



Beautiful plotting in R: A ggplot2 cheatsheet

Posted on August 4, 2014 by zev@zevross.com · 49 Comments

Even the most experienced R users need help creating elegant graphics. The `ggplot2` library is a phenomenal tool for creating graphics in R but even after many years of near-daily use we still need to refer to our Cheat Sheet. Up until now, we've kept these key tidbits on a local PDF. But for our own benefit (and hopefully yours) we decided to post the most useful bits of code.

* Last updated January 20, 2016 (with `ggplot2` 2.0 replace `vjust` with `margin` for title text)

You may also be interested in these other `ggplot2`-related posts:

[Under the hood of ggplot2 graphics in R](#)

[Mapping in R using the ggplot2 package](#)

[A new data processing workflow for R: dplyr, magrittr, tidyr and ggplot2](#)

We start with the the quick setup and a default plot followed by a range of adjustments below.

- [Quick-setup: The dataset](#)
- [A default plot in ggplot2](#)
- [Working with the title](#)
 - [Add a title \(`ggtitle\(\)` or `labs\(\)`\)](#)
 - [Make title bold and add a little space at the baseline \(`face, margin`\)](#)
 - [Use a non-traditional font in your title \(`family`\)](#)
 - [Change spacing in multi-line text \(`lineheight`\)](#)
- [Working with axes](#)
 - [Add x and y axis labels \(`labs\(\), xlab\(\)`\)](#)
 - [Get rid of axis tick and labels \(`theme\(\), axis.ticks.y`\)](#)
 - [Change size of and rotate tick text \(`axis.text.x`\)](#)
 - [Move the labels away from the plot \(and add color\) \(`theme\(\), axis.title.x`\)](#)
 - [Limit an axis to a range \(`ylim, scale_x_continuous\(\), coord_cartesian\(\)`\)](#)
 - [If you want the axes to be the same \(`coord_equal\(\)`\)](#)
 - [Use a function to alter labels \(`label=function\(x\){}`\)](#)
- [Working with the legend](#)
 - [Turn off the legend title \(`legend.title`\)](#)
 - [Change the styling of the legend title \(`legend.title`\)](#)
 - [Change the title of the legend \(`name`\)](#)

- [Change the background boxes in the legend \(`legend.key`\)](#)
- [Change the size of the symbols in the legend only \(`guides\(\)`, `guide_legend`\)](#)
- [Leave a layer off the legend \(`show_guide`\)](#)
- [Manually adding legend items \(`guides\(\)`, `override.aes`\)](#)
- [Working with the background colors](#)
 - [Change the panel color \(`panel.background`\)](#)
 - [Change the grid lines \(`panel.grid.major`\)](#)
 - [Change the plot background \(not the panel\) color \(`plot.background`\)](#)
- [Working with margins](#)
 - [Changing the plot margin \(`plot.margin`\)](#)
- [Working with multi-panel plots](#)
 - [Create a single row of plots based on one variable \(`facet_wrap\(\)`\)](#)
 - [Create a matrix of plots based on one variable \(`facet_wrap\(\)`\)](#)
 - [Allow scales to roam free \(`scales`\)](#)
 - [Create a grid of plots using two variables \(`facet_grid\(\)`\)](#)
 - [Put two \(potentially unrelated\) plots side by side \(`pushViewport\(\)`, `grid.arrange\(\)`\)](#)
- [Working with themes](#)
 - [Use a new theme \(`theme_xx\(\)`\)](#)
 - [Change the size of all plot text elements \(`theme_set\(\)`, `base_size`\)](#)
 - [Tip on creating a custom theme](#)
- [Working with colors](#)
 - [Categorical variables: manually select the colors \(`scale_color_manual`\)](#)
 - [Categorical variables: try a built-in palette \(based on colorbrewer2.org\) \(`scale_color_brewer`\):](#)
 - [Color choice with continuous variables \(`scale_color_gradient\(\)`, `scale_color_gradient2\(\)`\)](#)
- [Working with annotation](#)
 - [Add text annotation in the top-right, top-left etc. \(`annotation_custom\(\)` and `textGrob\(\)`\)](#)
- [Working with coordinates](#)
 - [Flip a plot on it's side \(`coord_flip\(\)`\)](#)
- [Working with plot types](#)
 - [Alternatives to the box plot \(`geom_jitter\(\)` and `geom_violin\(\)`\)](#)
 - [Create a ribbon \(`geom_ribbon\(\)`\)](#)
 - [Create a tiled correlation plot \(`geom_tile\(\)`\)](#)
- [Working with smooths](#)
 - [Default – adding LOESS or GAM \(`stat_smooth\(\)`\)](#)
 - [Specifying the formula \(`stat_smooth\(formula=\)`\)](#)
 - [Adding a linear fit \(`stat_smooth\(method="lm"\)`\)](#)
- [Create interactive, online versions of your plots \(easier than you think\)](#)

Quick-setup: The dataset

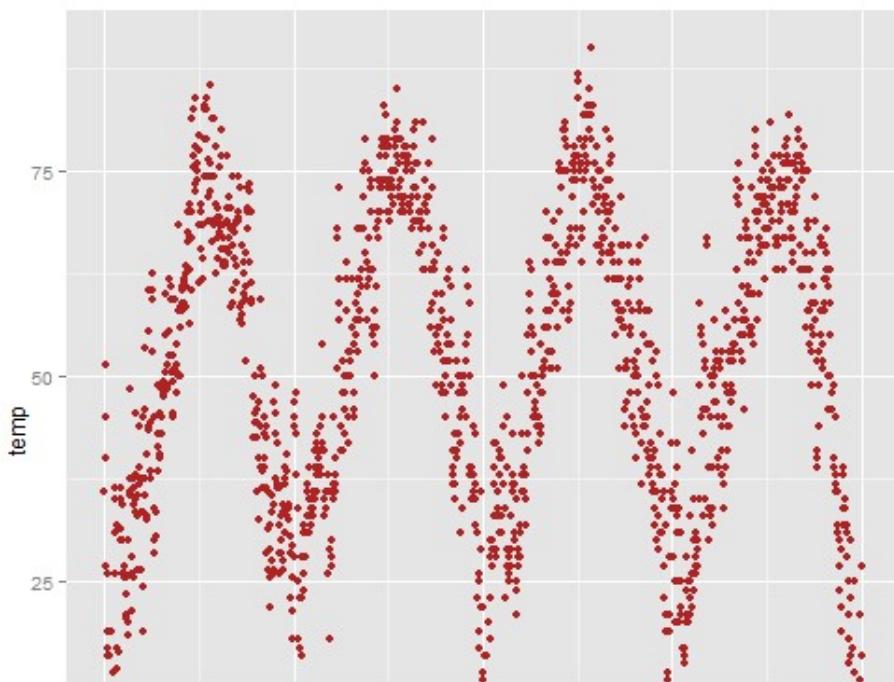
We're using data from the National Morbidity and Mortality Air Pollution Study (NMMAPS). To make the plots manageable we're limiting the data to Chicago and 1997-2000. For more detail on this dataset, consult Roger Peng's book [Statistical Methods in Environmental Epidemiology with R](#).

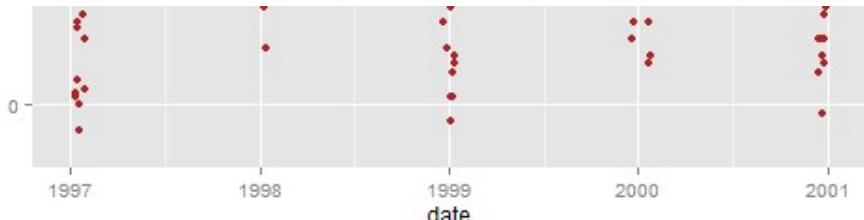
You can also download the data we're using in this post [here](#).

```
library(ggplot2)
nmmaps<-read.csv("chicago-nmmaps.csv", as.is=T)
nmmaps$date<-as.Date(nmmaps$date)
nmmaps<-nmmaps[nmmaps$date>as.Date("1996-12-31"),]
nmmaps$year<-substring(nmmaps$date,1,4)
head(nmmaps)
##      city      date death temp dewpoint pm10    o3 time season year
## 3654 chic 1997-01-01 137 36.0    37.50 13.052 5.659 3654 winter 1997
## 3655 chic 1997-01-02 123 45.0    47.25 41.949 5.525 3655 winter 1997
## 3656 chic 1997-01-03 127 40.0    38.00 27.042 6.289 3656 winter 1997
## 3657 chic 1997-01-04 146 51.5    45.50 25.073 7.538 3657 winter 1997
## 3658 chic 1997-01-05 102 27.0    11.25 15.343 20.761 3658 winter 1997
## 3659 chic 1997-01-06 127 17.0     5.75  9.365 14.941 3659 winter 1997
```

A default plot in ggplot2

```
g<-ggplot(nmmaps, aes(date, temp))+geom_point(color="firebrick")
g
```



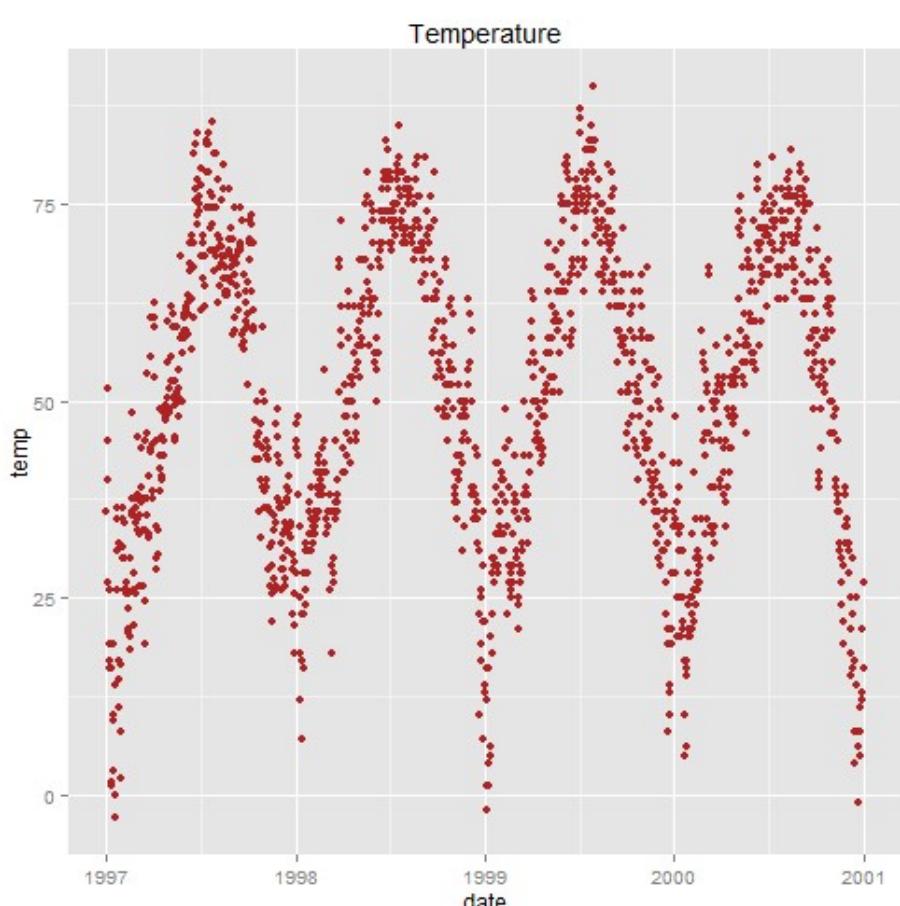


[Back to table of contents](#)

Working with the title

Add a title (`ggtitle()` or `labs()`)

```
g<-g+ggtitle('Temperature')  
g
```



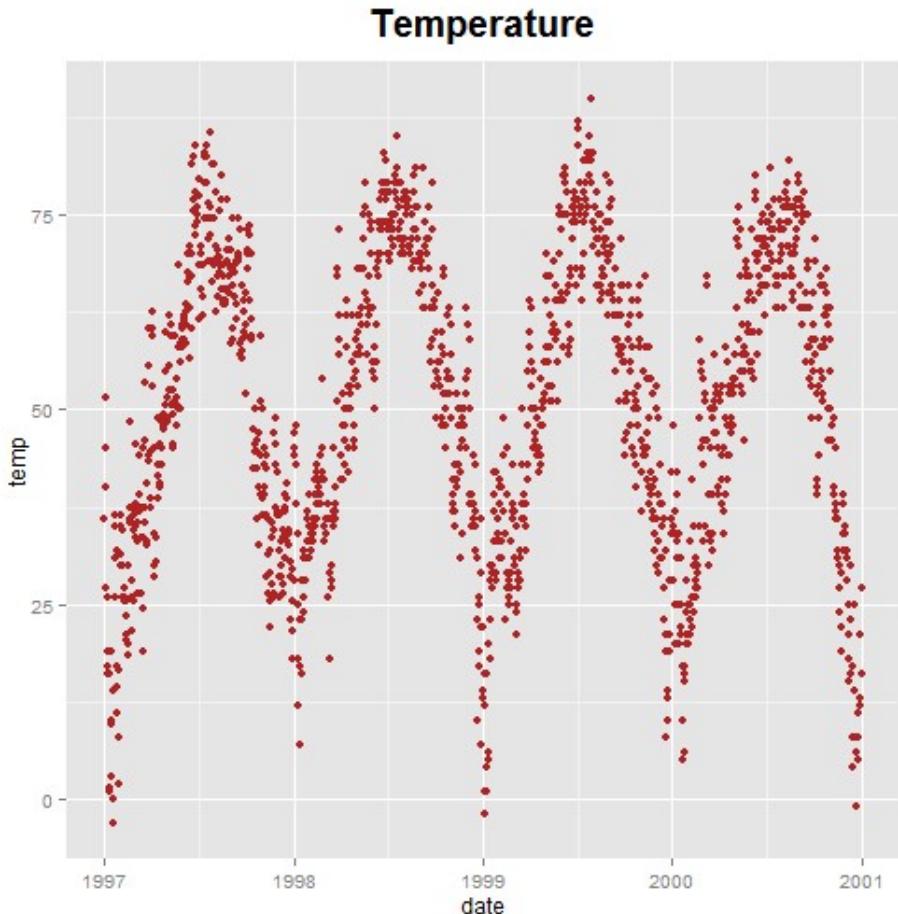
Alternatively, you can use `g+labs(title='Temperature')`

[Back to table of contents](#)

Make title bold and add a little space at the baseline (face, margin)

In ggplot2 versions before 2.0 I used the `vjust` argument to move the title away from the plot. With 2.0 this no longer works and a blog comment (below) helped me identify an alternative using [this link](#). The `margin` argument uses the `margin` function and you provide the top, right, bottom and left margins (the default unit is points).

```
g+theme(plot.title = element_text(size=20, face="bold",
  margin = margin(10, 0, 10, 0)))
```



[Back to table of contents](#)

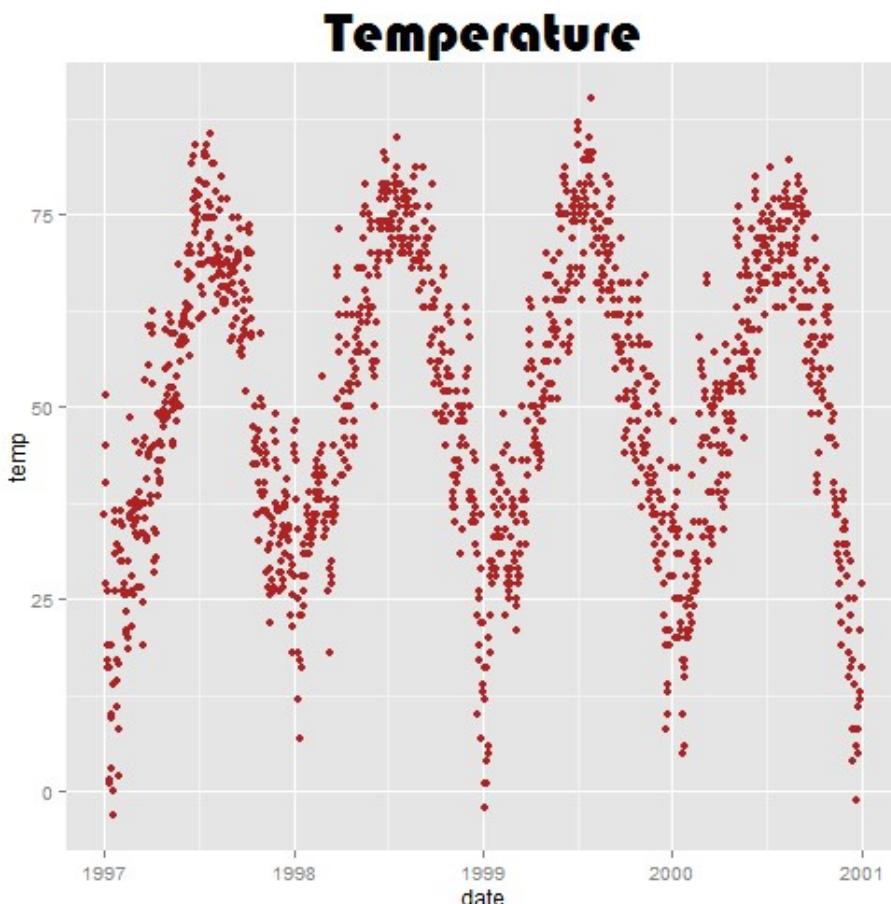
Use a non-traditional font in your title (family)

Note that you can also use different fonts. It's not as easy as it seems here, check out [this post](#) if you need to use different fonts. This may not work on a Mac (send me a note and let me know).

