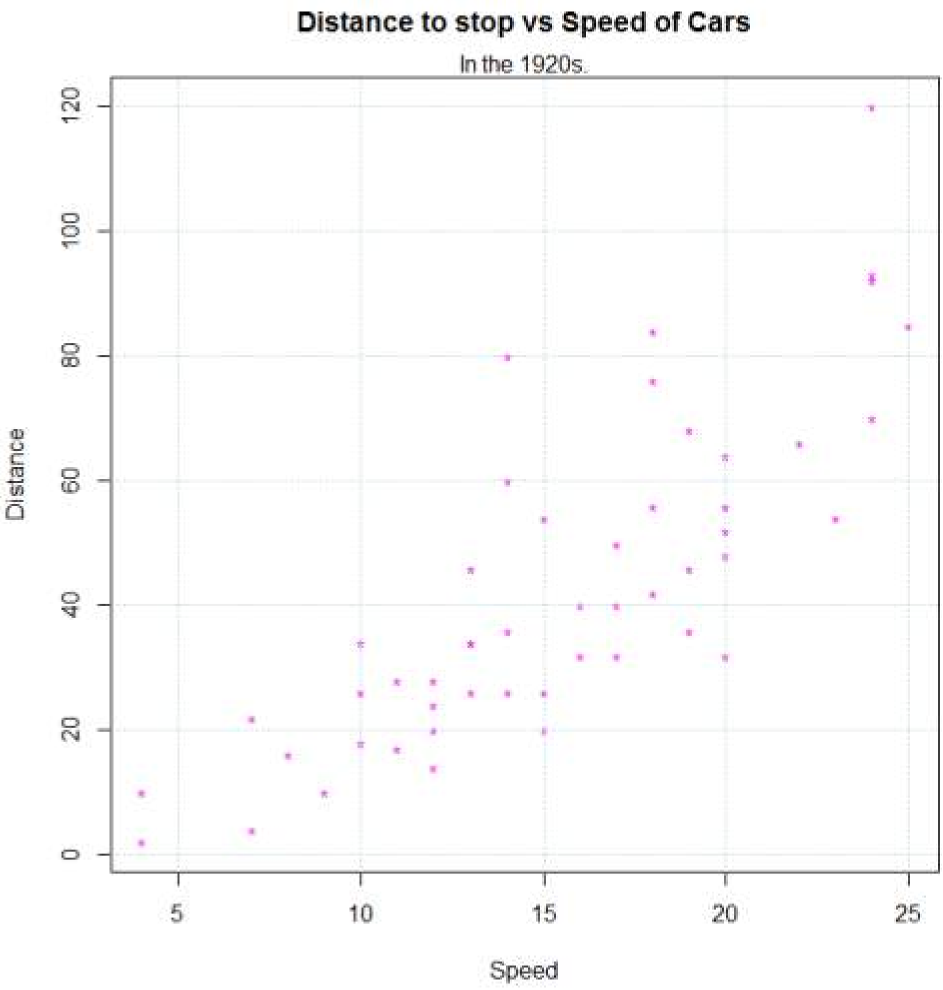
We can use many other variations in the code to get the same result. We can also change the parameters to obtain different results.

```
with(cars, plot(dist~speed, pch = 2, col = 3,
     main = "Distance to stop vs Speed of Cars",
     xlab = "Speed", ylab = "Distance"))
```



Additional features can be added to this plot by calling `points()`, `text()`, `mtext()`, `lines()`, `grid()`, etc.

