chapter 6

Scales, Axes and Legends

```
library(ggplot2)
library(gridExtra)
library(dplyr)
```

6.1 Introduction

- Scales control the mapping from data to aesthetics.
- Scales also provide the tools that let you read the plot: the axes and legends.

Formally, each scale is a function from a region in data space (the domain of the scale) to a region in aesthetic space (the range of the scale). The axis or legend is the inverse function: it allows you to convert visual properties back to data.

6.2 Modifying Scales

```
# when u write:
ggplot(mpg, aes(displ, hwy)) +
geom_point(aes(colour = class))
```

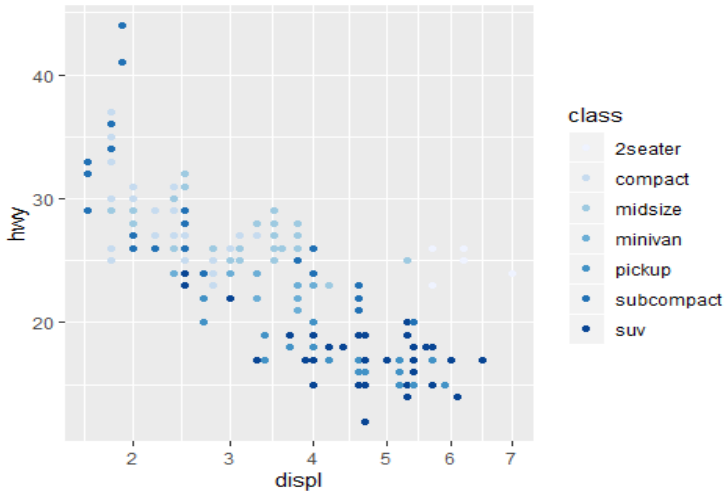
-> actually happens (default) :

```
ggplot(mpg, aes(displ, hwy)) +
geom_point(aes(colour = class)) +
scale_x_continuous() +
scale_y_continuous() +
scale_colour_discrete()

-----------------------------------------------------------------------------------------------------------------------
```

```
ggplot(mpg, aes(displ, hwy)) +
geom_point(aes(colour = class)) +
scale_x_continuous("A really awesome x axis ") +
scale_y_continuous("An amazingly great y axis ")
```

But !! Use of + to "add" scales is not adding. It is overriding!!!

```
ggplot(mpg, aes(displ, hwy)) +
geom_point(aes(colour = class)) +
scale_x_sqrt() +
scale_colour_brewer()
```



* naming scheme for scales : made up of three pieces separated by "_"

1. scale
2. name of the aesthetic (color, shape, x ···)
3. name of the scale (continuous, discrete, brewer···)

6.3 Guides : Legends and Axes

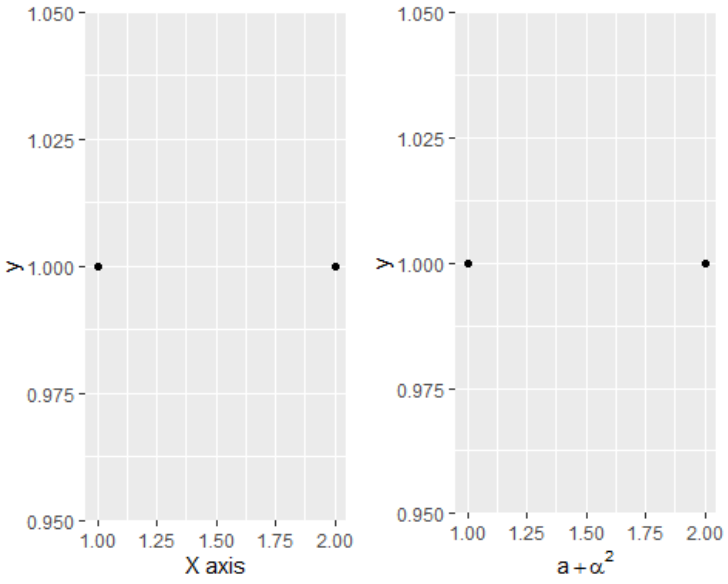
- axes & legends are the same type of thing!

Axis	Legend	Argument name
Label	title	*name*
Ticks & grid line	key	*breaks*
Tick label	Key label	*labels*

6.3.1 Scale Title

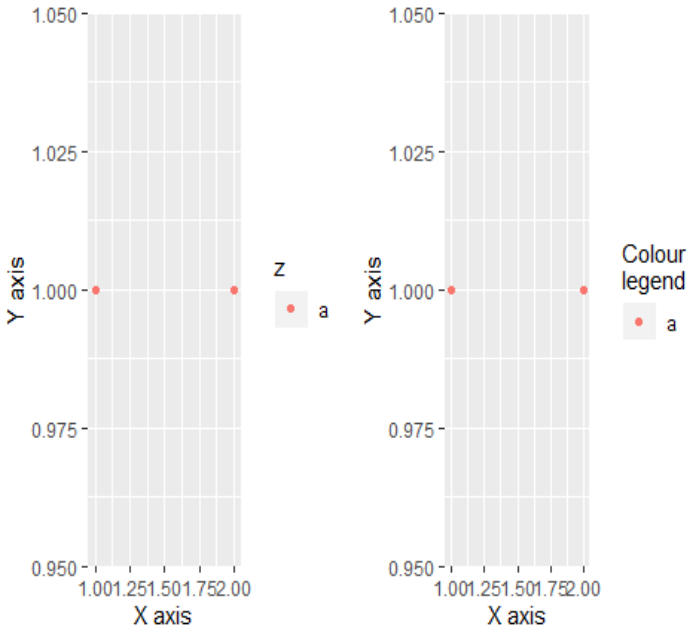
- the first argument to the scale function, **name**, is the axes/legend title.

```
df = data.frame(x = 1:2, y =1, z = "a")
p = ggplot(df, aes(x,y)) + geom_point()
p1 = p + scale_x_continuous("X axis")
p2 = p + scale_x_continuous(quote(a + alpha ^ 2)) # methematical expressions
by quote
grid.arrange(p1,p2, ncol=2)
```



-> save you some typing : xlab(), ylab(), labs()