If you are having trouble with this you might take a look at this [StackOverflow](#) discussion.

```
library(extrafont)
```

```
g+theme(plot.title = element_text(size=30, lineheight=.8,
  vjust=1, family="Bauhaus 93"))
```

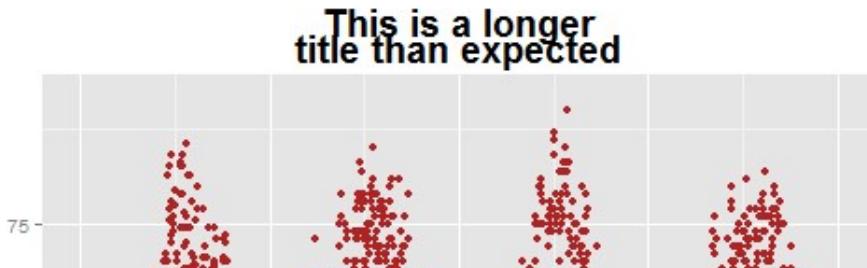


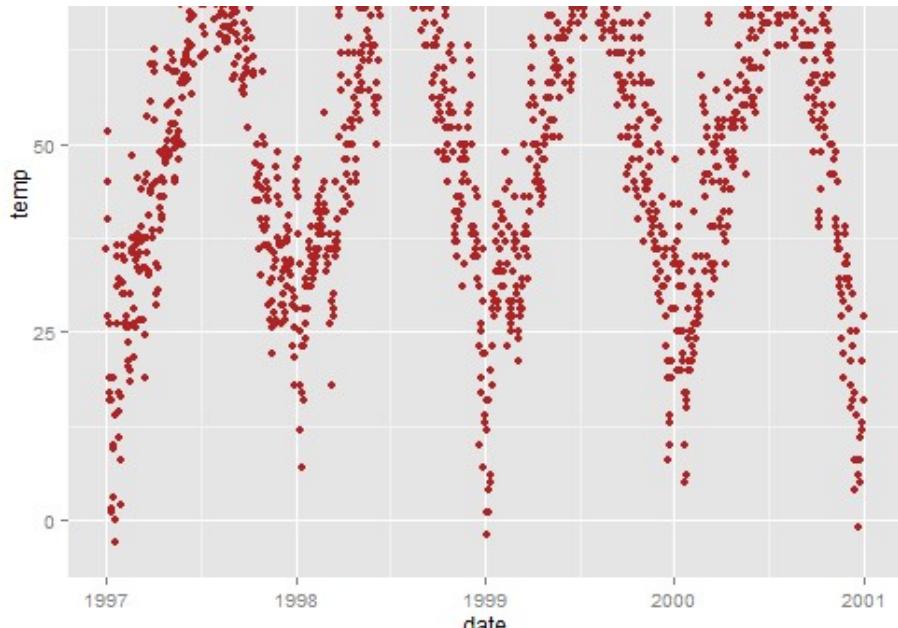
[Back to table of contents](#)

Change spacing in multi-line text (lineheight)

You can use the `lineheight` argument to change the spacing between lines. In this example, I've squished the lines together a bit (`lineheight < 1`).

```
g<-g+ggtitle("This is a longer\n\ttitle than expected")
g+theme(plot.title = element_text(size=20, face="bold", vjust=1, lineheight=0.6))
```





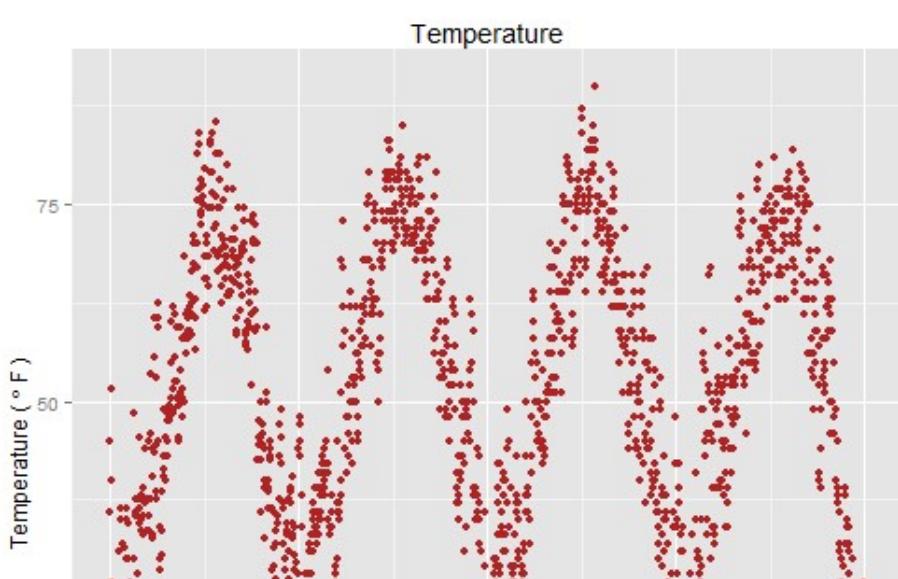
[Back to table of contents](#)

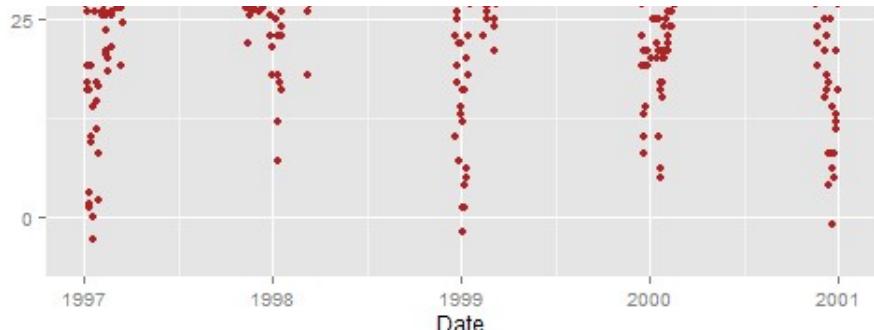
Working with axes

Add x and y axis labels (`labs()`, `xlab()`)

The easiest is:

```
g<-g+labs(x="Date", y=expression(paste("Temperature ( ", degree ~ F, " )")), title="Temperature")  
g
```



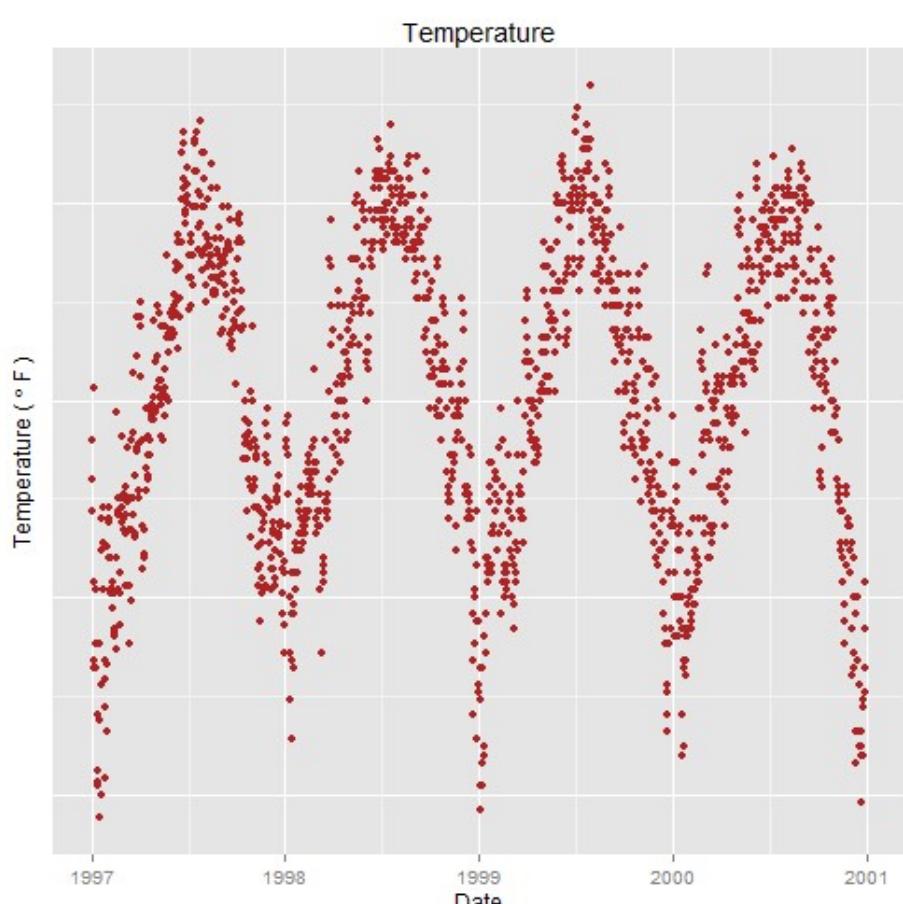


[Back to table of contents](#)

Get rid of axis ticks and tick text (`theme()`, `axis.ticks.y`)

I wouldn't normally do this but demonstration purposes:

```
g + theme(axis.ticks.y = element_blank(), axis.text.y = element_blank())
```

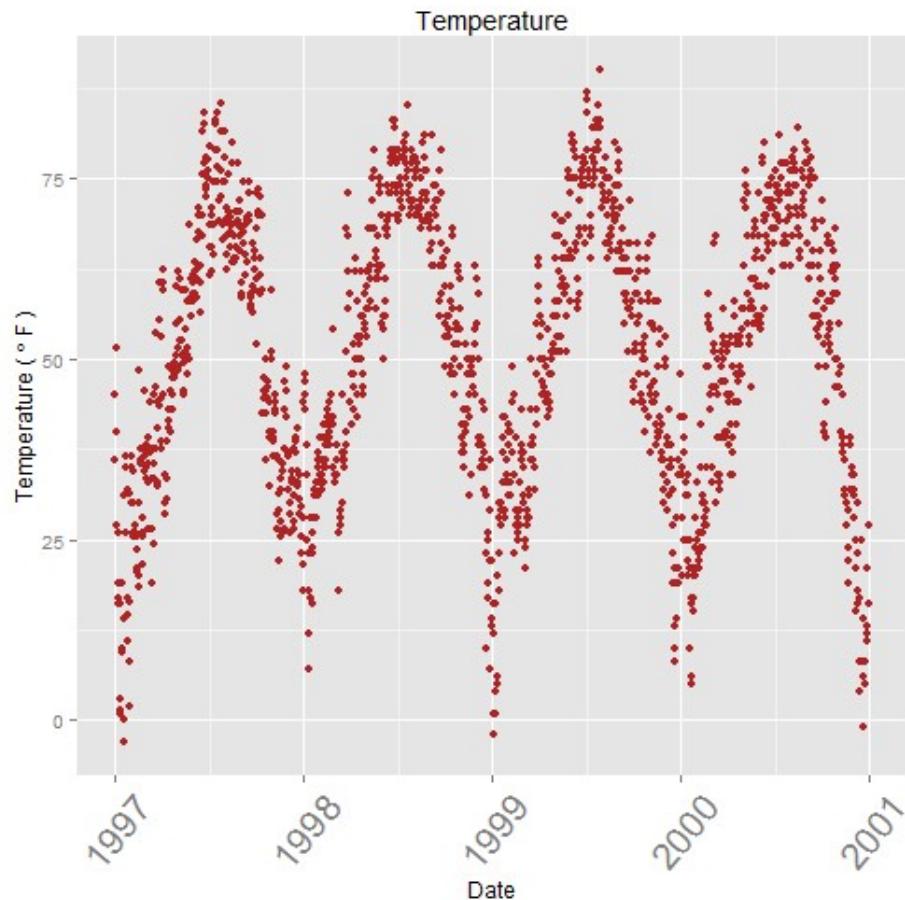


[Back to table of contents](#)

Change size of and rotate tick text (`axis.text.x`)

Go ahead, try to say ‘tick text’ three times fast.

```
g + theme(axis.text.x=element_text(angle=50, size=20, vjust=0.5))
```

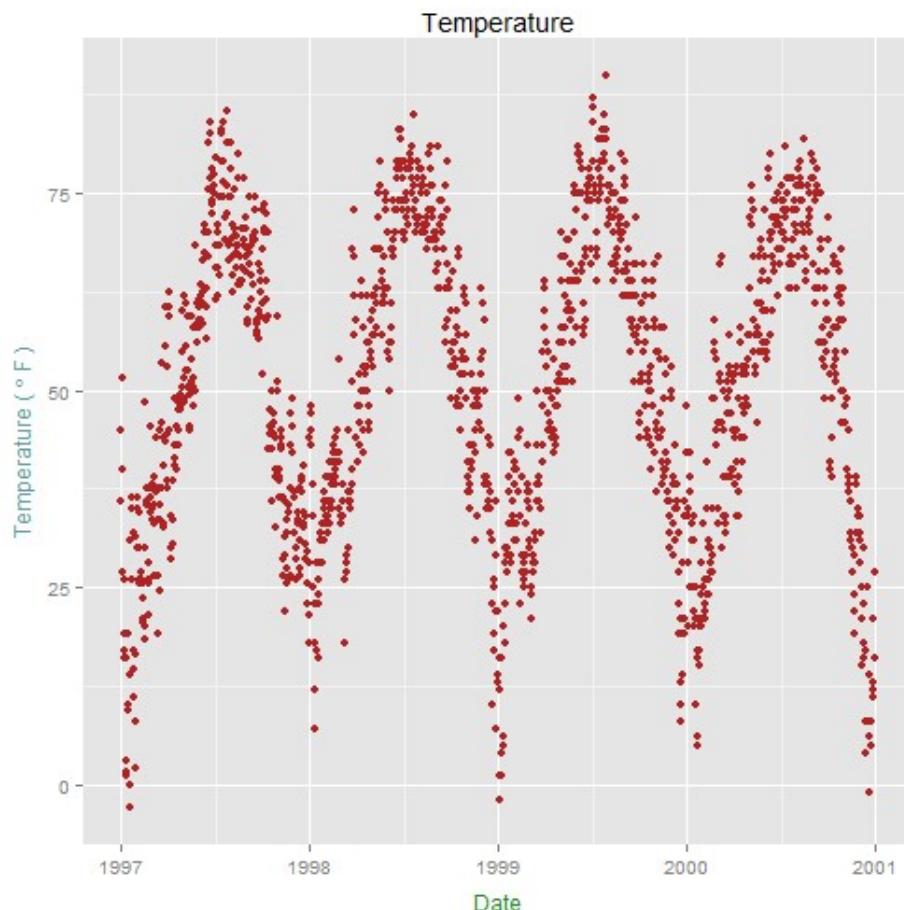


[Back to table of contents](#)

Move the labels away from the plot (and add color) (`theme()`, `axis.title.x`)

I find that the labels are too close to the plot in the default settings so, similar to with the title, I'm using the `vjust` argument.

```
g + theme(
  axis.title.x = element_text(color="forestgreen", vjust=-0.35),
  axis.title.y = element_text(color="cadetblue" , vjust=0.35)
)
```