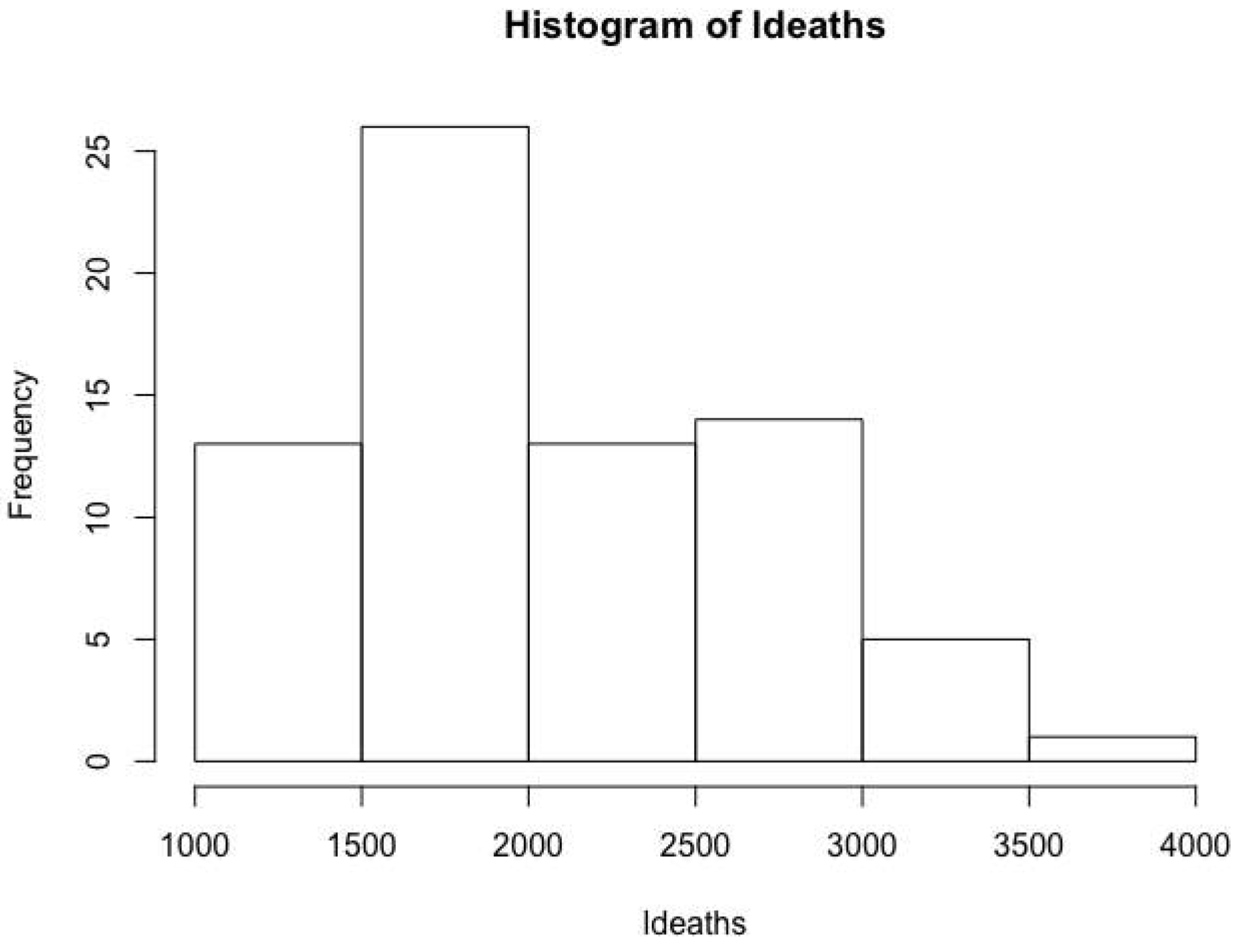
```
plot(dist~speed, pch = "*", col = "magenta", data=cars,
     main = "Distance to stop vs Speed of Cars",
     xlab = "Speed", ylab = "Distance")
mtext("In the 1920s.")
grid(,col="lightblue")
```