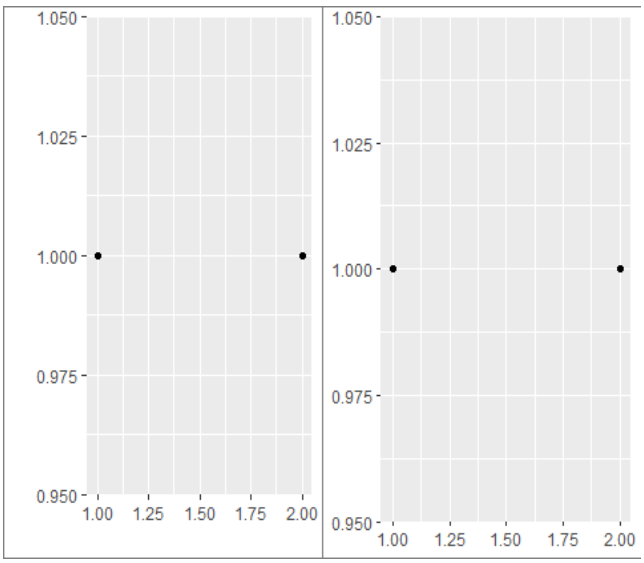
```
p <- ggplot(df, aes(x, y)) + geom_point(aes(colour = z))

p1 = p +
    xlab("X axis") +
    ylab("Y axis")

p2 = p + labs(x = "X axis", y = "Y axis", colour = "Colour\nlegend")

grid.arrange(p1,p2, ncol=2)
```



* two ways to remove the axia label :

1. “” omits the label, but still allocates space
2. NULL removes the label and its space

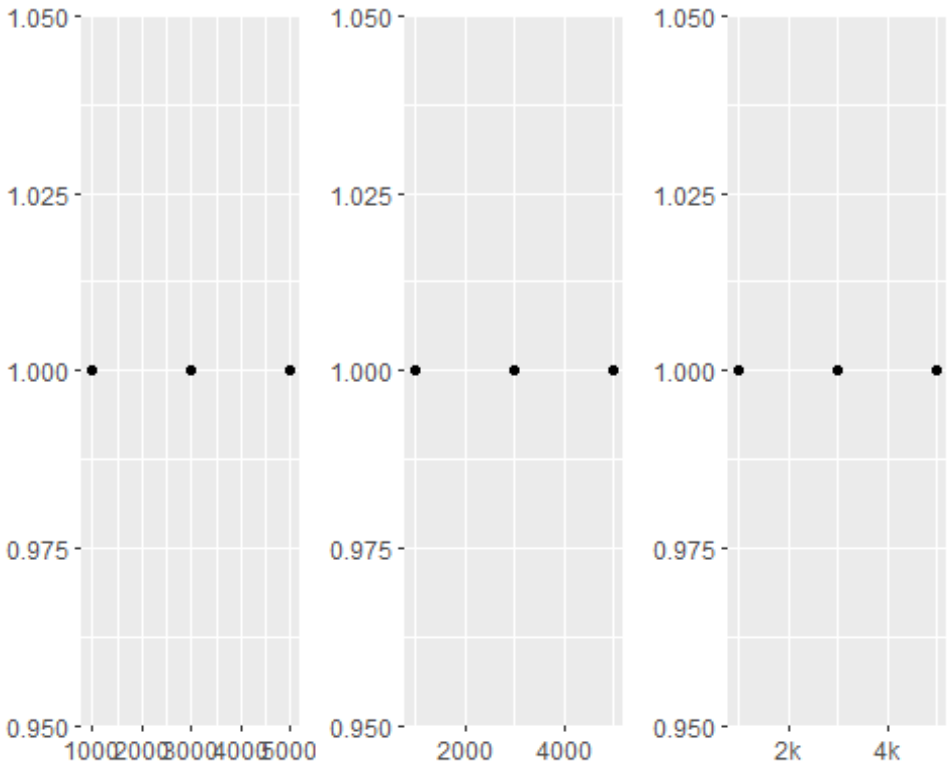
```
p <- ggplot(df, aes(x, y)) +
geom_point() +
theme(plot.background = element_rect(colour = "grey50"))

p1 = p + labs(x = "", y = "")
p2 = p + labs(x = NULL, y = NULL)

grid.arrange(p1,p2, ncol=2)
```



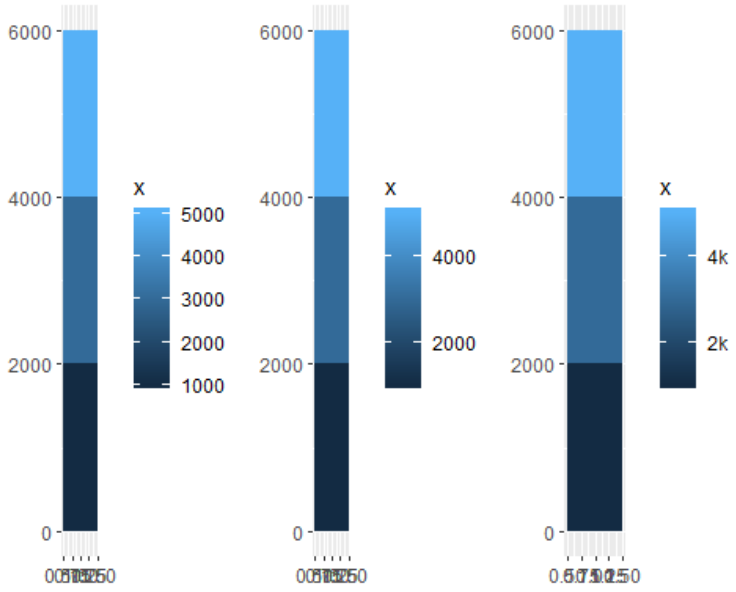
6.3.2 Breaks and Labels

breaks argument controls which values appear as tick marks on axes and keys on legends.