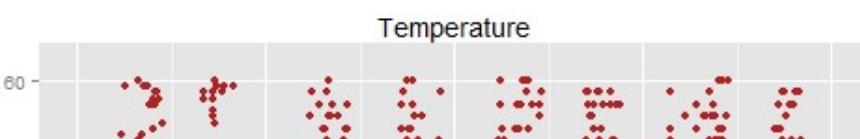


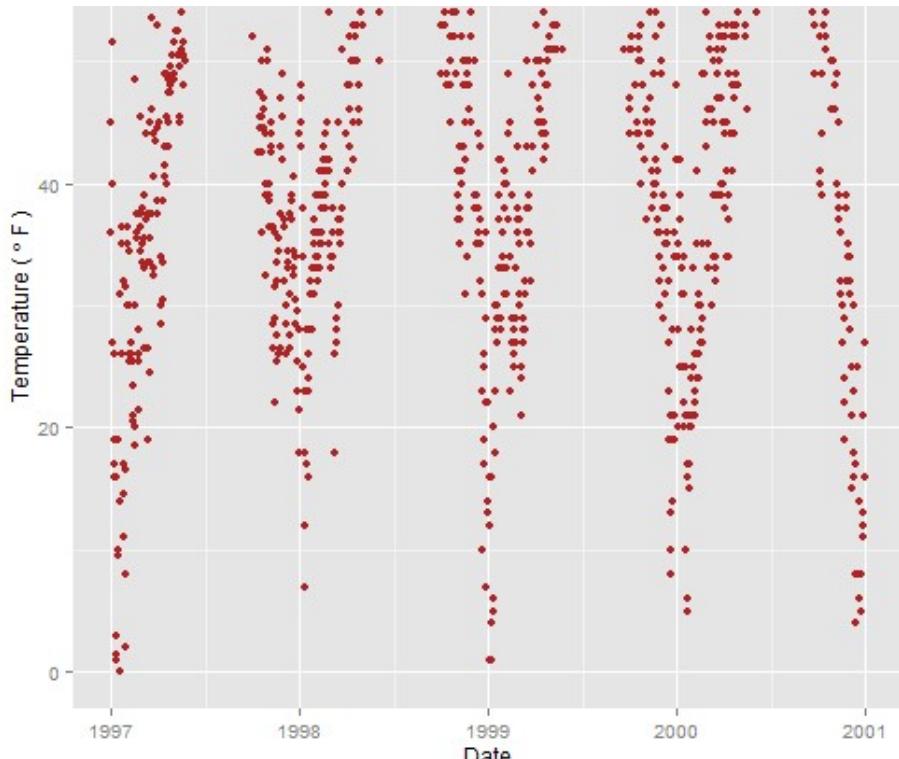
[Back to table of contents](#)

Limit an axis to a range (`ylim()`, `scale_x_continuous()`, `coord_cartesian()`)

Again, this plot is for demonstration purposes:

```
g + ylim(c(0,60))
```





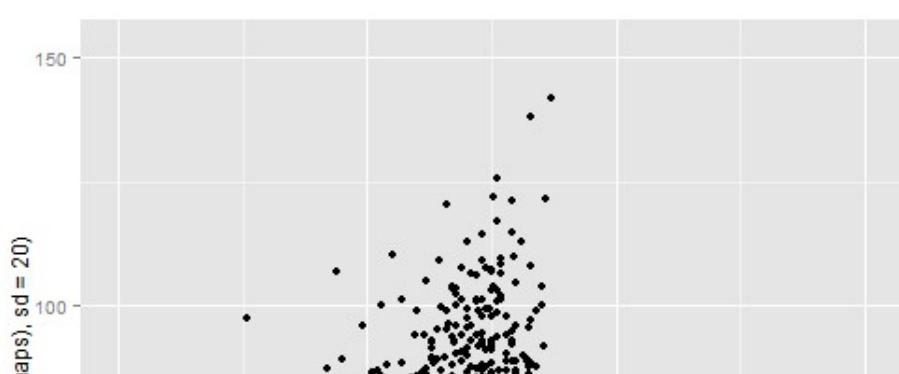
Alternatively: `g+scale_x_continuous(limits=c(0,35))` or `g+coord_cartesian(xlim=c(0,35))`. The former removes all data points outside the range and second adjusts the visible area.

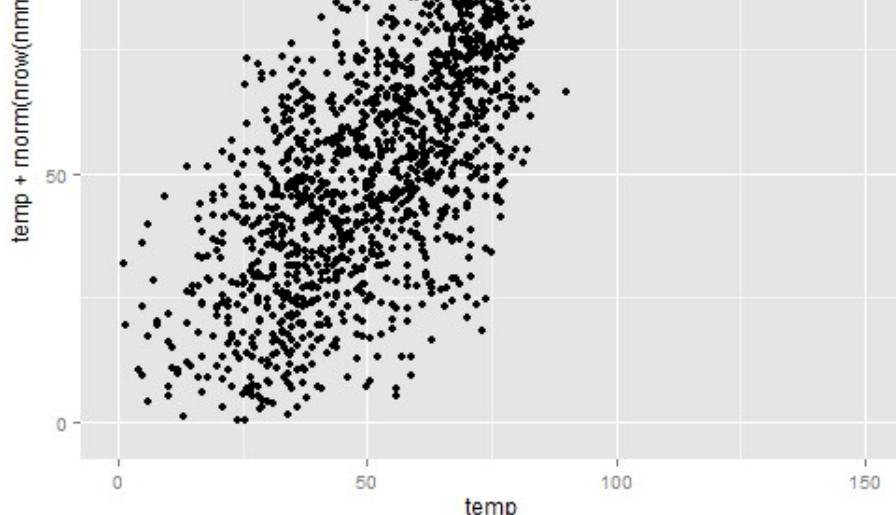
[Back to table of contents](#)

If you want the axes to be the same (`coord_equal()`)

There must be a better way than this. In the example, I'm plotting temperature against temperature with some random noise (for demonstration purposes) and I want both axes to be the same scale/same range.

```
ggplot(nmmaps, aes(temp, temp+rnorm(nrow(nmmaps), sd=20)))+geom_point()+
  xlim(c(0,150))+ylim(c(0,150))+  
  coord_equal()
```



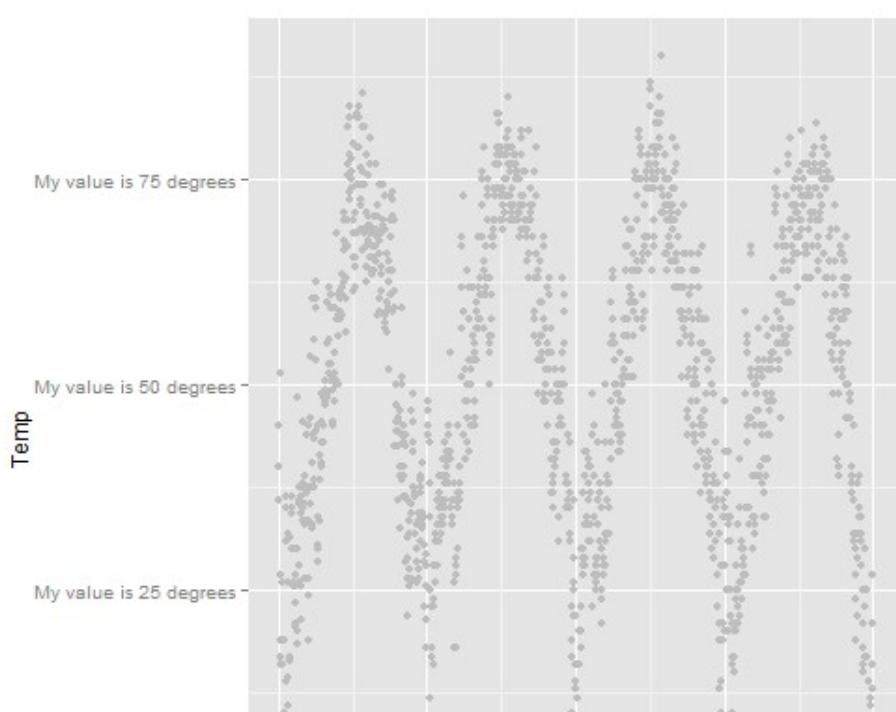


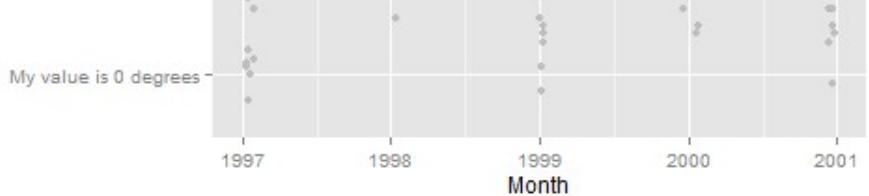
[Back to table of contents](#)

Use a function to alter labels (`label=function(x){}`)

Sometimes it's handy to alter your labels a little, perhaps adding units or percent signs without adding them to your data. You can use a function in this case. Here is an example:

```
ggplot(nmmmaps, aes(date, temp))+  
  geom_point(color="grey") +  
  labs(x="Month", y="Temp") +  
  scale_y_continuous(label=function(x){return(paste("My value is", x, "degrees"))})
```





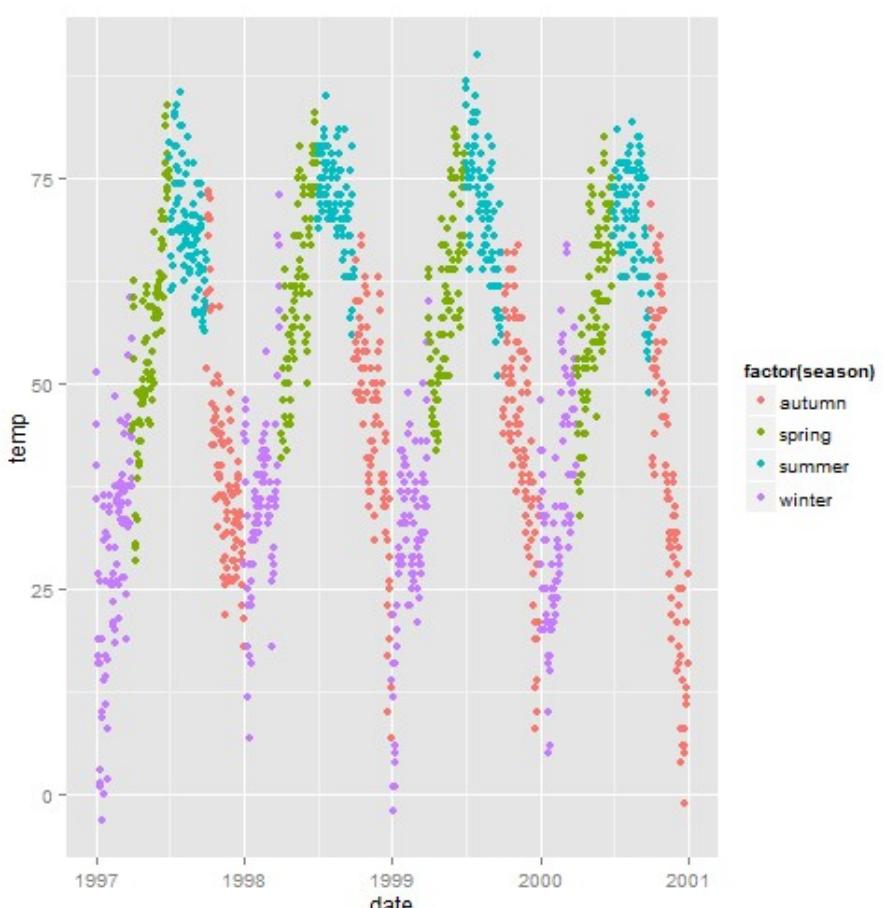
Not pretty here, but this can come in handy.

[Back to table of contents](#)

Working with the legend

We will color code the plot based on season. You can see that by default the legend title is what we specified in the `color` argument.

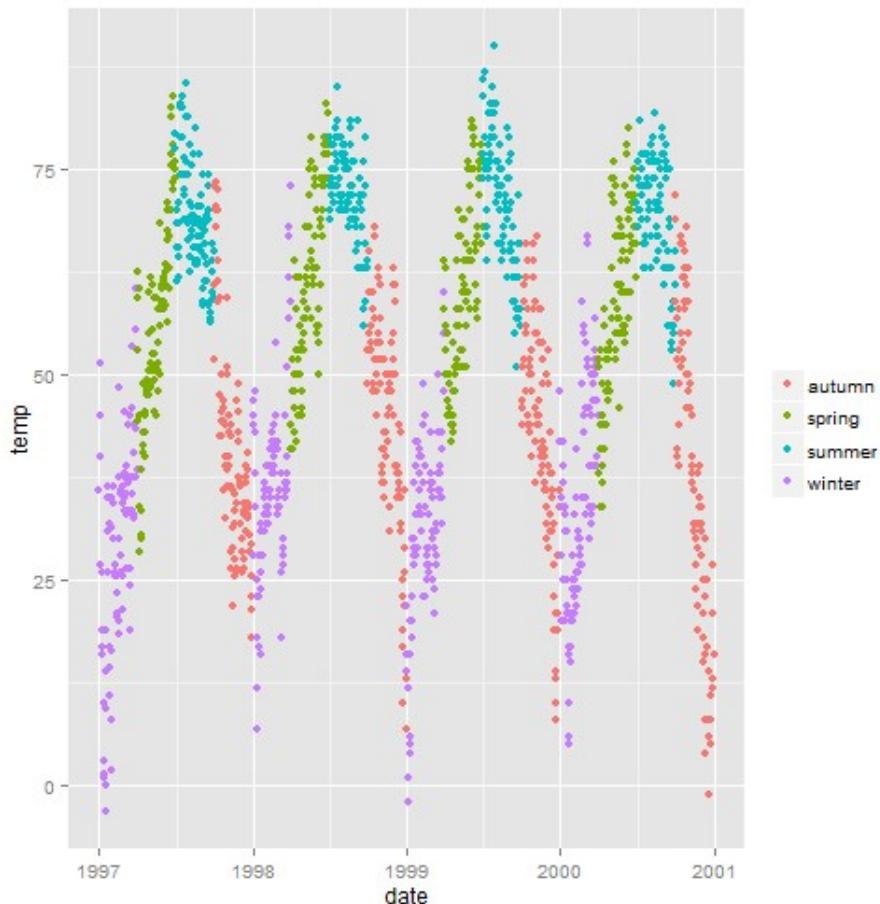
```
g<-ggplot(nmmaps, aes(date, temp, color=factor(season)))+geom_point()
g
```



[Back to table of contents](#)

Turn off the legend title (legend.title)

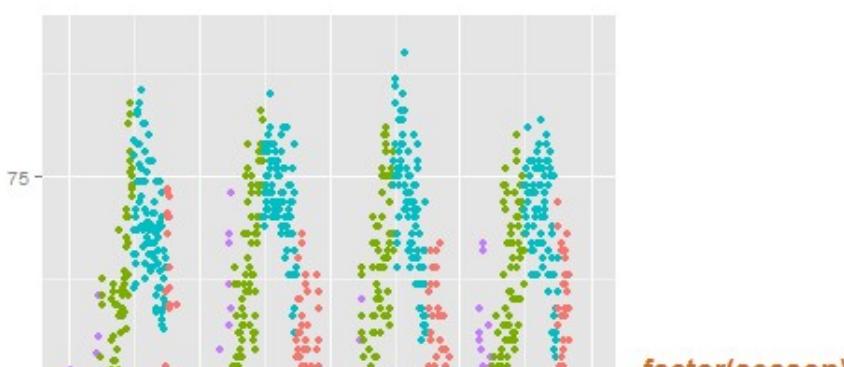
```
g+theme(legend.title=element_blank())
```

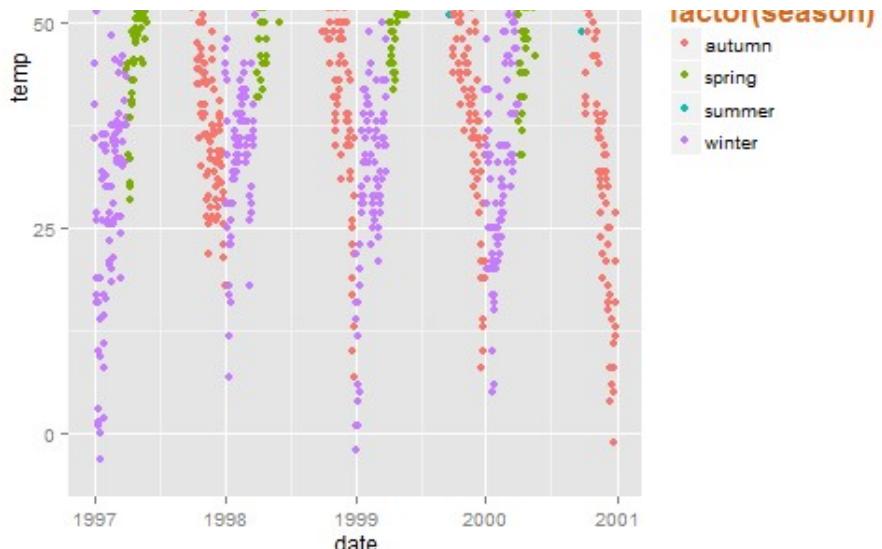


[Back to table of contents](#)