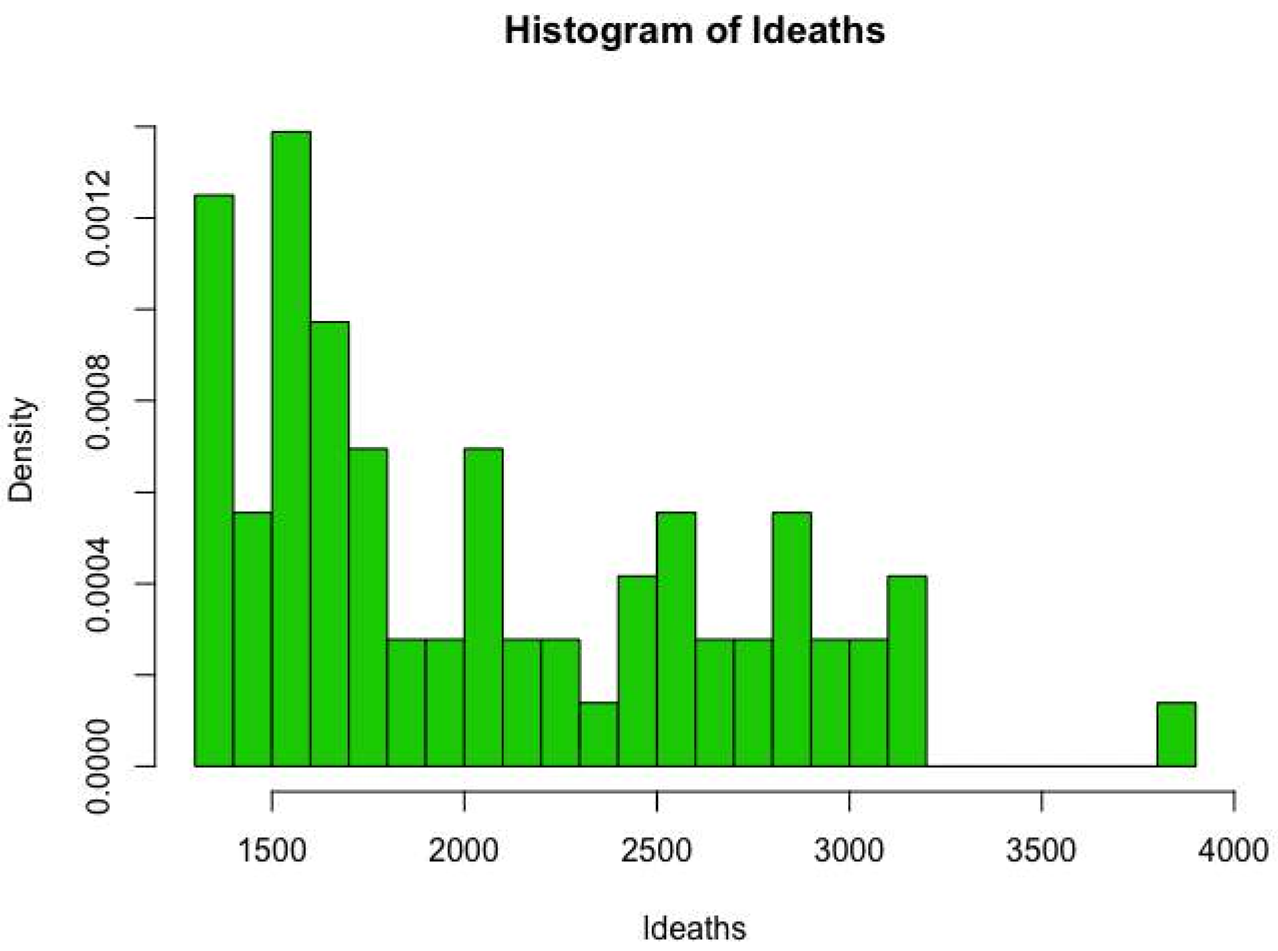
Section 26.5: Histograms

Histograms allow for a pseudo-plot of the underlying distribution of the data.

```
hist(ldeaths)
```




```r
hist(ldeaths, breaks = 20, freq = F, col = 3)
```