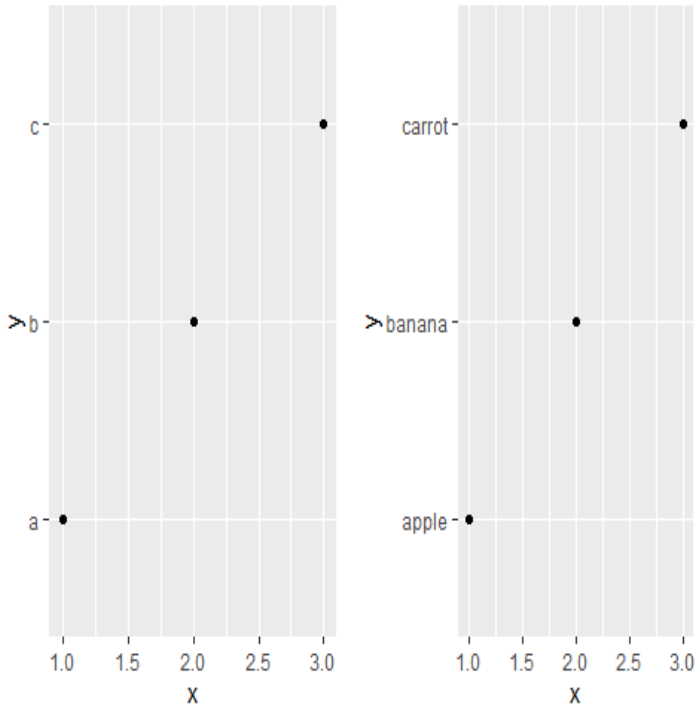
```
df = data.frame(x = c(1, 3, 5)*1000, y = 1)
axs = ggplot(df, aes(x, y)) +
  geom_point() +
  labs(x = NULL, y = NULL)

a1 = axs
a2 = axs + scale_x_continuous(breaks = c(2000,4000))
a3 = axs + scale_x_continuous(breaks = c(2000,4000), labels = c("2k", "4k"))

grid.arrange(a1,a2,a3, ncol = 3)
```




```
leg <- ggplot(df, aes(y, x, fill = x)) +
  geom_tile() +
  labs(x = NULL, y = NULL)

l1 = leg
l2 = leg + scale_fill_continuous(breaks = c(2000, 4000))
l3 = leg + scale_fill_continuous(breaks = c(2000, 4000), labels = c("2k", "4k
"))

grid.arrange(l1,l2,l3,ncol = 3)
```

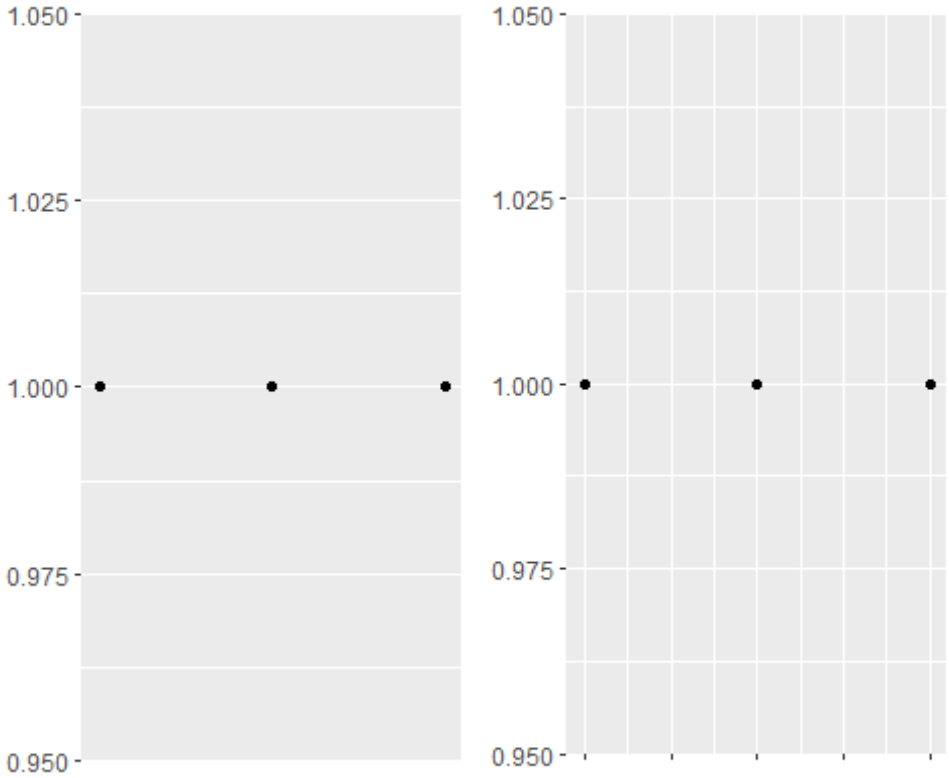



```
df2 <- data.frame(x = 1:3, y = c("a", "b", "c"))
p1 = ggplot(df2, aes(x, y)) +
  geom_point()
p2 = ggplot(df2, aes(x, y)) +
  geom_point() +
  scale_y_discrete(labels = c(a = "apple", b = "banana", c = "carrot"))

grid.arrange(p1, p2, ncol = 2)
```



To suppress breaks or labels : set them to NULL

```
a1 = axs + scale_x_continuous(breaks = NULL)
a2 = axs + scale_x_continuous(labels = NULL)

grid.arrange(a1, a2, ncol = 2)
```



u can supply a function to breaks or labels

- breaks function : should have one argument, the limits, and should return a numeric vector of breaks

- labels function : should accept a numeric vector of breaks and return a character vector of labels

usefull labelling functions :

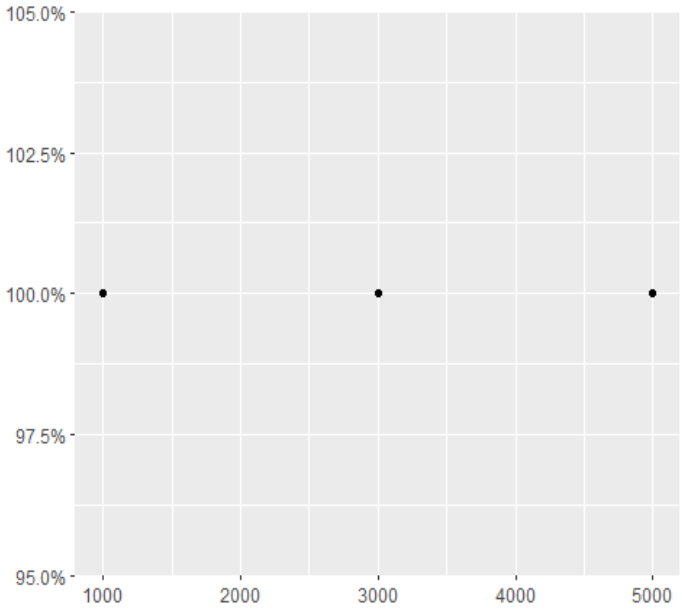
- scales::comma format() - adds commas to make it easier to read large numbers.