Change the styling of the legend title (legend.title)

```
g+theme(legend.title = element_text(colour="chocolate", size=16, face="bold"))
```



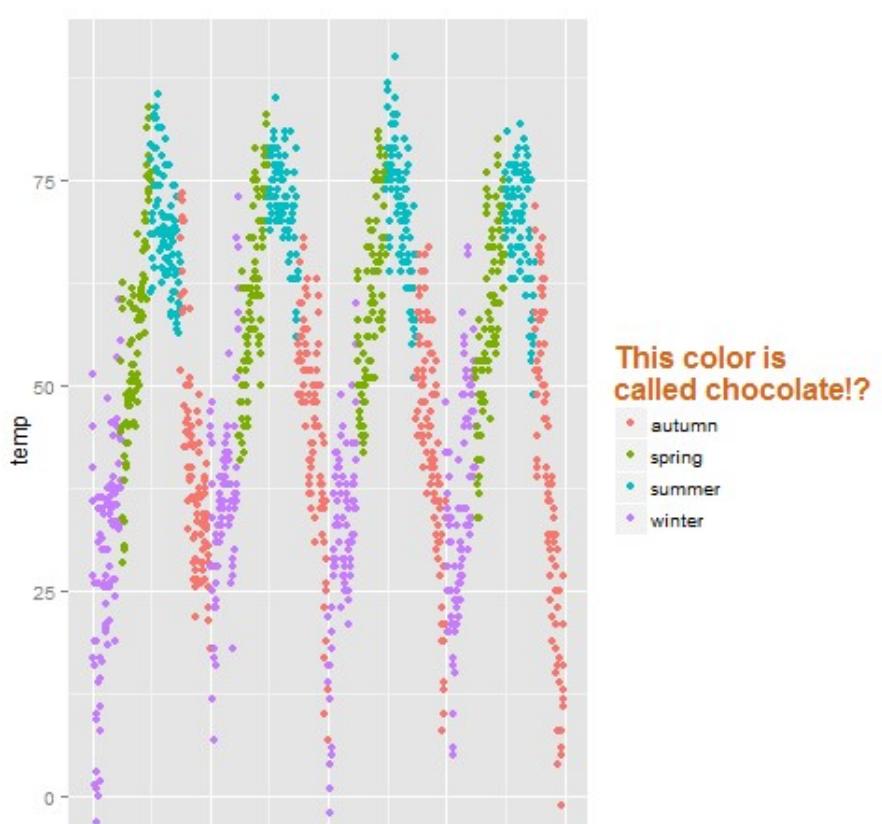


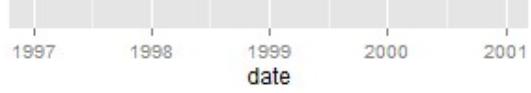
[Back to table of contents](#)

Change the title of the legend (name)

To change the title of the legend you would use the `name` argument in your `scale` function. If you don't use a `scale` function you will need to change the data itself so that it has the right format.

```
g+theme(legend.title = element_text(colour="chocolate", size=16, face="bold"))+
  scale_color_discrete(name="This color is\ncalled chocolate!?"")
```



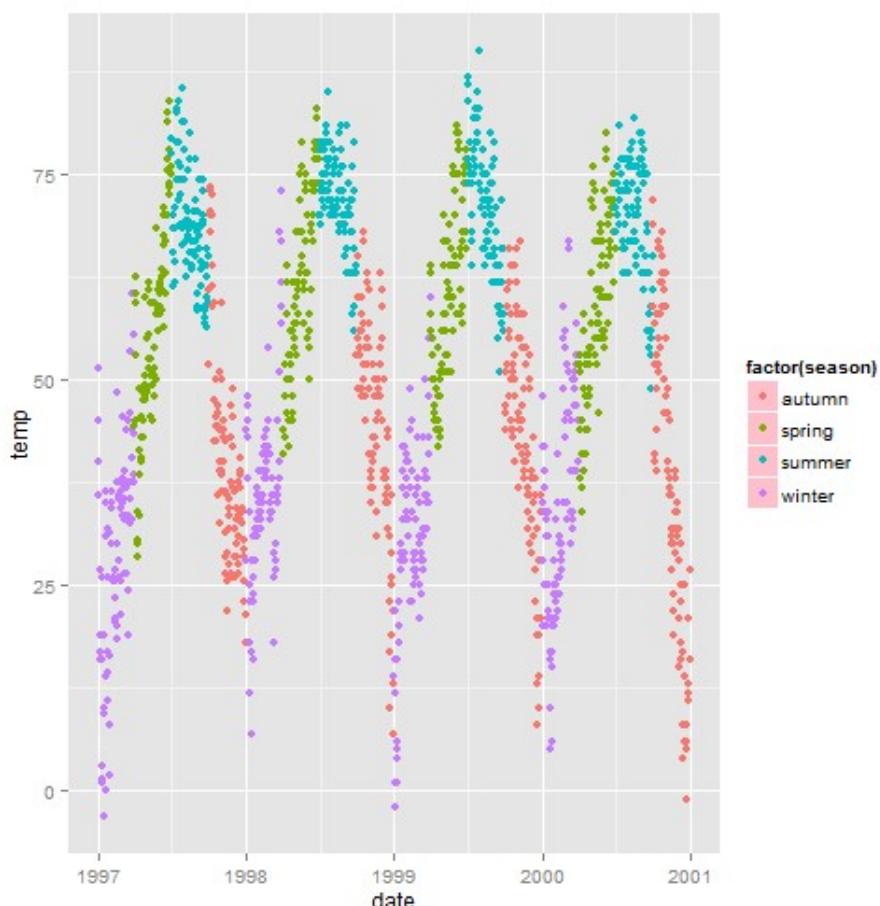


[Back to table of contents](#)

Change the background boxes in the legend (legend.key)

I have mixed feelings about those boxes. If you want to get rid of them entirely use `fill=NA`.

```
g+theme(legend.key=element_rect(fill='pink'))
```

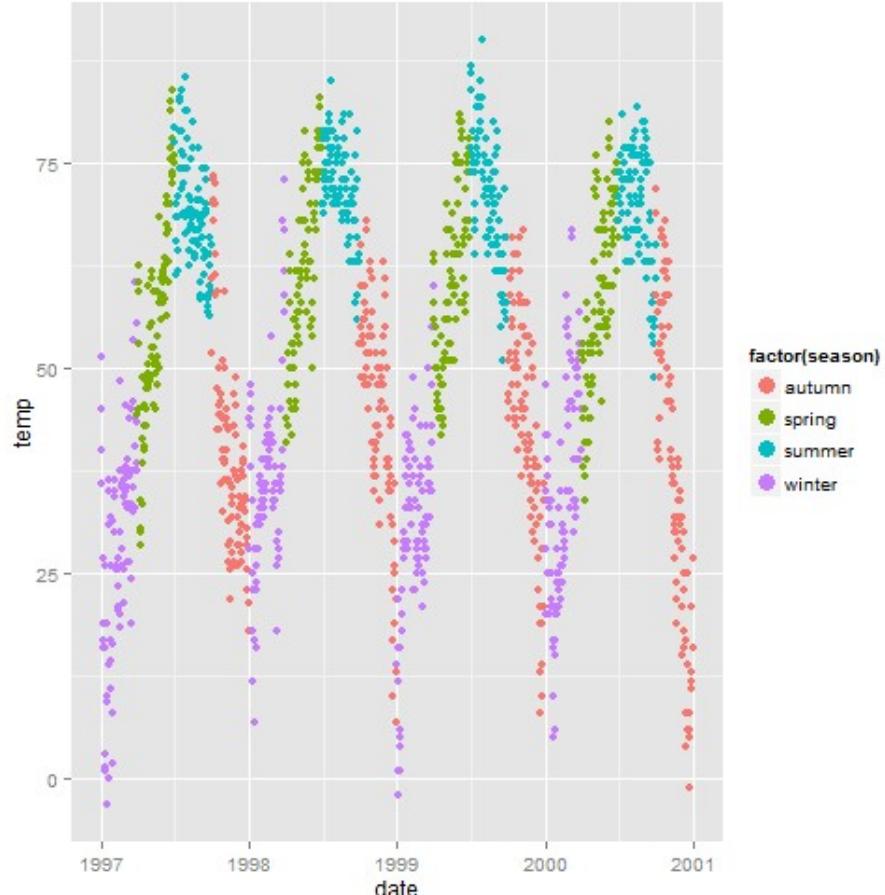


[Back to table of contents](#)

Change the size of the symbols in the legend only (guides(), guide_legend)

Points in the legend get a little lost, especially without the boxes. To override the default try:

```
g+guides(colour = guide_legend(override.aes = list(size=4)))
```

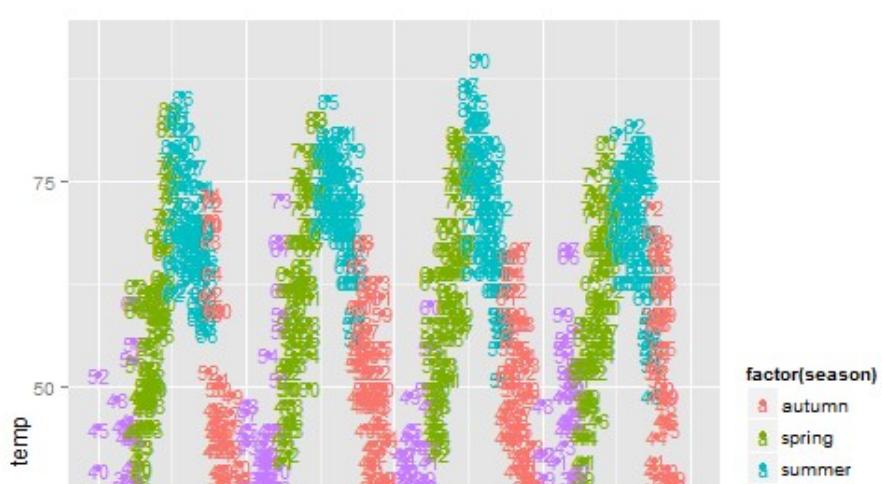


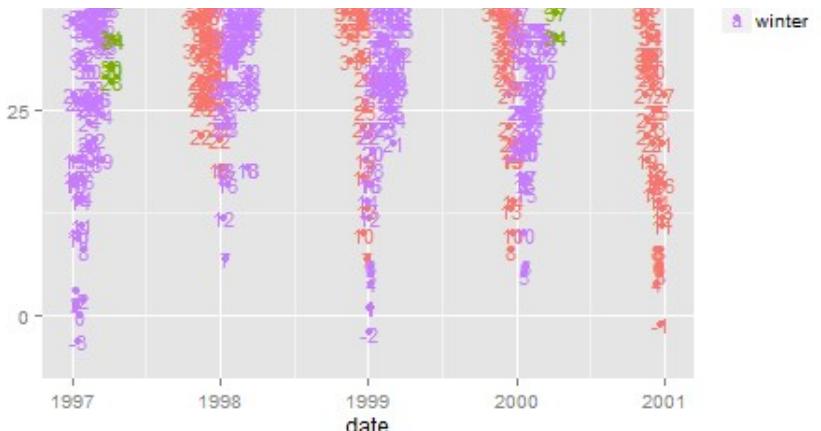
[Back to table of contents](#)

Leave a layer off the legend (show_guide)

Let's say you have a point layer and you add label text to it. By default, both the points and the label text end up in the legend like this (again, who would make a plot like this? It's for demonstration purposes):

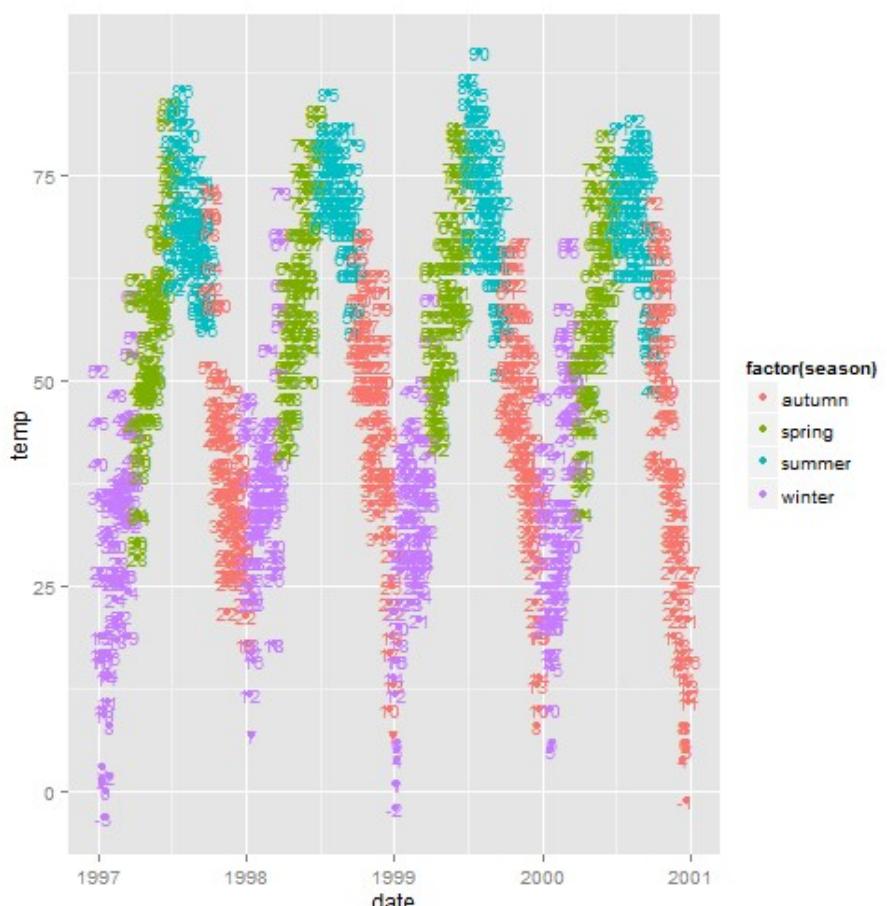
```
g+geom_text(data=nmmmaps, aes(date, temp, label=round(temp)), size=4)
```





You can use `show_guide=FALSE` to turn a layer off in the legend. Useful!

```
g+geom_text(data=nmmaps, aes(date, temp, label=round(temp), size=4), show_guide=FALSE)
```



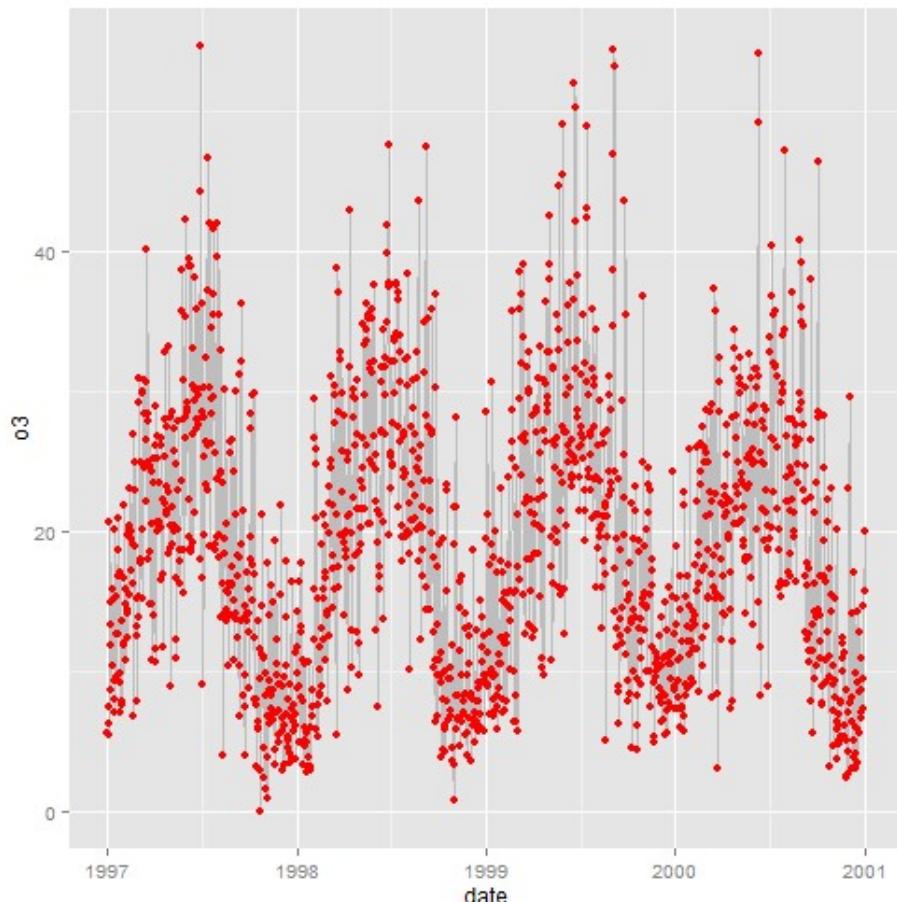
[Back to table of contents](#)

Manually adding legend items (`guides()`, `override.aes`)

ggplot2 will not add a legend automatically unless you map aesthetics (color, size etc) to a variable. There are times, though,

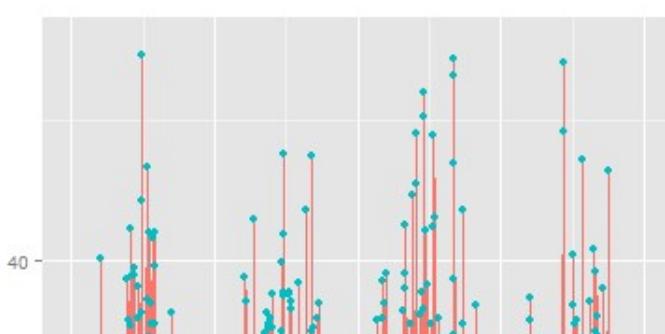
that I want to have a legend so that it's clear what you're plotting. Here is the default:

```
# here there is no legend automatically
ggplot(nmmmaps, aes(x=date, y=o3))+geom_line(color="grey")+geom_point(color="red")
```



We can force a legend by mapping to a “variable”. We are mapping the lines and the points using `aes` and we are mapping **not** to a variable in our dataset but to a single string (so that we get just one color for each).

