Axes and Text

Many high level plotting functions (plot, hist, boxplot, etc.) allow you to include axis and text options (as well as other graphical paramters). For example

```
# Specify axis options within plot()
plot(x, y, main="title", sub="subtitle",
  xlab="X-axis label", ylab="y-axix label",
  xlim=c(xmin, xmax), ylim=c(ymin, ymax))
```

For finer control or for modularization, you can use the functions described below.

Titles

Use the **title( )** function to add labels to a plot.

```
title(main="main title", sub="sub-title",
   xlab="x-axis label", ylab="y-axis label")
```

Many other graphical parameters (such as text size, font, rotation, and color) can also be specified in the**title( )** function.

```
# Add a red title and a blue subtitle. Make x and y
# labels 25% smaller than the default and green.
title(main="My Title", col.main="red",
  sub="My Sub-title", col.sub="blue",
  xlab="My X label", ylab="My Y label",
  col.lab="green", cex.lab=0.75)
```

Text Annotations

Text can be added to graphs using the **text( )** and **mtext( )** functions. **text( )** places text within the graph while **mtext( )** places text in one of the four margins.

```
text(location, "text to place", pos, ...)
mtext("text to place", side, line=n, ...)
```

Common options are described below.

option	**description**
location	location can be an **x,y coordinate**. Alternatively, the text can be placed interactively via mouse by specifying location as **locator(1)**.
pos	position relative to location. 1=below, 2=left, 3=above, 4=right. If you specify**pos**, you

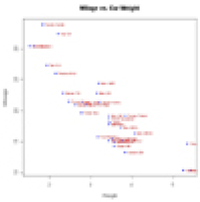
	can specify **offset=** in percent of character width.
side	which margin to place text. 1=bottom, 2=left, 3=top, 4=right. you can specify**line=** to indicate the line in the margin starting with 0 and moving out. you can also specify **adj=0** for left/bottom alignment or **adj=1** for top/right alignment.

Other common options are **cex**, **col**, and **font** (for size, color, and font style respectively).

Labeling points

You can use the **text( )** function (see above) for labeling point as well as for adding other text annotations. Specify location as a set of x, y coordinates and specify the text to place as a vector of labels. The x, y, and label vectors should all be the same length.

```
# Example of labeling points
attach(mtcars)
plot(wt, mpg, main="Milage vs. Car Weight",
   xlab="Weight", ylab="Mileage", pch=18, col="blue")
text(wt, mpg, row.names(mtcars), cex=0.6, pos=4, col="red")
```



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Math Annotations

You can add mathematically formulas to a graph using TEX-like rules. See **help(plotmath)** for details and examples.

Axes

You can create custom axes using the **axis( )** function.

```
axis(side, at=, labels=, pos=, lty=, col=, las=, tck=, ...)
```

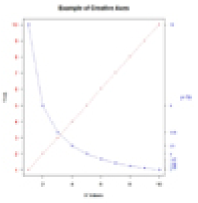
where

option	description
side	an integer indicating the side of the graph to draw the axis (1=bottom, 2=left, 3=top, 4=right)
at	a numeric vector indicating where tic marks should be drawn
labels	a character vector of labels to be placed at the tickmarks (if NULL, the *at* values will be used)
pos	the coordinate at which the axis line is to be drawn. (i.e., the value on the other axis where it crosses)
lty	line type
col	the line and tick mark color
las	labels are parallel (=0) or perpendicular(=2) to axis
tck	length of tick mark as fraction of plotting region (negative number is outside graph,

	positive number is inside, 0 suppresses ticks, 1 creates gridlines) default is -0.01
(...)	other graphical parameters

If you are going to create a custom axis, you should suppress the axis automatically generated by your high level plotting function. The option **axes=FALSE** suppresses both x and y axes. **xaxt="n"** and **yaxt="n"**suppress the x and y axis respectively. Here is a (somewhat overblown) example.

```
# A Silly Axis Example

# specify the data
x <- c(1:10); y <- x; z <- 10/x

# create extra margin room on the right for an axis
par(mar=c(5, 4, 4, 8) + 0.1)

# plot x vs. y
plot(x, y,type="b", pch=21, col="red",
   yaxt="n", lty=3, xlab="", ylab="")

# add x vs. 1/x
lines(x, z, type="b", pch=22, col="blue", lty=2)

# draw an axis on the left
axis(2, at=x,labels=x, col.axis="red", las=2)

# draw an axis on the right, with smaller text and ticks
axis(4, at=z,labels=round(z,digits=2),
  col.axis="blue", las=2, cex.axis=0.7, tck=-.01)

# add a title for the right axis
mtext("y=1/x", side=4, line=3, cex.lab=1,las=2, col="blue")

# add a main title and bottom and left axis labels
title("An Example of Creative Axes", xlab="X values",
   ylab="Y=X")
```



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Minor Tick Marks

The **minor.tick( )** function in the **Hmisc** package adds minor tick marks.

```
# Add minor tick marks
library(Hmisc)
minor.tick(nx=n, ny=n, tick.ratio=n)
```

nx is the number of minor tick marks to place between x-axis major tick marks.

ny does the same for the y-axis. **tick.ratio** is the size of the minor tick mark relative to the major tick mark. The length of the major tick mark is retrieved from **par(**"tck"**)**.

Reference Lines

Add reference lines to a graph using the **abline( )** function.

```
abline(h=yvalues, v=xvalues)
```

Other graphical parameters (such as line type, color, and width) can also be specified in the **abline( )**function.

```
# add solid horizontal lines at y=1,5,7
abline(h=c(1,5,7))
# add dashed blue verical lines at x = 1,3,5,7,9
abline(v=seq(1,10,2),lty=2,col="blue")
```

Note: You can also use the **grid( )** function to add reference lines.

Legend

Add a legend with the **legend()** function.

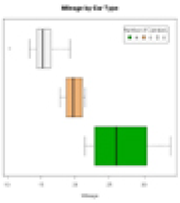
```
legend(location, title, legend, ...)
```

Common options are described below.

option	description
location	There are several ways to indicate the location of the legend. You can give an**x,y coordinate** for the upper left hand corner of the legend. You can use**locator(1)**, in which case you use the mouse to indicate the location of the legend. You can also use the **keywords** "bottom", "bottomleft", "left", "topleft", "top", "topright", "right", "bottomright", or "center". If you use a keyword, you may want to use **inset=** to specify an amount to move the legend into the graph (as fraction of plot region).
title	A character string for the legend title (optional)
legend	A character vector with the labels
...	Other options. If the legend labels colored lines, specify **col=** and a vector of colors. If the legend labels point symbols, specify **pch=** and a vector of point symbols. If the legend labels line width or line style, use **lwd=** or **lty=** and a vector of widths or styles. To create colored boxes for the legend (common in bar, box, or pie charts), use **fill=** and a vector of colors.

Other common legend options include **bty** for box type, **bg** for background color, **cex** for size, and**text.col** for text color. Setting **horiz=TRUE** sets the legend horizontally rather than vertically.

```
# Legend Example
attach(mtcars)
boxplot(mpg~cyl, main="Milage by Car Weight",
   yaxt="n", xlab="Milage", horizontal=TRUE,
   col=terrain.colors(3))
legend("topright", inset=.05, title="Number of Cylinders",
   c("4","6","8"), fill=terrain.colors(3), horiz=TRUE)
```



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For more on legends, see **help(legend)**. The examples in the help are particularly informative.