- scales::unit format(unit, scale) - adds a unit suffix, optionally scaling.

- scales::dollar format(prefix, suffix) - displays currency values, rounding to two decimal places and adding a prefix or suffix.

- scales::wrap format() - wraps long labels into multiple lines.

```
axs + scale_y_continuous(labels = scales::percent_format())
```

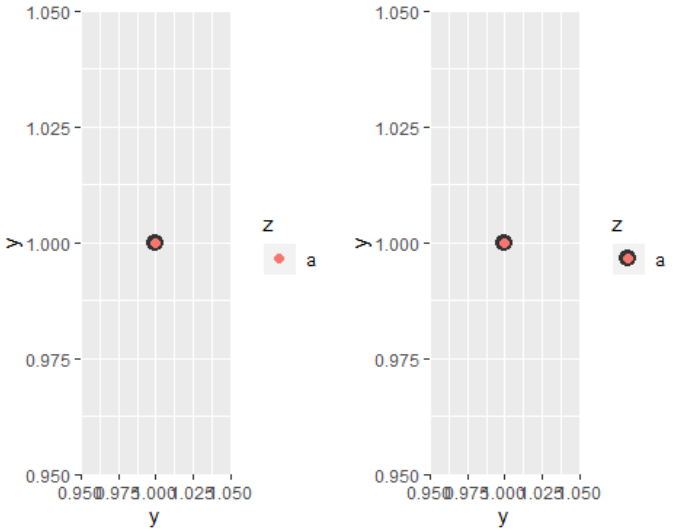


6.4 Legends

6.4.1 Layers and Legends

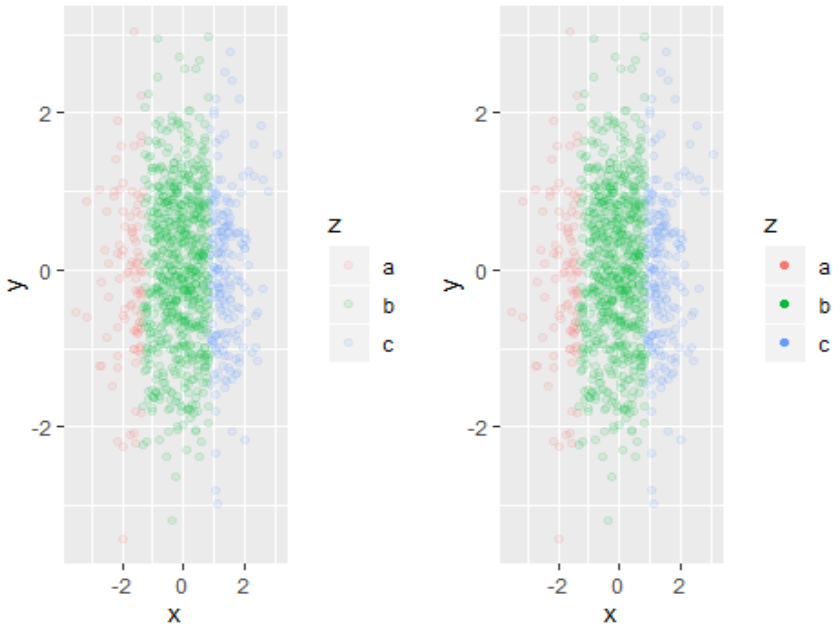
You can override whether or not a layer appears in the legend with : show.legend

```
df = data.frame(x = 1:2, y =1, z = "a")

p1 = ggplot(df, aes(y,y)) +
  geom_point(size = 4, color = "grey20") +
  geom_point(aes(color = z), size = 2)

p2 = ggplot(df, aes(y,y)) +
  geom_point(size = 4, color = "grey20", show.legend = TRUE) +
  geom_point(aes(color = z), size = 2)

grid.arrange(p1, p2, ncol = 2)
```



You can display differently to the geoms in the plot : override.aes

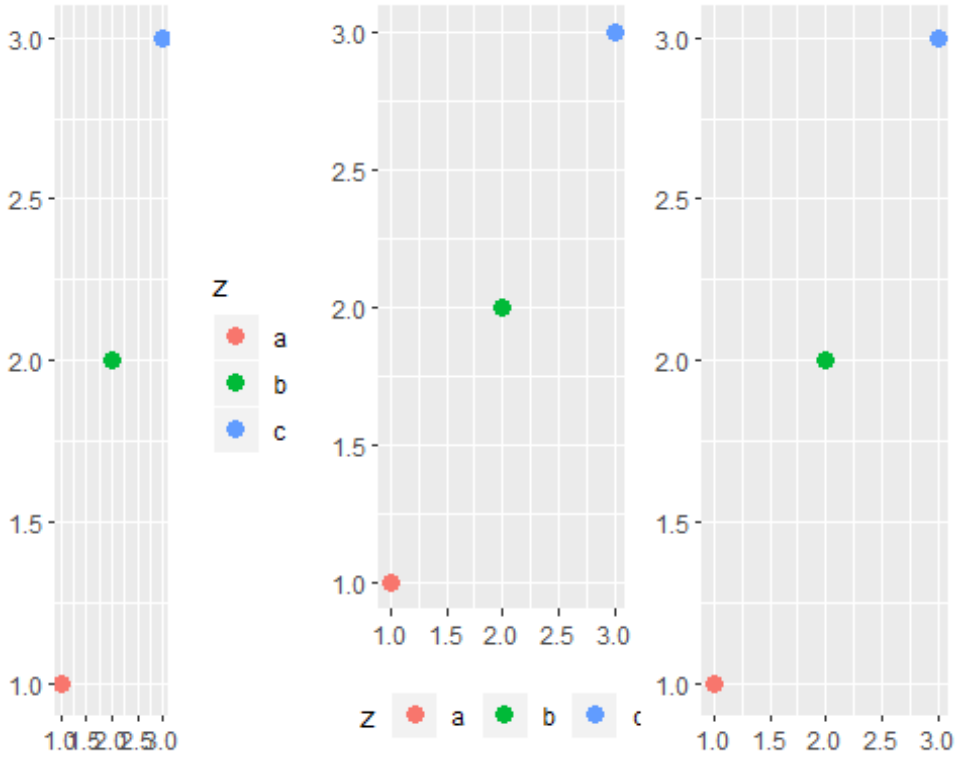
```
norm <- data.frame(x = rnorm(1000), y = rnorm(1000))
norm$z <- cut(norm$x, 3, labels = c("a", "b", "c"))

p1 = ggplot(norm, aes(x, y)) +
geom_point(aes(colour = z), alpha = 0.1)

p2 = ggplot(norm, aes(x, y)) +
geom_point(aes(colour = z), alpha = 0.1) +
guides(colour = guide_legend(override.aes = list(alpha = 1)))

grid.arrange(p1, p2, ncol = 2)
```