Section 26.6: Matplot

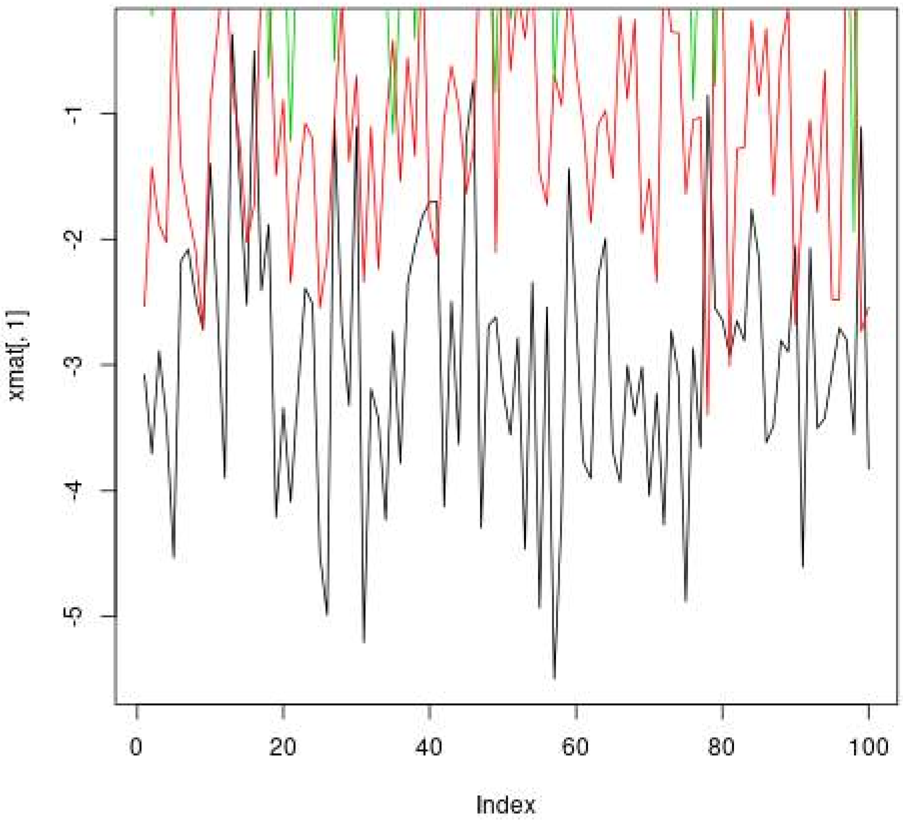
`matplot` is useful for quickly plotting multiple sets of observations from the same object, particularly from a matrix, on the same graph.

Here is an example of a matrix containing four sets of random draws, each with a different mean.

```
xmat <- cbind(rnorm(100, -3), rnorm(100, -1), rnorm(100, 1), rnorm(100, 3))
head(xmat)
#          [,1]        [,2]       [,3]     [,4]
# [1,] -3.072793 -2.53111494  0.6168063 3.780465
# [2,] -3.702545 -1.42789347 -0.2197196 2.478416
# [3,] -2.890698 -1.88476126  1.9586467 5.268474
# [4,] -3.431133 -2.02626870  1.1153643 3.170689
# [5,] -4.532925  0.02164187  0.9783948 3.162121
# [6,] -2.169391 -1.42699116  0.3214854 4.480305
```

One way to plot all of these observations on the same graph is to do one `plot` call followed by three more `points` or `lines` calls.

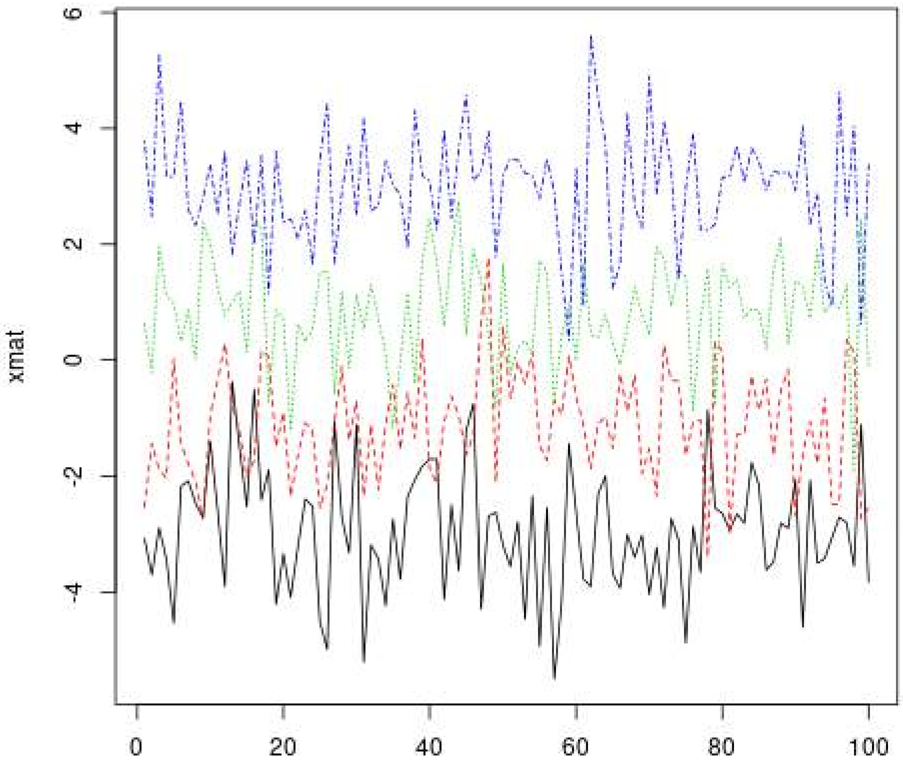
```
plot(xmat[,1], type = 'l')
lines(xmat[,2], col = 'red')
lines(xmat[,3], col = 'green')
lines(xmat[,4], col = 'blue')
```