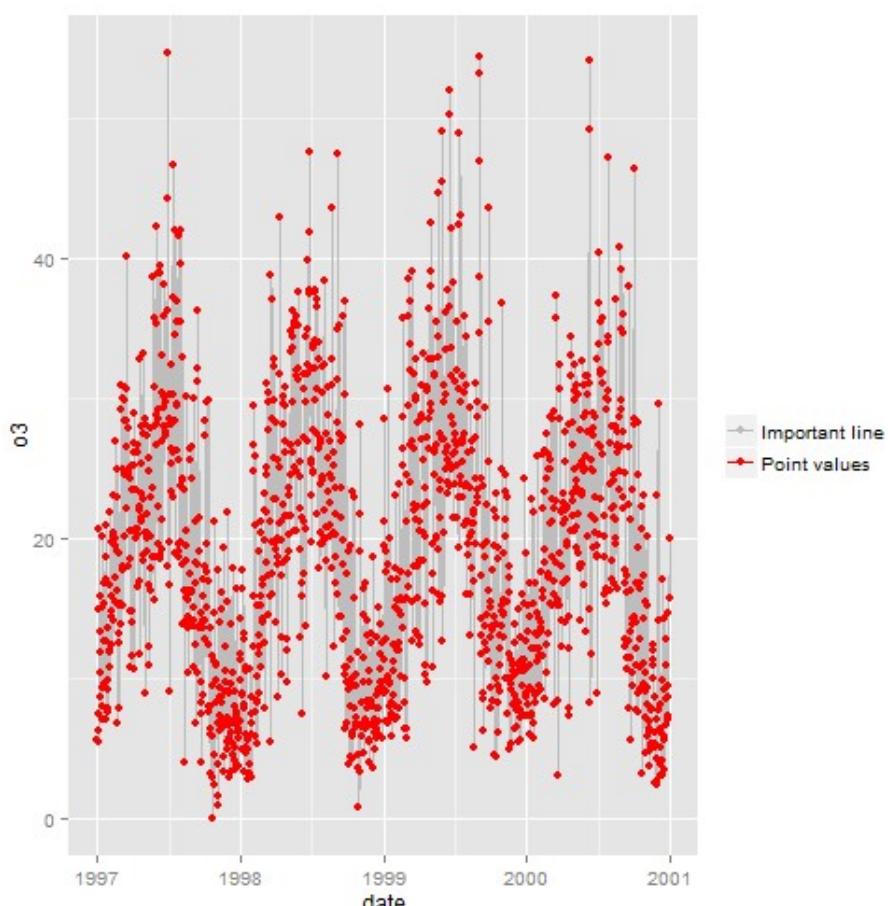
```
ggplot(nmmmaps, aes(x=date, y=o3))+geom_line(aes(color="Important line"))+
  geom_point(aes(color="My points"))
```





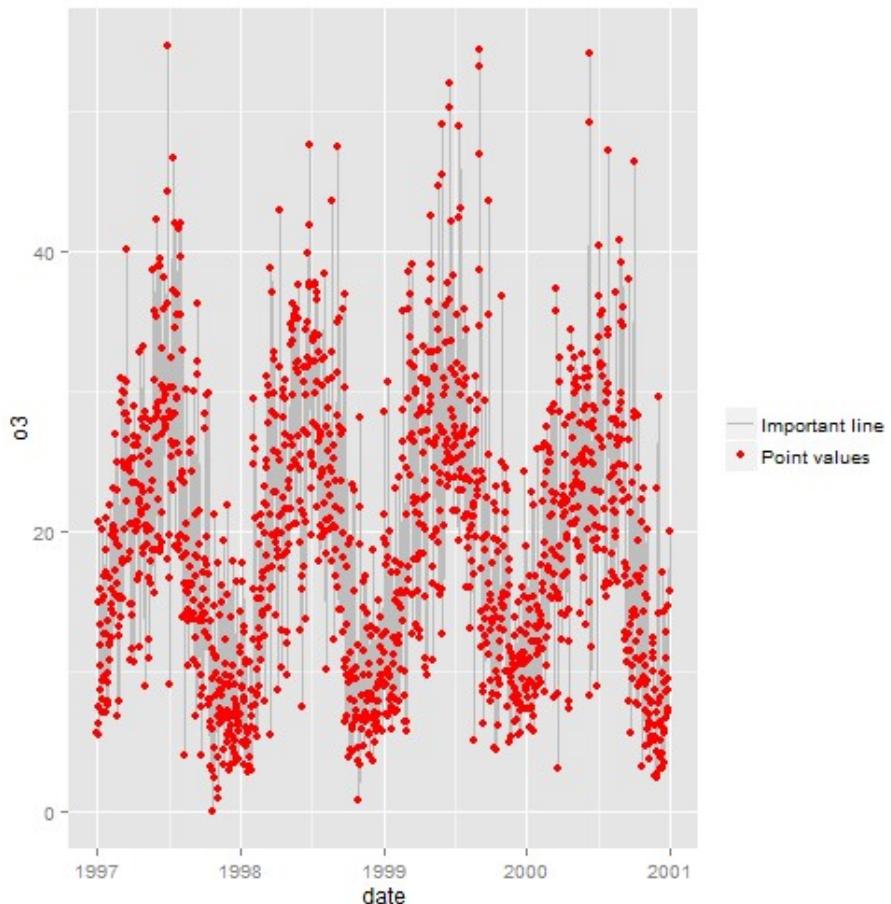
We're getting close but this is not what I want. I wanted grey and red. To change the color, we use `scale_colour_manual()`.

```
ggplot(nmmaps, aes(x=date, y=o3))+geom_line(aes(color="Important line"))+
  geom_point(aes(color="Point values"))+
  scale_colour_manual(name='', values=c('Important line'='grey', 'Point values'='red'))
```



Tantalizingly close! But we don't want a line with a point for both. Line=grey and point=red. The final step is to override the aesthetics in the legend. The `guide()` function allows us to control guides like the legend:

```
ggplot(nmmaps, aes(x=date, y=o3))+geom_line(aes(color="Important line"))+
  geom_point(aes(color="Point values"))+
  scale_colour_manual(name='', values=c('Important line'='grey', 'Point values'='red'), guide='legend')
  guides(colour = guide_legend(override.aes = list(linetype=c(1,0)
                                                , shape=c(NA, 16))))
```



Voila!

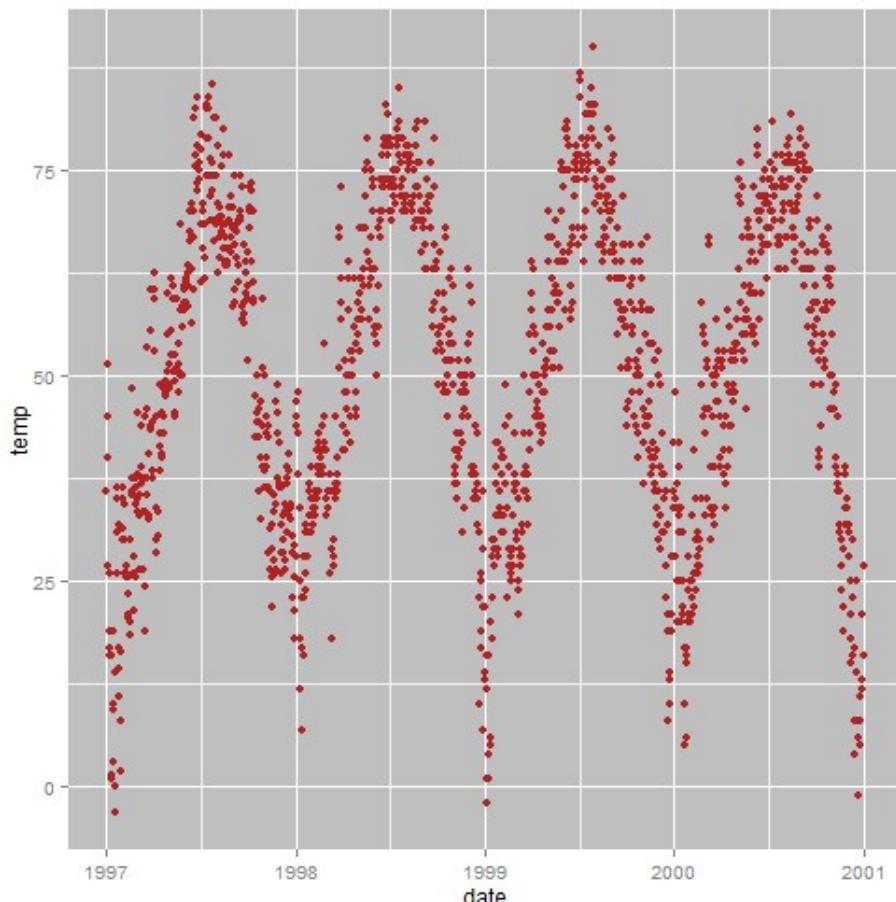
[Back to table of contents](#)

Working with the background colors

There are ways to change the entire look of your plot with one function (see below) but if you want to simply change the background color of the panel you can use the following:

Change the panel color (`panel.background`)

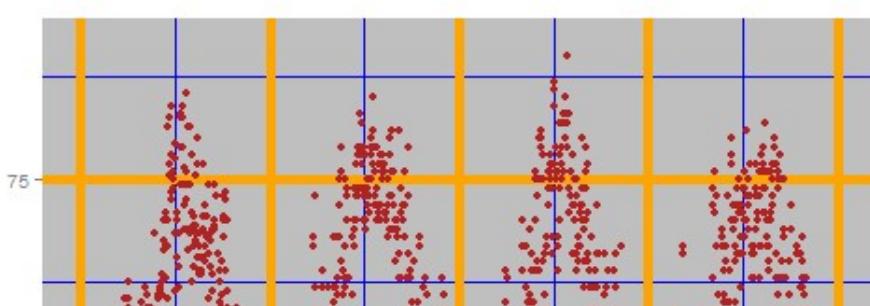
```
ggplot(nmmmaps, aes(date, temp))+geom_point(color="firebrick")+
  theme(panel.background = element_rect(fill = 'grey75'))
```

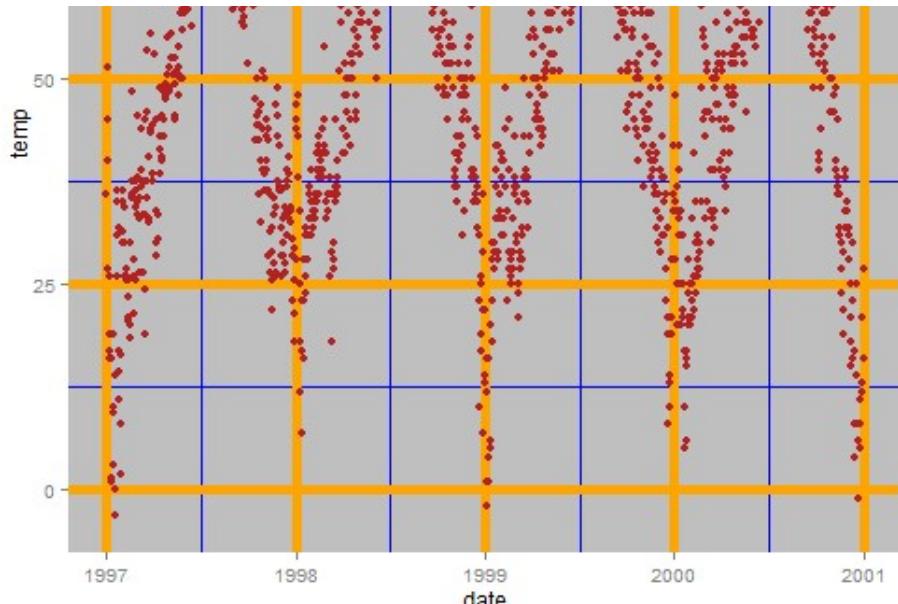


[Back to table of contents](#)

Change the grid lines (panel.grid.major)

```
ggplot(nmmmaps, aes(date, temp))+geom_point(color="firebrick")+
  theme(panel.background = element_rect(fill = 'grey75'),
        panel.grid.major = element_line(colour = "orange", size=2),
        panel.grid.minor = element_line(colour = "blue"))
```

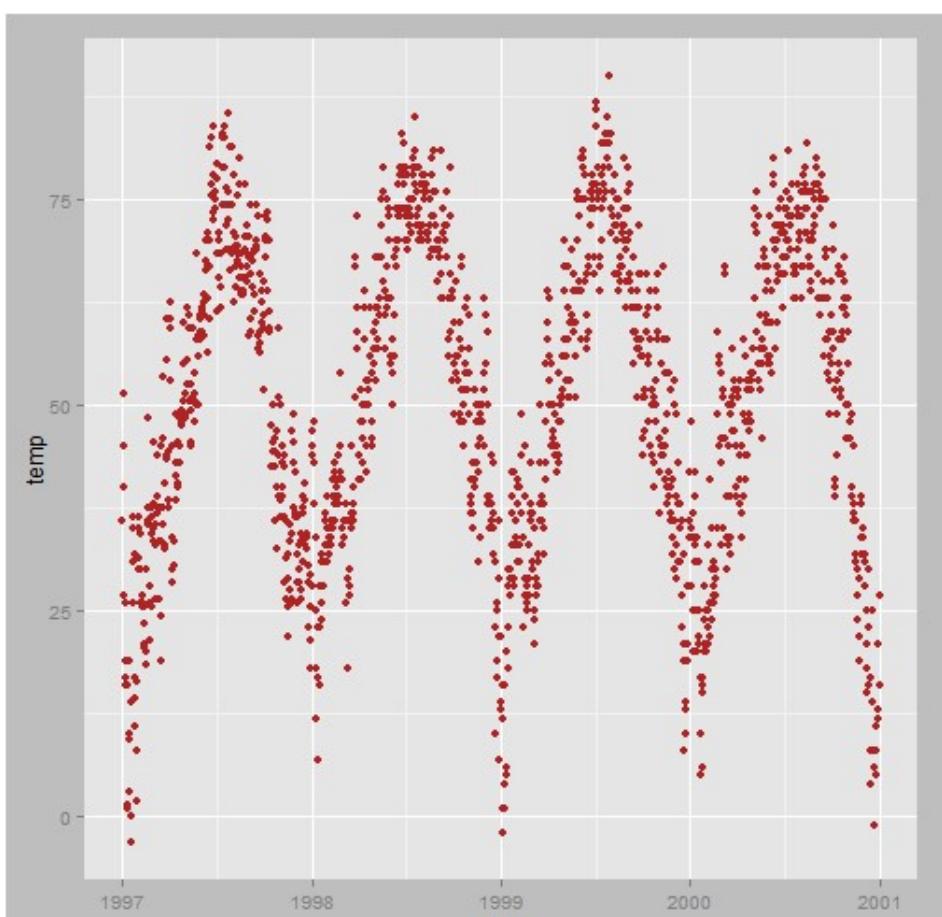




[Back to table of contents](#)