6.4.2 Legend Layout

overall display of the legends are controlled through the : theme()

```
df <- data.frame(x = 1:3, y = 1:3, z = c("a", "b", "c"))

base <- ggplot(df, aes(x, y)) +
geom_point(aes(colour = z), size = 3) +
xlab(NULL) +
ylab(NULL)

theme1 =  base + theme(legend.position = "right") # the default
theme2 =  base + theme(legend.position = "bottom")
theme3 =  base + theme(legend.position = "none")

grid.arrange(theme1, theme2, theme3, ncol = 3)
```

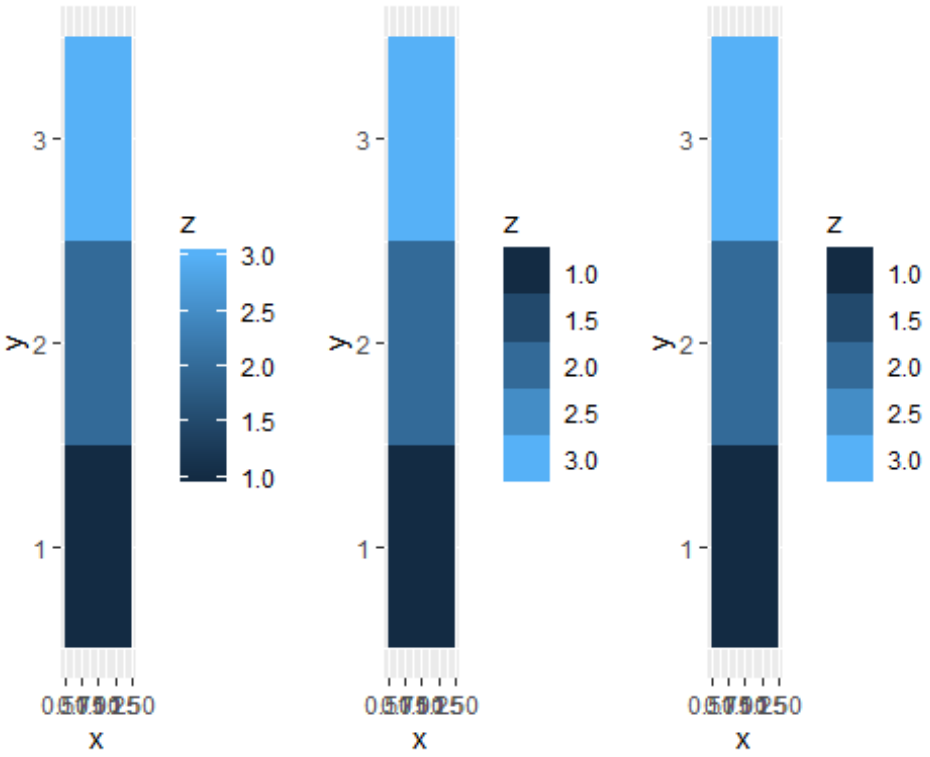


6.4.3 Guide Functions

* guide_colourbar()

* guide_legend()

```
df <- data.frame(x = 1, y = 1:3, z = 1:3)
base <- ggplot(df, aes(x, y)) + geom_raster(aes(fill = z))

g1 = base
g2 = base + scale_fill_continuous(guide = guide_legend())
g3 = base + guides(fill = guide_legend()) # guides() works like labs()

grid.arrange(g1,g2,g3, ncol = 3)
```



guide_legend() : usefull options!!