However, this is both tedious, and causes problems because, among other things, by default the axis limits are fixed by `plot` to fit only the first column.

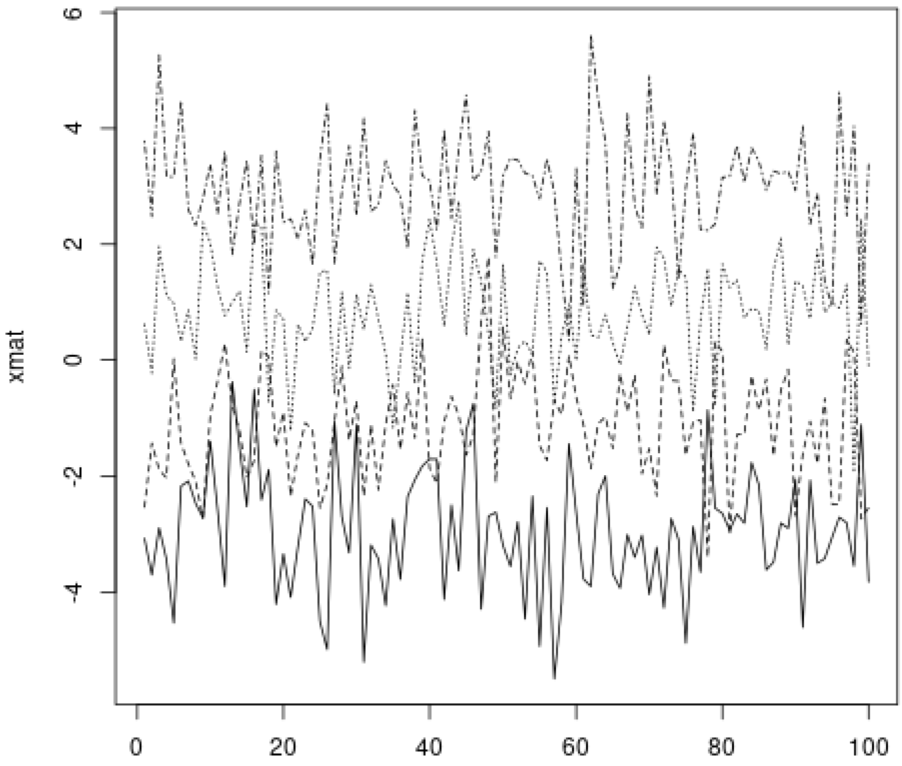
Much more convenient in this situation is to use the `matplot` function, which only requires one call and automatically takes care of axis limits *and* changing the aesthetics for each column to make them distinguishable.

```
matplot(xmat, type = 'l')
```