Change the plot background (not the panel) color (plot.background)

```
ggplot(nmmaps, aes(date, temp))+geom_point(color="firebrick")+
  theme(plot.background = element_rect(fill = 'grey'))
```



date

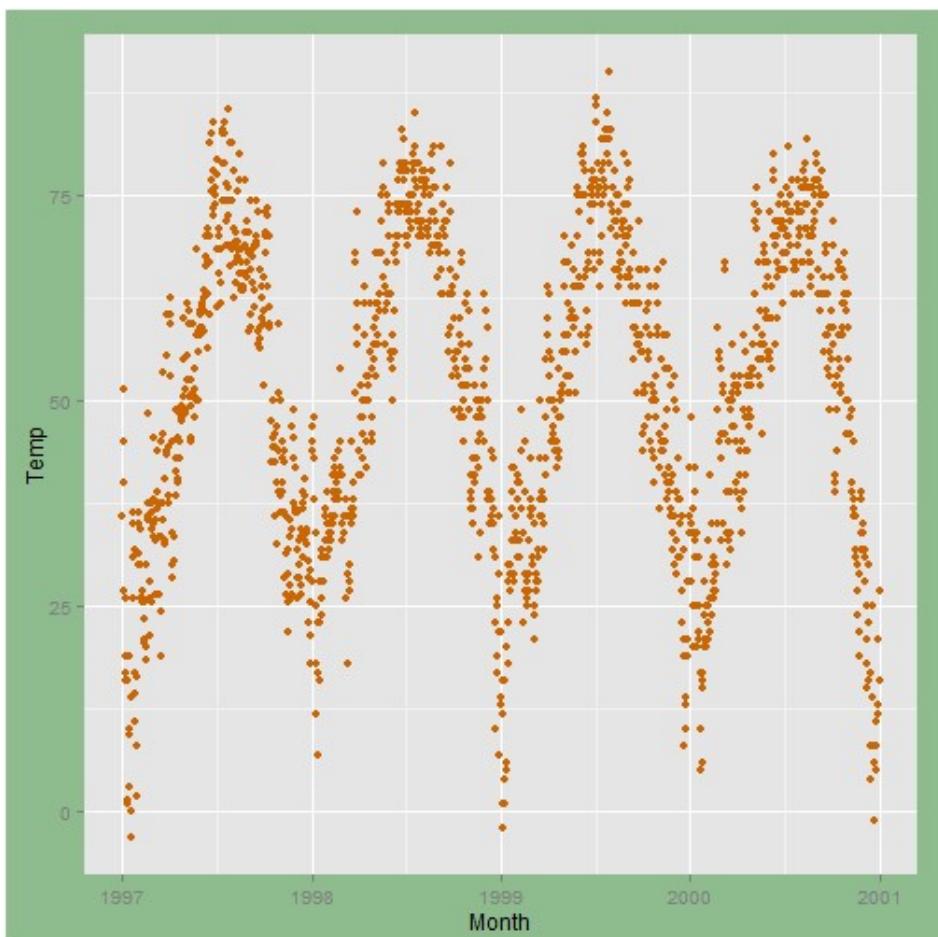
[Back to table of contents](#)

Working with margins

Changing the plot margin (`plot.margin`)

I sometimes find that I need to add a little space to one margin of my plot. Similar to the previous examples we can use an argument to the `theme()` function. In this case the argument is `plot.margin`. In order to illustrate I'm going to add a background color using `plot.background` so you can see the default:

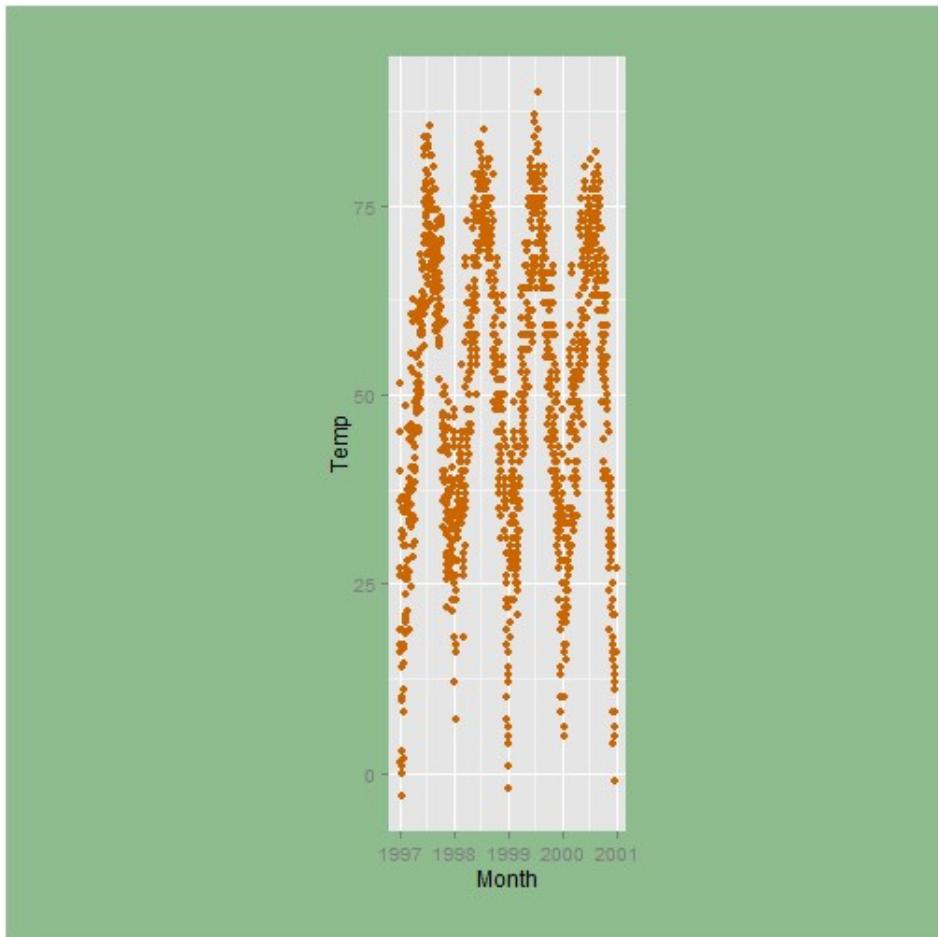
```
# the default
ggplot(nmmaps, aes(date, temp))+
  geom_point(color="darkorange3")+
  labs(x="Month", y="Temp")+
  theme(plot.background=element_rect(fill="darkseagreen"))
```



Now let's add extra space to both the left and right. The argument, `plot.margin`, can handle a variety of different units (cm, inches etc) but it requires the use of the function `unit` from the package `grid` to specify the units. Here I'm using a 6 cm

margin on the right and left.

```
library(grid)
ggplot(nmmaps, aes(date, temp))+
  geom_point(color="darkorange3")+
  labs(x="Month", y="Temp")+
  theme(plot.background=element_rect(fill="darkseagreen"),
        plot.margin = unit(c(1, 6, 1, 6), "cm")) #top, right, bottom, left
```



Again, not a pretty plot!

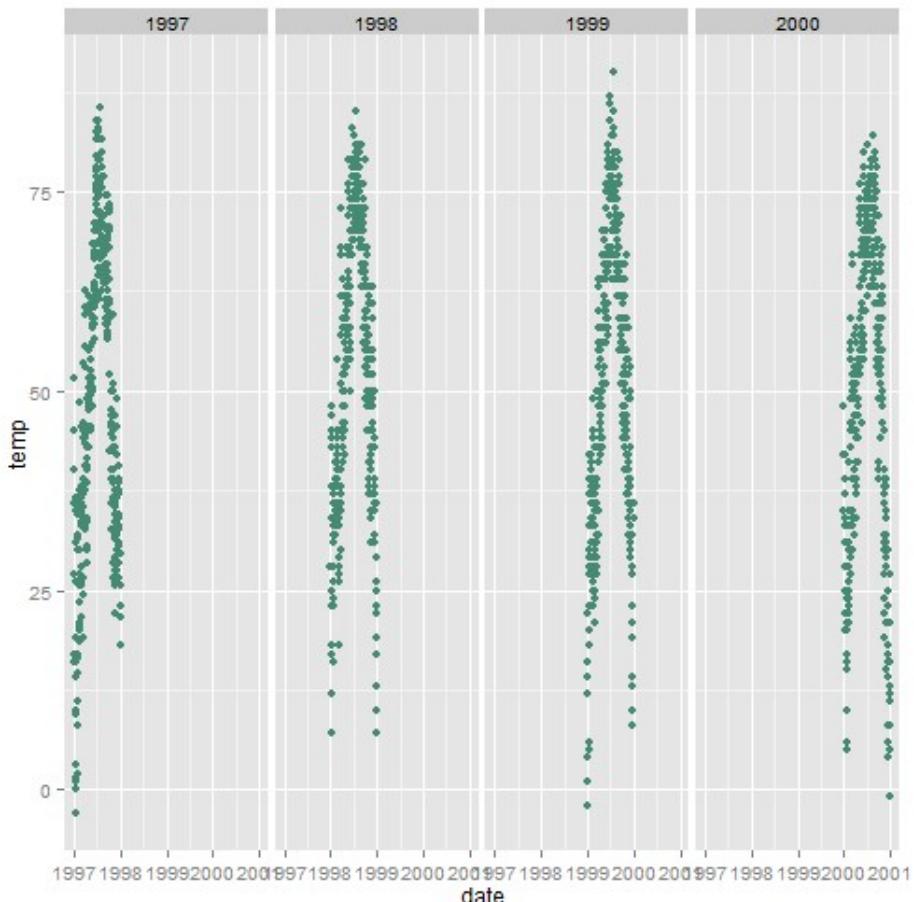
[Back to table of contents](#)

Creating multi-panel plots

The `ggplot2` package has two nice functions for creating multi-panel plots. They are related but a little different: `facet_wrap` creates essentially a ribbon of plots based on a single variable while `facet_grid` can take two variables.

Create a single row of plots based on one variable (`facet_wrap()`)

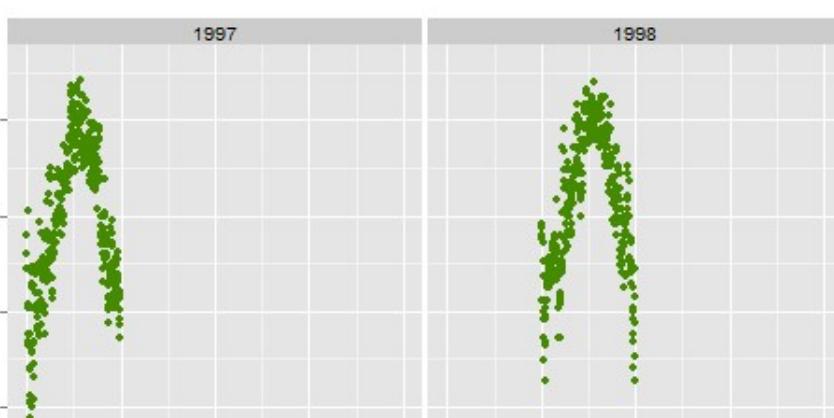
```
ggplot(nmmaps, aes(date,temp))+geom_point(color="aquamarine4")+facet_wrap(~year, nrow=1)
```

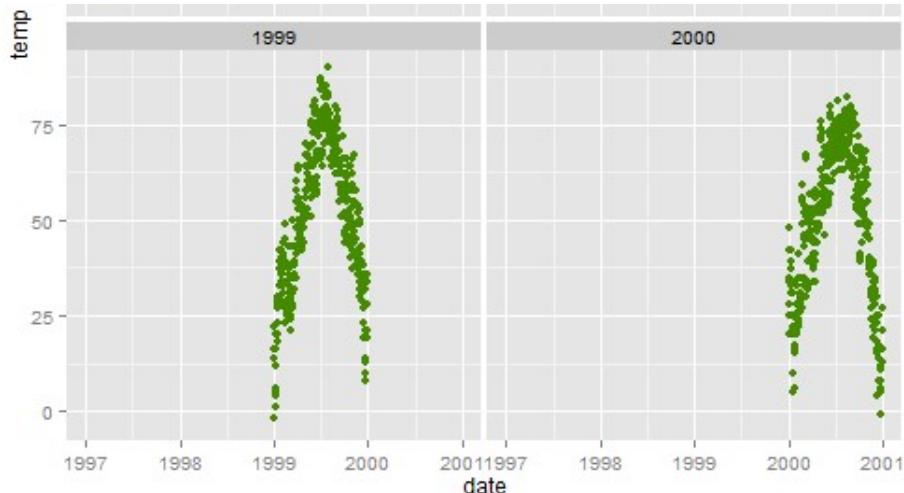


[Back to table of contents](#)

Create a matrix of plots based on one variable (facet_wrap())

```
ggplot(nmmaps, aes(date,temp))+geom_point(color="chartreuse4")+
  facet_wrap(~year, ncol=2)
```



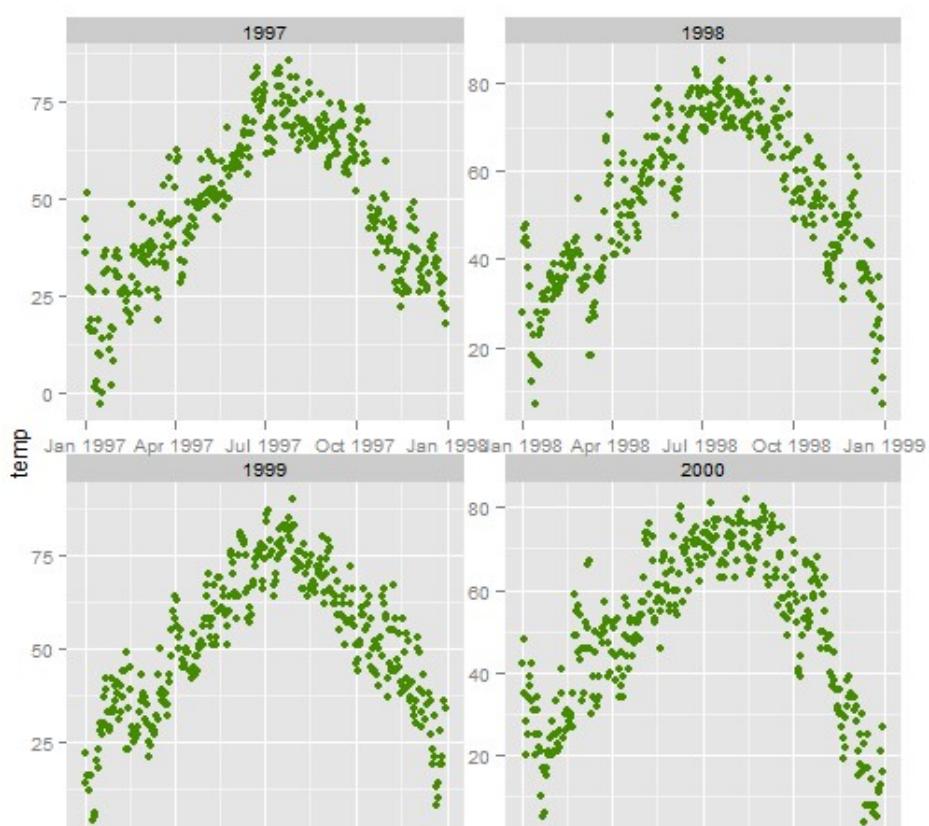


[Back to table of contents](#)

Allow scales to roam free (scales)

The default for multi-panel plots in ggplot2 is to use equivalent scales in each panel. But sometimes you want to allow a panel's own data to determine the scale. This is not often a good idea since it may give your user the wrong impression about the data but to do this you can set `scales="free"` like this:

```
ggplot(nmmaps, aes(date,temp))+geom_point(color="chartreuse4")+
  facet_wrap(~year, ncol=2, scales="free")
```