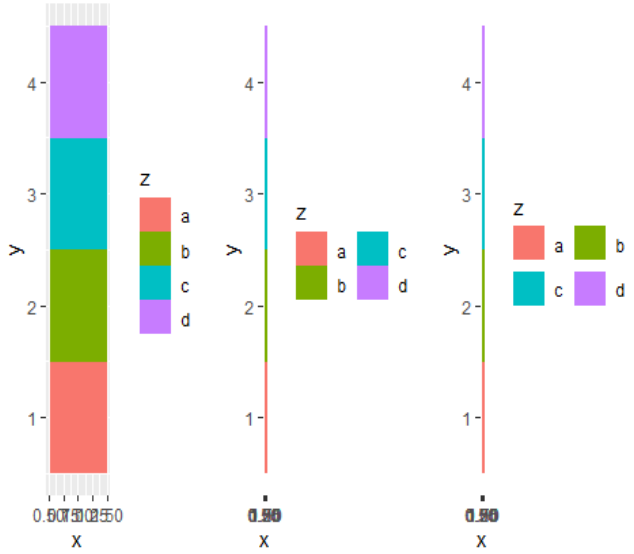
- nrow, ncol

- reverse

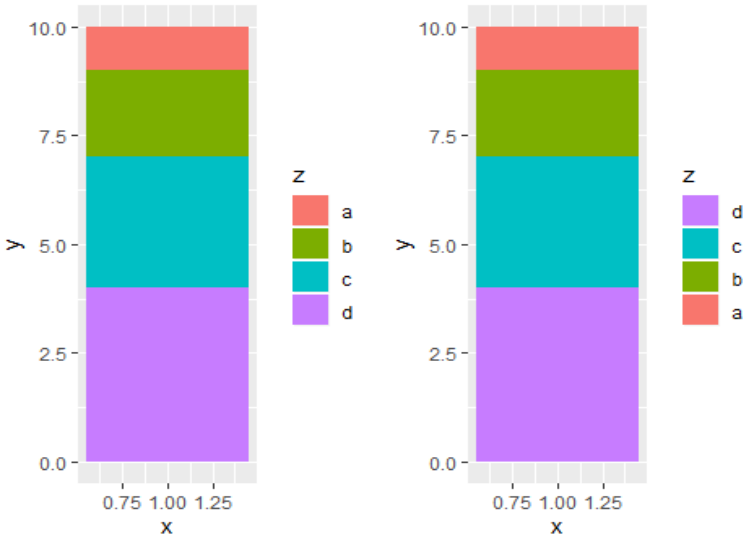
- override.aes

- keywidth, keyheight : specify the size of the keys

```r
# 1. nrow, ncol
df <- data.frame(x = 1, y = 1:4, z = letters[1:4])
p <- ggplot(df, aes(x, y)) + geom_raster(aes(fill = z))
p1 = p
p2 = p + guides(fill = guide_legend(ncol = 2))
p3 = p + guides(fill = guide_legend(ncol = 2, byrow = TRUE))

grid.arrange(p1,p2,p3, ncol = 3)
```




```r
# 2. reverse
p <- ggplot(df, aes(1, y)) + geom_bar(stat = "identity", aes(fill = z))
p1 = p
p2= p + guides(fill = guide_legend(reverse = TRUE))

grid.arrange(p1,p2, ncol = 2)
```

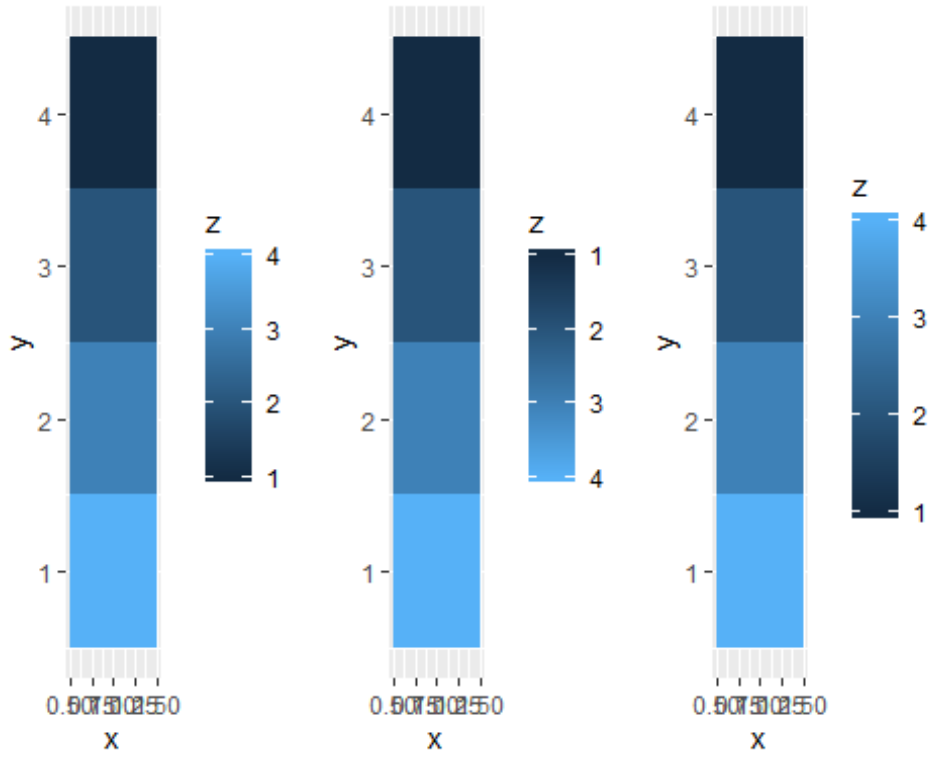


guide_colourbar

- barwidth and barheight (along with default.unit) : allow you to specify the size of the bar. These are grid units, e.g. unit(1, “cm”).

- nbin : controls the number of slices. - reverse : flips the colour bar to put the lowest values at the top.

```
df <- data.frame(x = 1, y = 1:4, z = 4:1)
p <- ggplot(df, aes(x, y)) + geom_tile(aes(fill = z))
p1 = p
p2 = p + guides(fill = guide_colorbar(reverse = TRUE))
p3 = p + guides(fill = guide_colorbar(barheight = unit(4, "cm")))

grid.arrange(p1,p2,p3, ncol = 3)
```

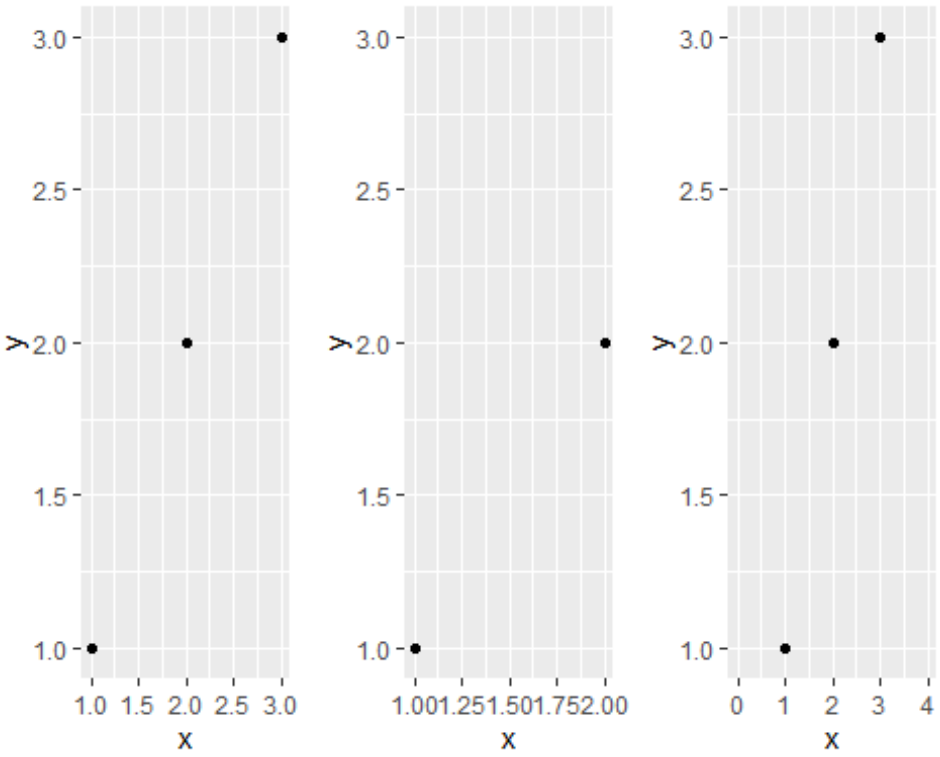


6.5 Limits

- For continuous scales : numeric vector of length two
- For discrete scales : charatoer vector which enumerates all possible values
- you only want to set the upper or lower limit, set the other value to NA