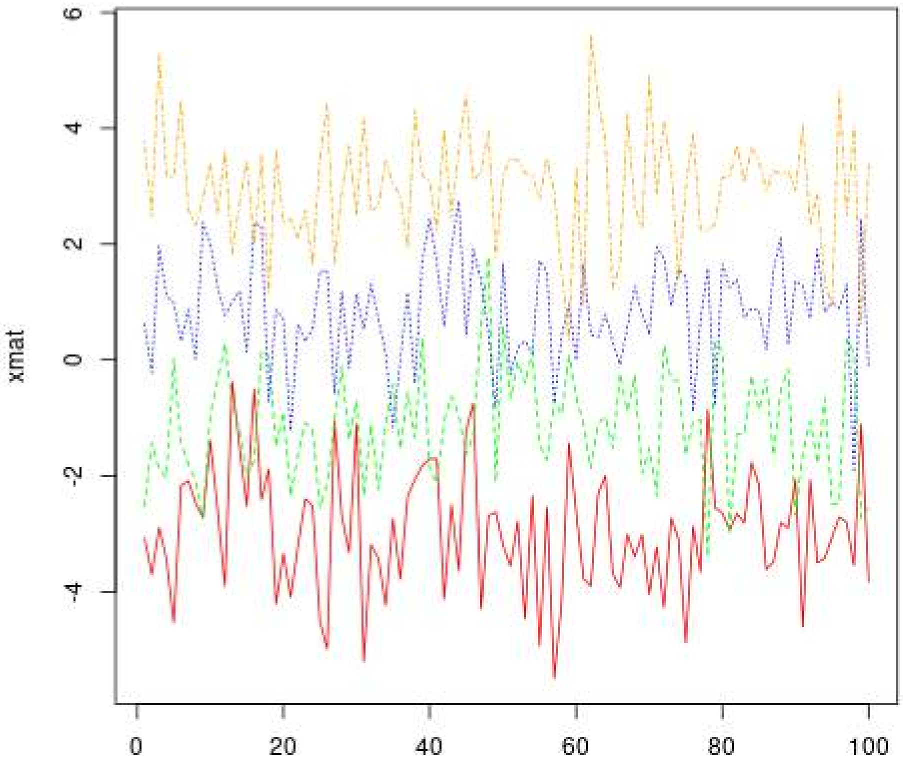
Note that, by default, **`matplot`** varies both color (**`col`**) and linetype (`lty`) because this increases the number of possible combinations before they get repeated. However, any (or both) of these aesthetics can be fixed to a single value...

```
matplot(xmat, type = 'l', col = 'black')
```



...or a custom vector (which will recycle to the number of columns, following standard R vector recycling rules).

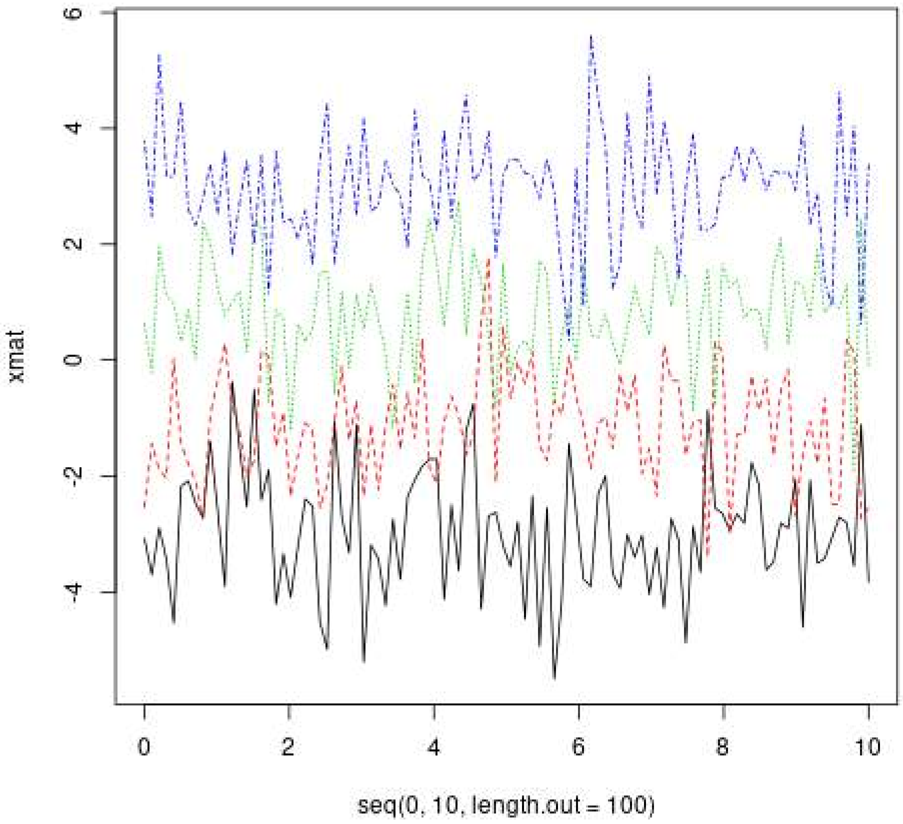
```
matplot(xmat, type = 'l', col = c('red', 'green', 'blue', 'orange'))
```