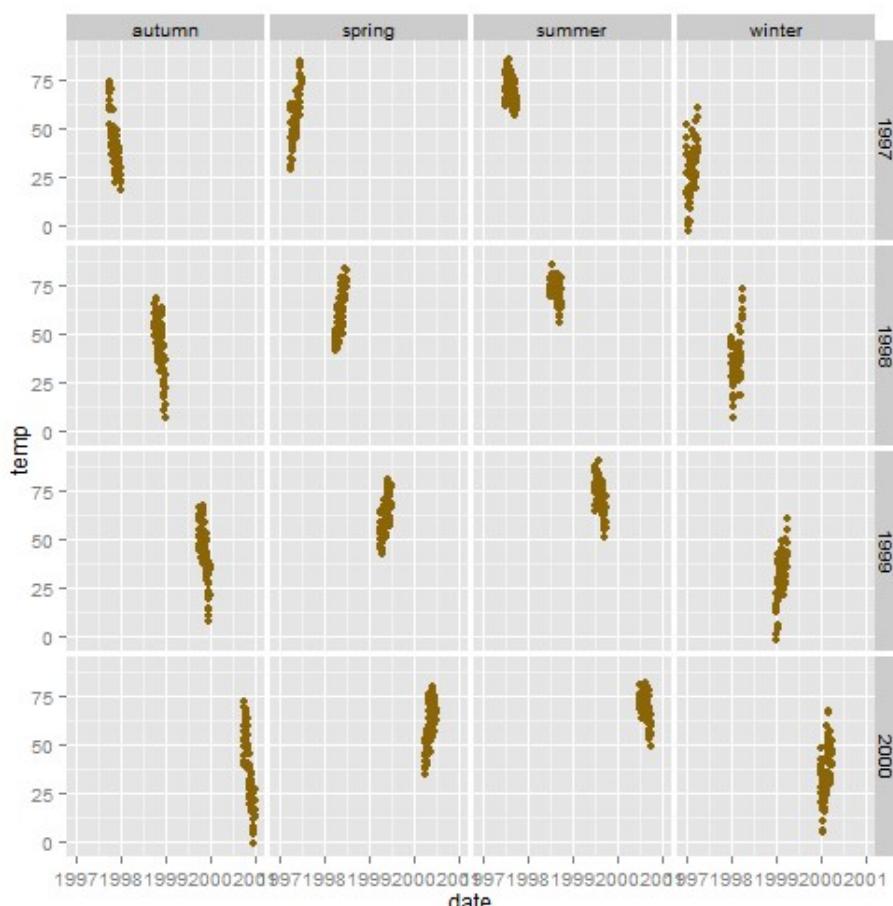




[Back to table of contents](#)

Create a grid of plots using two variables (`facet_grid()`)

```
ggplot(nmmmaps, aes(date,temp))+geom_point(color="darkgoldenrod4")+
  facet_grid(year~season)
```



[Back to table of contents](#)

Put two (potentially unrelated) plots side by side (`pushViewport()`, `grid.arrange()`)

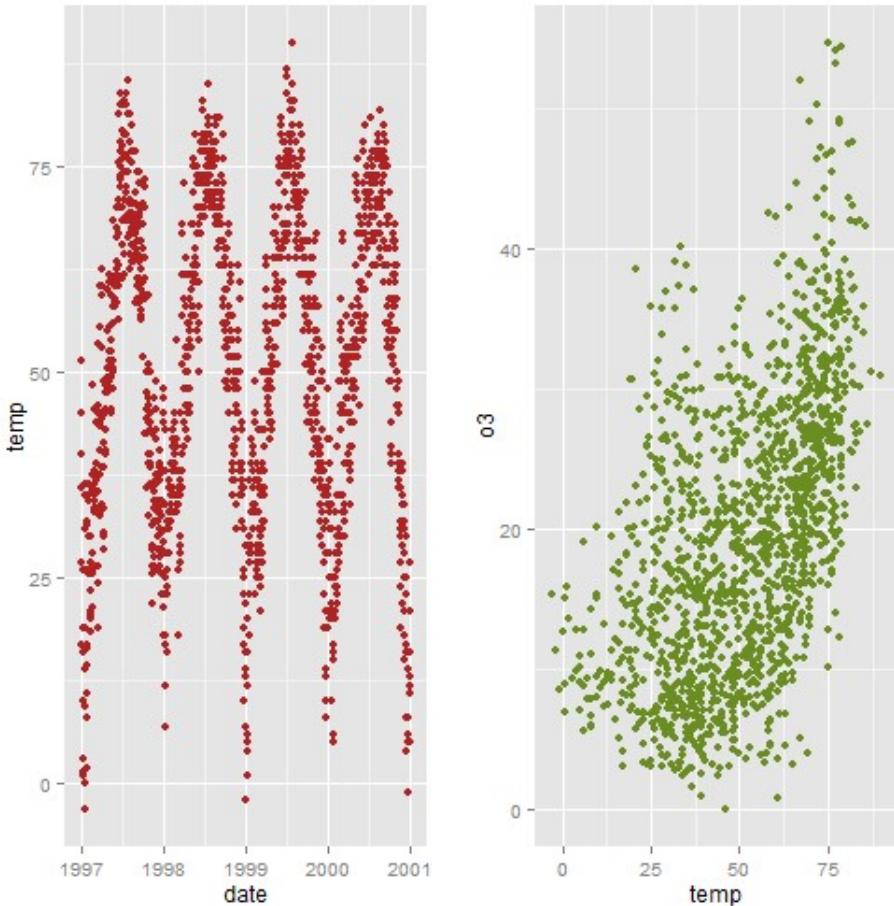
I find that doing this is not nearly as straightforward as traditional (base) graphics. Here are two approaches:

```
myplot1<-ggplot(nmmmaps, aes(date, temp))+geom_point(color="firebrick")
myplot2<-ggplot(nmmmaps, aes(temp, o3))+geom_point(color="olivedrab")

library(grid)
```

```
pushViewport(viewport(layout = grid.layout(1, 2)))
print(myplot1, vp = viewport(layout.pos.row = 1, layout.pos.col = 1))
print(myplot2, vp = viewport(layout.pos.row = 1, layout.pos.col = 2))

# alternative, a little easier
library(gridExtra)
grid.arrange(myplot1, myplot2, ncol=2)
```



To change from row to column arrangement you can change `facet_grid(season~year)` to `facet_grid(year~season)`.

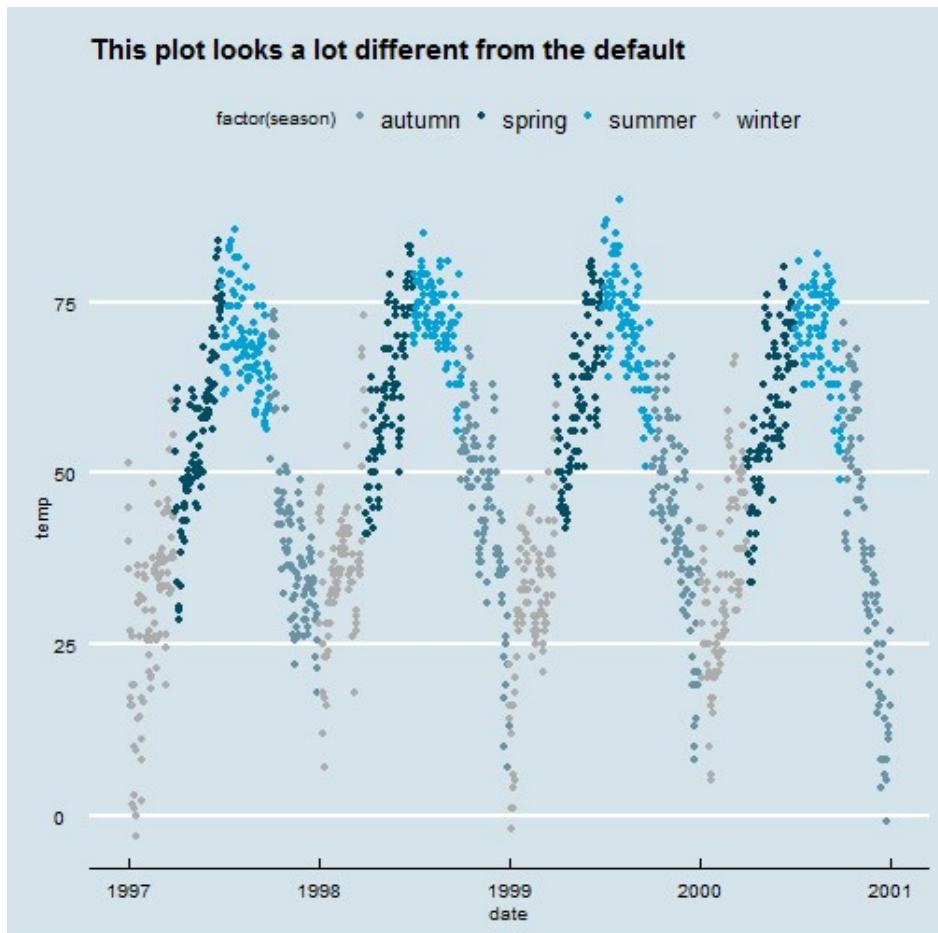
[Back to table of contents](#)

Working with themes

You can change the entire look of the plots by using custom theme. As an example, Jeffrey Arnold has put together the library `ggthemes` with several custom themes. For a list you can visit [the ggthemes site](#). Here is an example:

Use a new theme (`theme_XX()`)

```
library(ggthemes)
ggplot(nmmaps, aes(date, temp, color=factor(season)))+
  geom_point() + ggtitle("This plot looks a lot different from the default")+
  theme_economist() + scale_colour_economist()
```



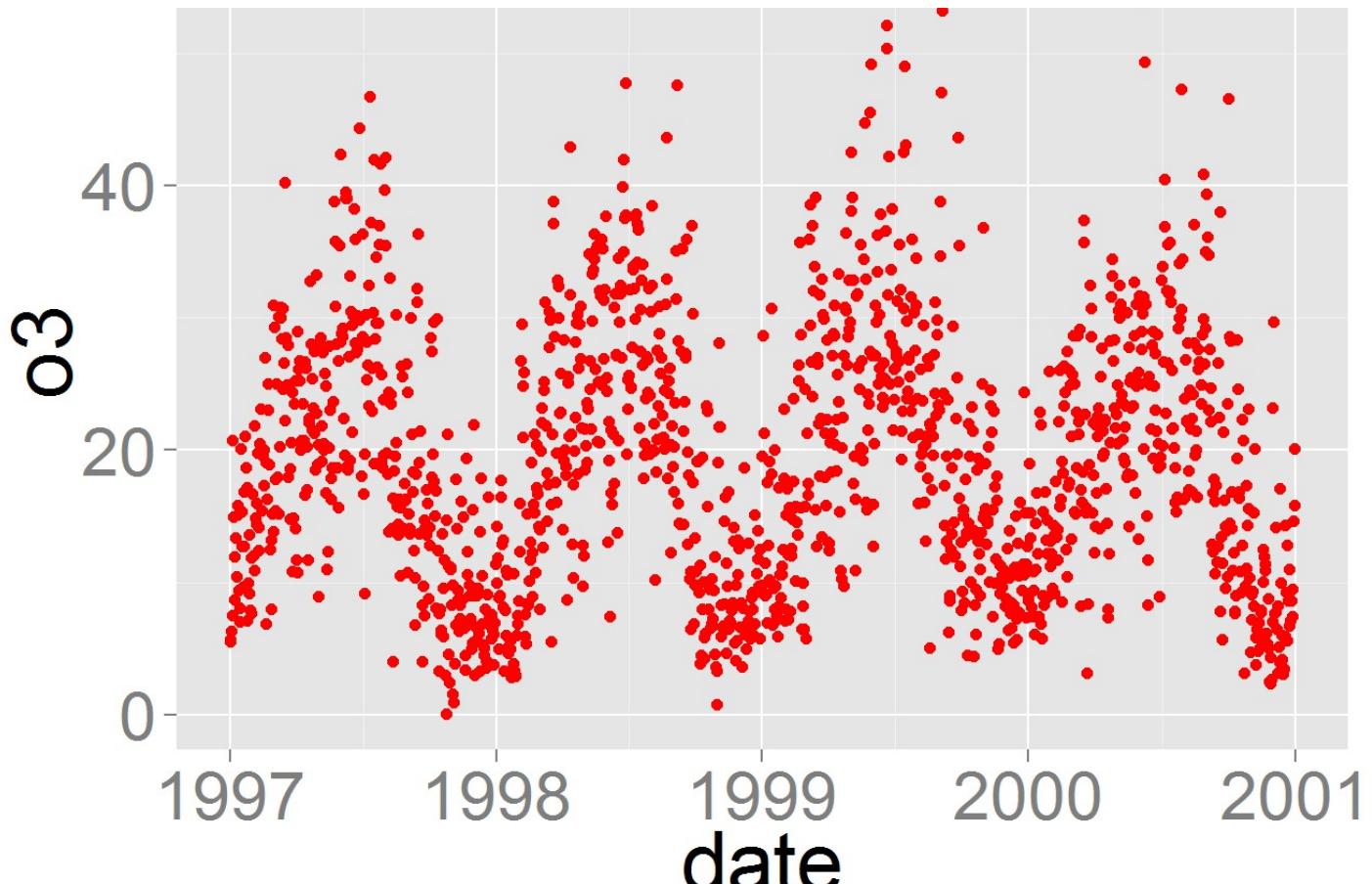
[Back to table of contents](#)

Change the size of all plot text elements

Personally, I find default size of the tick text, legends and other elements to be a little too small. Luckily it's incredibly easy to change the size of all the text elements at once. If you look below at the [section on creating a custom theme](#) you'll notice that the sizes of all the elements are relative (`rel()`) to the `base_size`. As a result, you can simply change the `base_size` and you're done. Here is the code:

```
theme_set(theme_gray(base_size = 30))
ggplot(nmmaps, aes(x=date, y=o3)) + geom_point(color="red")
```





[Back to table of contents](#)

Tip on creating a custom theme

If you want to change the theme for an entire session you can use `theme_set` as in `theme_set(theme_bw())`. The default is called `theme_gray`. If you wanted to create your own custom theme, you could extract the code directly from the gray theme and modify. Note that the `rel()` function changes the sizes relative to the `base_size`.

```
theme_gray

function (base_size = 12, base_family = "")
{
  theme(
    line = element_line(colour = "black", size = 0.5, linetype = 1, lineend = "butt"),
    rect = element_rect(fill = "white", colour = "black", size = 0.5, linetype = 1),
    text = element_text(family = base_family, face = "plain", colour = "black", size = base_size)

    axis.text = element_text(size = rel(0.8), colour = "grey50"),
    strip.text = element_text(size = rel(0.8)),
    axis.line = element_blank(),
    axis.text.x = element_text(vjust = 1),
    axis.text.y = element_text(hjust = 1),
    axis.ticks = element_line(colour = "grey50"),
```

```

axis.title.x = element_text(),
axis.title.y = element_text(angle = 90),
axis.ticks.length = unit(0.15, "cm"),
axis.ticks.margin = unit(0.1, "cm"),

legend.background = element_rect(colour = NA),
legend.margin = unit(0.2, "cm"),
legend.key = element_rect(fill = "grey95", colour = "white"),
legend.key.size = unit(1.2, "lines"),
legend.key.height = NULL,
legend.key.width = NULL,
legend.text = element_text(size = rel(0.8)),
legend.text.align = NULL,
legend.title = element_text(size = rel(0.8), face = "bold", hjust = 0),
legend.title.align = NULL,
legend.position = "right",
legend.direction = NULL,
legend.justification = "center",
legend.box = NULL,

panel.background = element_rect(fill = "grey90", colour = NA),
panel.border = element_blank(),
panel.grid.major = element_line(colour = "white"),
panel.grid.minor = element_line(colour = "grey95", size = 0.25),
panel.margin = unit(0.25, "lines"),
panel.margin.x = NULL,
panel.margin.y = NULL,

strip.background = element_rect(fill = "grey80", colour = NA),
strip.text.x = element_text(),
strip.text.y = element_text(angle = -90),

plot.background = element_rect(colour = "white"),
plot.title = element_text(size = rel(1.2)),
plot.margin = unit(c(1, 1, 0.5, 0.5), "lines"), complete = TRUE)
}

```

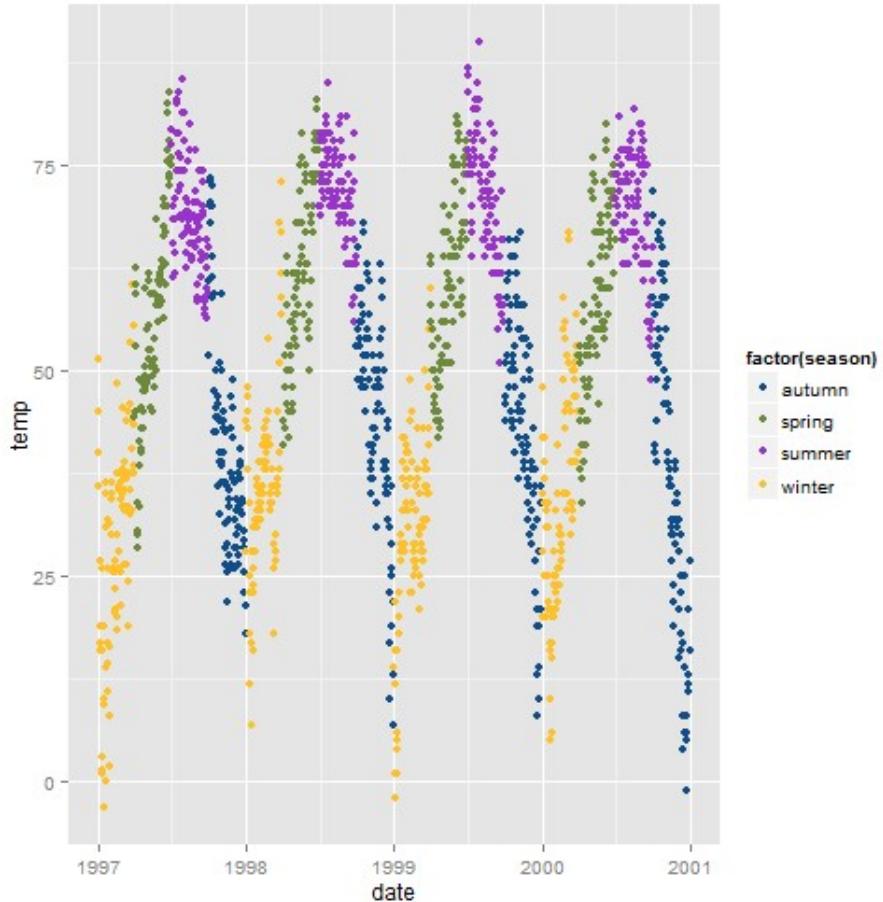
Working with colors

For simple applications working with colors is straightforward in `ggplot2` but when you have more advanced needs it can be a challenge. For a more advanced treatment of the topic you should probably get your hands on [Hadley's book](#) which has nice coverage. There are a few other good sources including the [R Cookbook](#) and the [ggplot2 online docs](#). Tian Zheng at Columbia has created a useful [PDF of R colors](#).