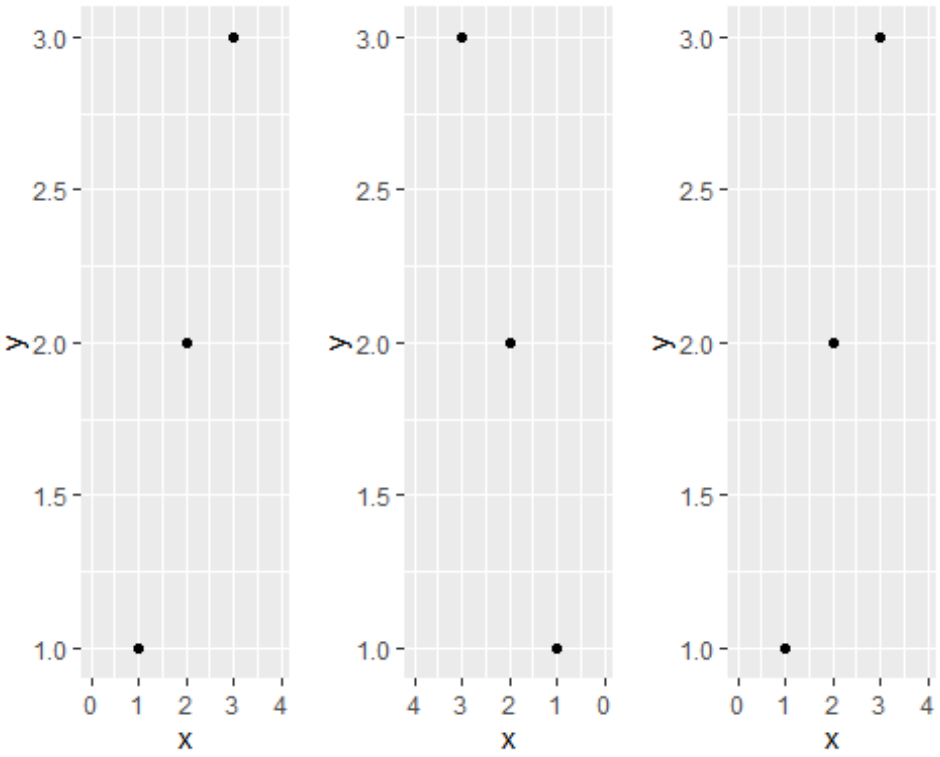
```
df = data.frame(x = 1:3, y = 1:3)
base = ggplot(df, aes(x, y)) + geom_point()

p1 = base
p2 = base + scale_x_continuous(limits = c(1,2))
p3 = base + scale_x_continuous(limits = c(0,4))

grid.arrange(p1,p2,p3, ncol = 3)
```

```
## Warning: Removed 1 rows containing missing values (geom_point).
```



easier : xlim(), ylim(), lims()

```
p1 = base + xlim(0, 4)
p2 = base + xlim(4, 0)
p3 = base + lims(x = c(0, 4))

grid.arrange(p1,p2,p3, ncol = 3)
```



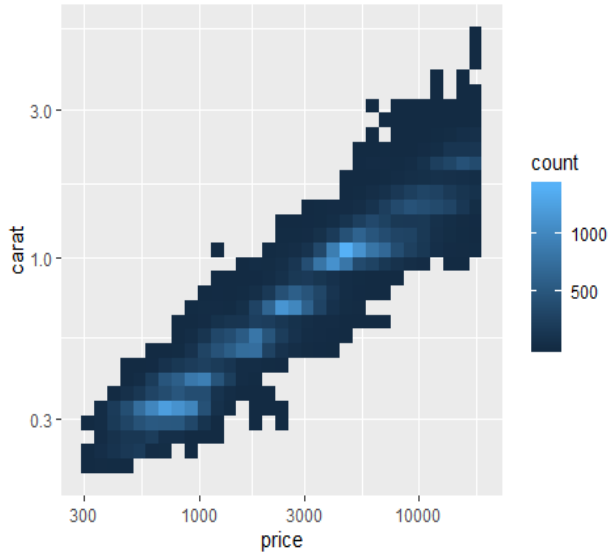
6.6 Scales Toolbox

6.6.1 Continuous Position Scales

The most common continuous position scales are

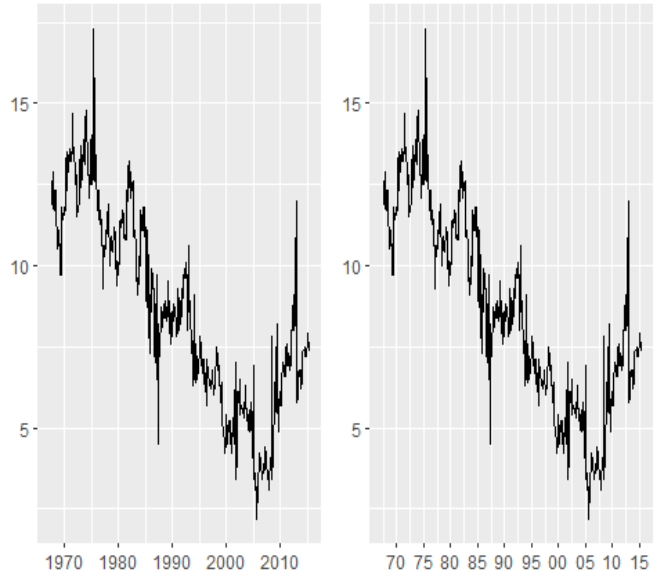
- scale_x_continuous scale_y_continuous

```
# trans argument
# there are many "transfomer"

ggplot(diamonds, aes(price, carat)) +
  geom_bin2d() +
  scale_x_continuous(trans = "log10") +
  scale_y_continuous(trans = "log10")
```