Standard graphical parameters, including `main`, `xlab`, `xmin`, work exactly the same way as for **`plot`**. For more on those, see `?`**`par`**.

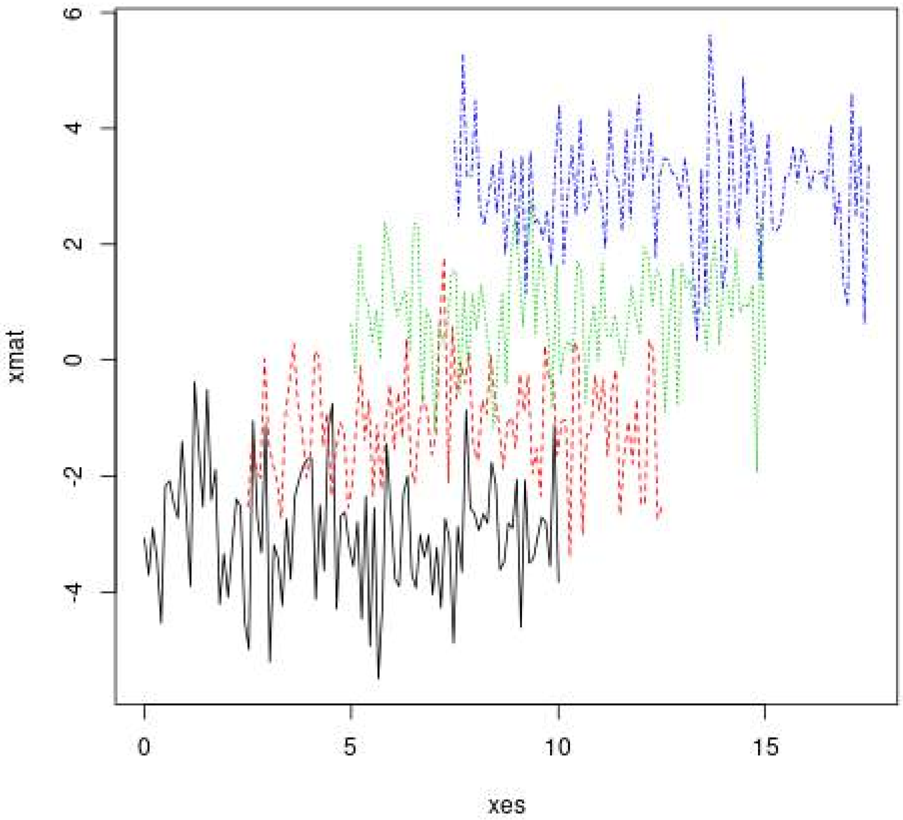
Like **`plot`**, if given only one object, **`matplot`** assumes it's the `y` variable and uses the indices for `x`. However, `x` and `y` can be specified explicitly.

```
matplot(x = seq(0, 10, length.out = 100), y = xmat, type='l')
```



In fact, both x and y can be matrices.

```
xes <- cbind(seq(0, 10, length.out = 100),
             seq(2.5, 12.5, length.out = 100),
             seq(5, 15, length.out = 100),
             seq(7.5, 17.5, length.out = 100))
matplot(x = xes, y = xmat, type = 'l')
```

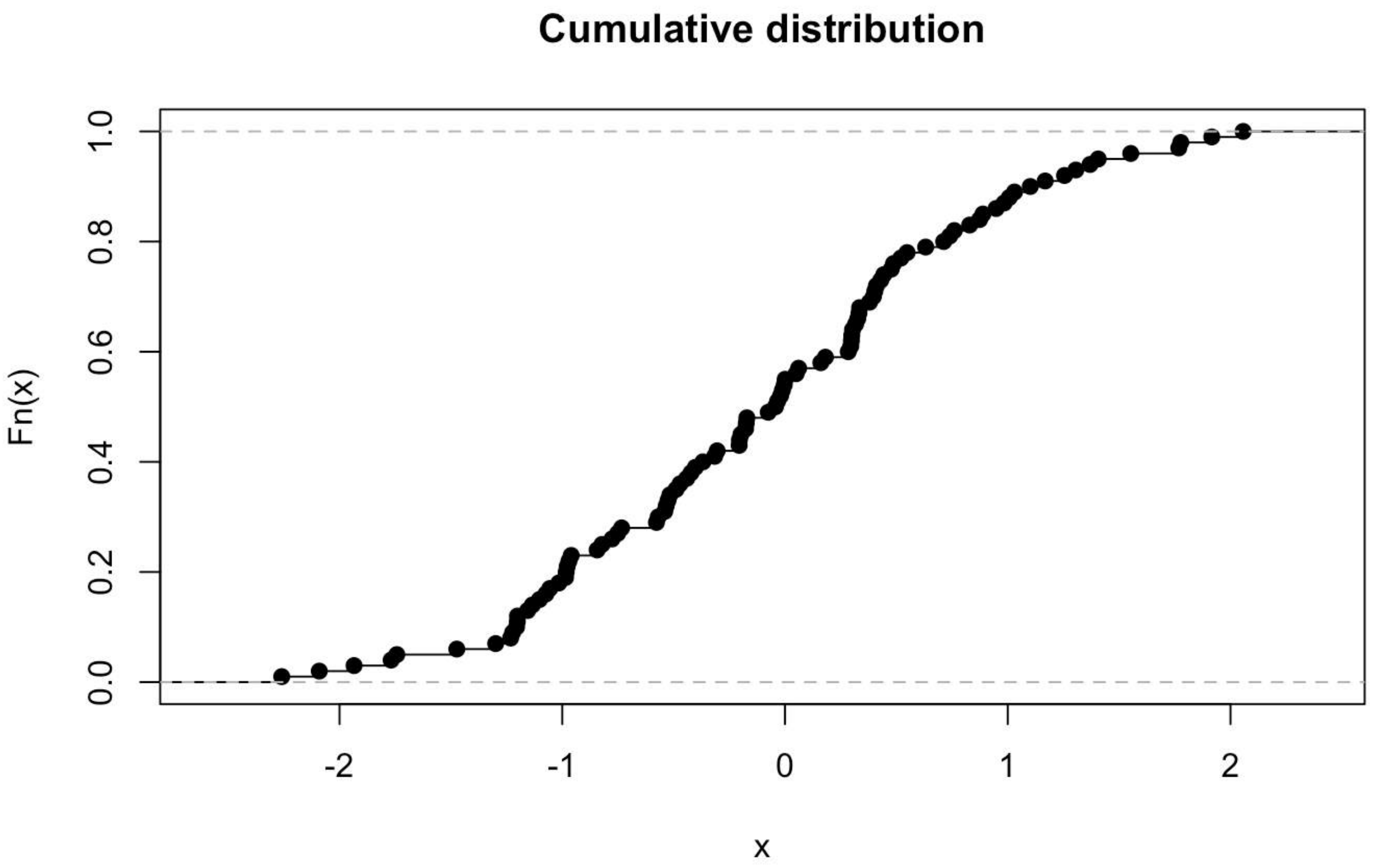


Section 26.7: Empirical Cumulative Distribution Function

A very useful and logical follow-up to histograms and density plots would be the Empirical Cumulative Distribution Function. We can use the function `ecdf()` for this purpose. A basic plot produced by the command

```
plot(ecdf(rnorm(100)),main="Cumulative distribution",xlab="x")
```

would look like


Cumulative distribution
Fn(x)
0.0
0.2
0.4
0.6
0.8
1.0
-2
-1
0
1
2
x