If you use a transformed scale, the axes will be labelled in the original data space; if you transform the data, the axes will be labelled in the transformed space.

```
# Data & date/time data
# -> date_breaks : position breaks by date units
# -> date_labels : controls the display of the labels
base <- ggplot(economics, aes(date, psavert)) +
geom_line(na.rm = TRUE) +
  labs(x = NULL, y = NULL)

p1 = base # Default breaks and labels
p2 = base + scale_x_date(date_labels = "%y", date_breaks = "5 years")
grid.arrange(p1,p2,ncol = 2)
```



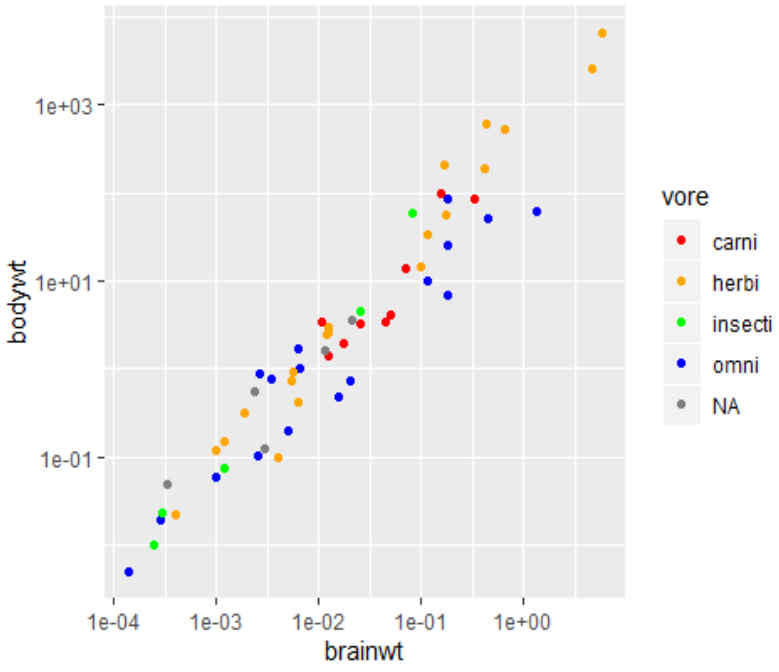
6.6.2 Colour

6.6.3 The Manual Discrete Scale

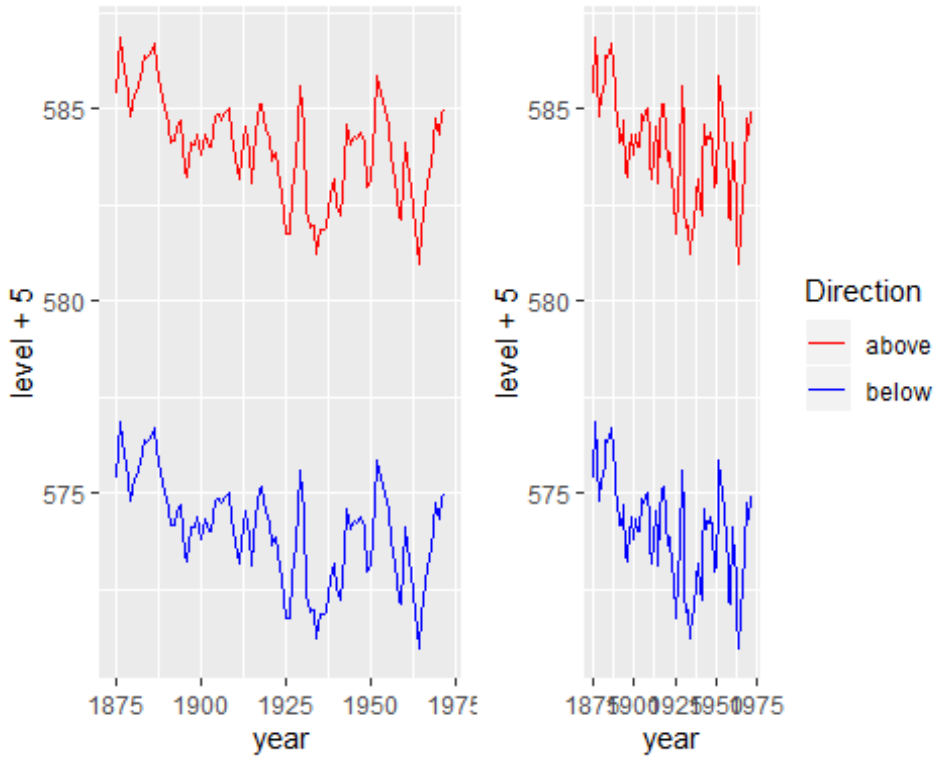
To customise these scales, create your own new scale with the manual scale!

```
plot <- ggplot(msleep, aes(brainwt, bodywt)) +
  scale_x_log10() +
  scale_y_log10()

colours <- c(
carni = "red",
insecti = "orange",
herbi = "green",
omni = "blue"
)

plot +
  geom_point(aes(colour = vore)) +
  scale_colour_manual(
    values = c("red", "orange", "green", "blue"), # you can : values = colour
s
    na.value = "grey50"
  )
```

```
## Warning: Removed 27 rows containing missing values (geom_point).
```



```
huron <- data.frame(year = 1875:1972, level = as.numeric(LakeHuron))

p1 = ggplot(huron, aes(year)) +
  geom_line(aes(y = level + 5), colour = "red") +
  geom_line(aes(y = level - 5), colour = "blue")

p2 = ggplot(huron, aes(year)) +
  geom_line(aes(y = level + 5, colour = "above")) +
  geom_line(aes(y = level - 5, colour = "below")) +
  scale_colour_manual("Direction",
                      values = c("above" = "red", "below" = "blue")
                      )

grid.arrange(p1,p2,ncol=2)
```



6.6.4 The identity Scale

Used when data is already scaled!

```
head(luv_colours)
```

```
##          L             u         v           col
## 1 9341.570 -3.370649e-12    0.0000         white
## 2 9100.962 -4.749170e+02 -635.3502     aliceblue
## 3 8809.518  1.008865e+03 1668.0042  antiquewhite
## 4 8935.225  1.065698e+03 1674.5948 antiquewhite1
```

```
## 5 8452.499  1.014911e+03 1609.5923 antiquewhite2
## 6 7498.378  9.029892e+02 1401.7026 antiquewhite3
```

```
ggplot(luv_colours, aes(u, v)) +
  geom_point(aes(colour = col), size = 3) +
  scale_color_identity() +
  coord_equal()
```