In order to use color with your data, most importantly, you need to know if you're dealing with a categorical or continuous variable.

Categorical variables: manually select the colors (`scale_color_manual()`)

```
ggplot(nmmaps, aes(date, temp, color=factor(season)))+
  geom_point() +
  scale_color_manual(values=c("dodgerblue4", "darkolivegreen4",
                             "darkorchid3", "goldenrod1"))
```

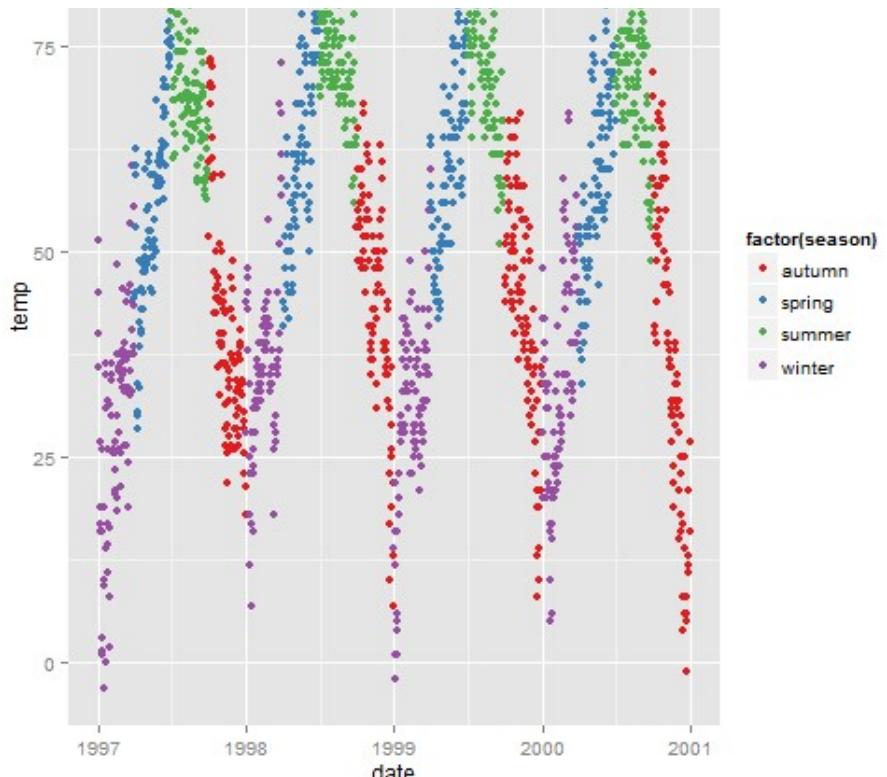


[Back to table of contents](#)

Categorical variables: try a built-in palette (based on colorbrewer2.org) (`scale_color_brewer()`):

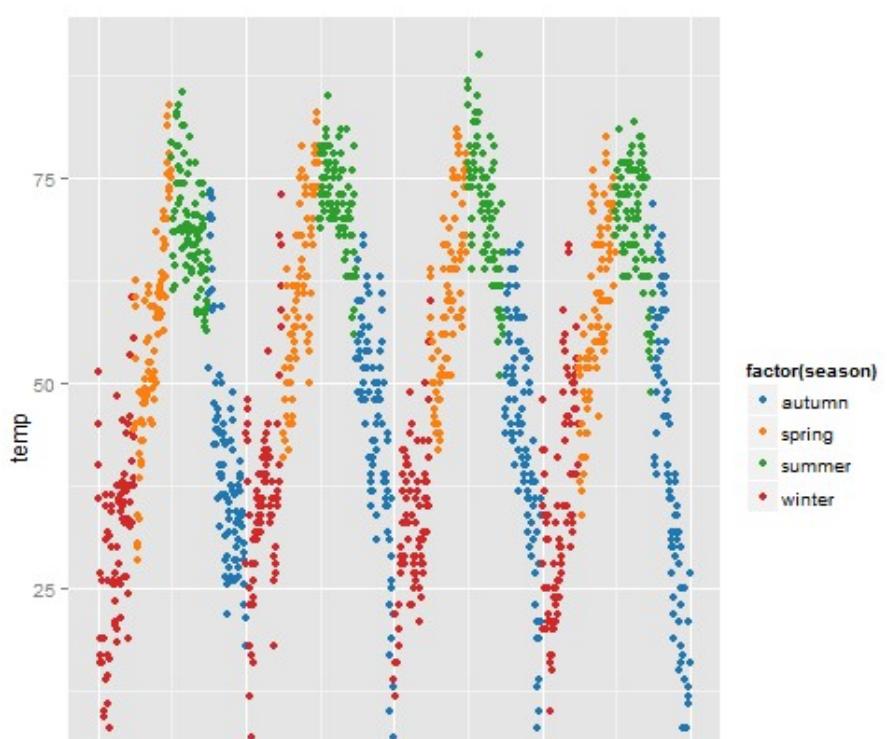
```
ggplot(nmmaps, aes(date, temp, color=factor(season)))+
  geom_point() +
  scale_color_brewer(palette="Set1")
```

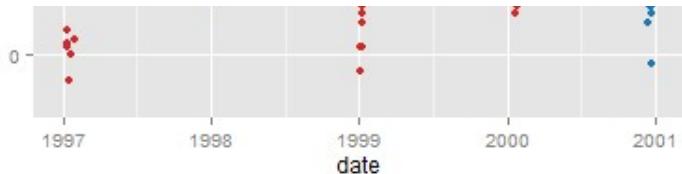




How about using the Tableau colors (but you need the library `ggthemes`):

```
library(ggthemes)
ggplot(nmmaps, aes(date, temp, color=factor(season)))+
  geom_point() +
  scale_colour_tableau()
```





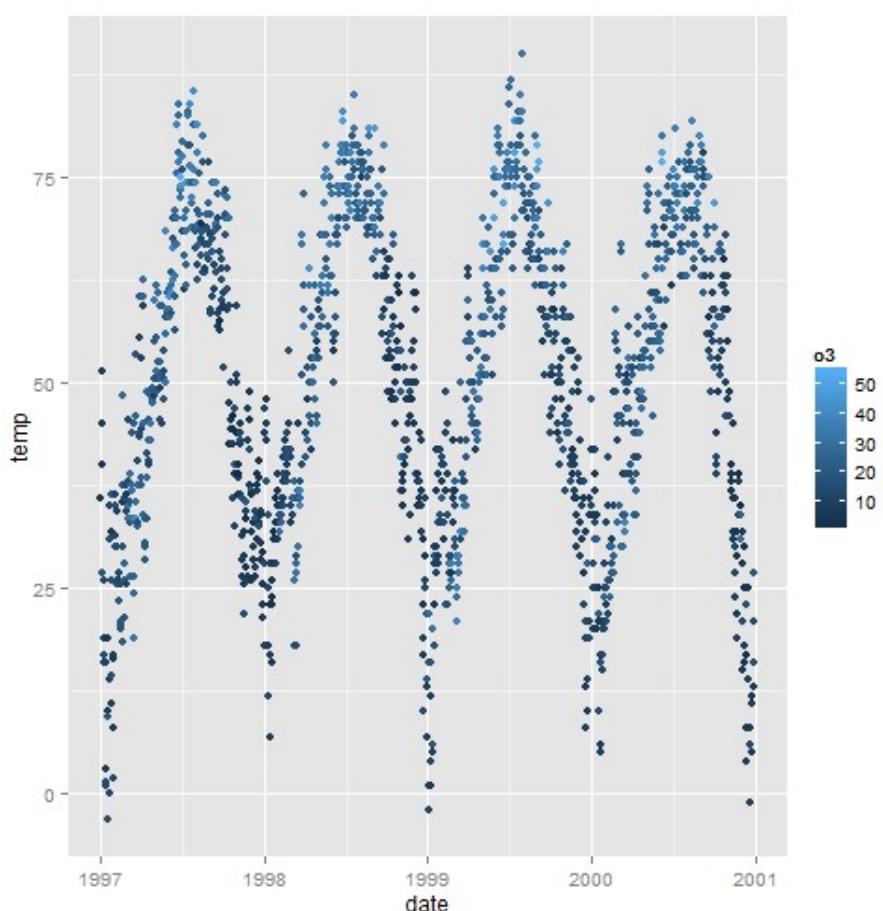
[Back to table of contents](#)

Color choice with continuous variables (`scale_color_gradient()`, `scale_color_gradient2()`)

In our example we will change the color variable to ozone, a continuous variable that is strongly related to temperature (higher temperature = higher ozone). The function `scale_color_gradient()` is a sequential gradient while `scale_color_gradient2()` is diverging.

Here is a default continuous color scheme (sequential color scheme):

```
ggplot(nmmaps, aes(date, temp, color=o3))+geom_point()
```

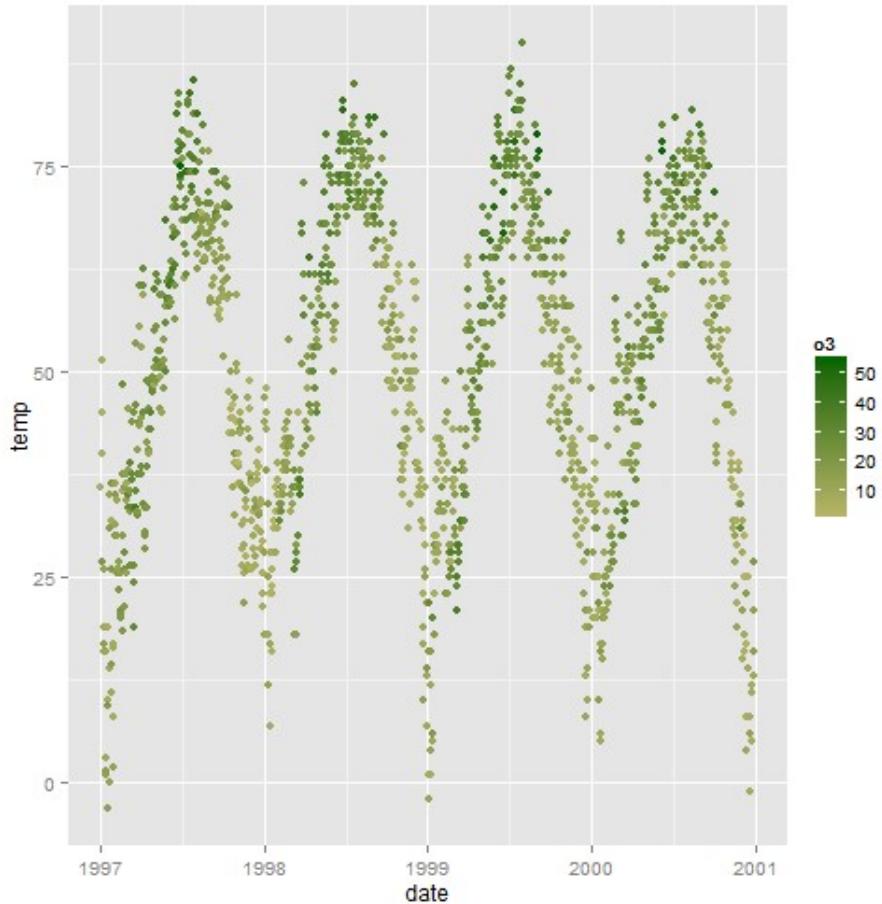


```
# this code produces an identical plot
```

```
#ggplot(nmmaps, aes(date, temp, color=o3))+geom_point()+scale_color_gradient()
```

Manually change the low and high colors (sequential color scheme):

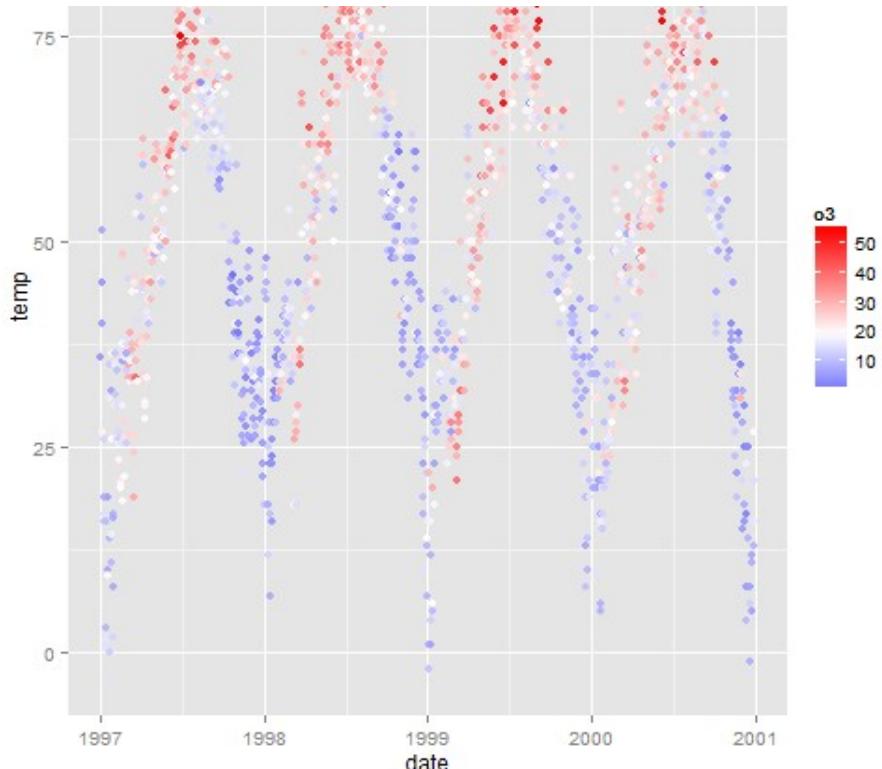
```
ggplot(nmmaps, aes(date, temp, color=o3))+geom_point()+
  scale_color_gradient(low="darkkhaki", high="darkgreen")
```



The temperature data is normally distributed so how about a diverging color scheme (rather than sequential). For diverging color you can use the `scale_color_gradient2` function.

```
mid<-mean(nmmaps$o3)
ggplot(nmmaps, aes(date, temp, color=o3))+geom_point()+
  scale_color_gradient2(midpoint=mid,
    low="blue", mid="white", high="red" )
```





[Back to table of contents](#)

Working with annotation

Add text annotation in the top-right, top-left etc. (`annotation_custom()` and `textGrob()`)

I often have trouble figuring out the best way to add text to a plot in say, the top left corner, without using hard-coded coordinates. With `ggplot2` you can set annotation coordinates to `Inf` but I find this only moderately useful. Here is an example (based on code from [here](#)) using the library `grid` that allows you to specify the location based on scaled coordinates where 0 is low and 1 is high.

The `grobTree` function (from `grid`) creates a grid graphical object and `textGrob` creates the text graphical object. The `annotation_custom()` function comes from `ggplot2` and is designed to use a grob as input.

```
library(grid)

my_grob = grobTree(textGrob("This text stays in place!", x=0.1, y=0.95, hjust=0,
                            gp=gpar(col="blue", fontsize=15, fontface="italic")))

ggplot(nmmaps, aes(temp, o3))+geom_point(color="firebrick")+
  annotation_custom(my_grob)
```

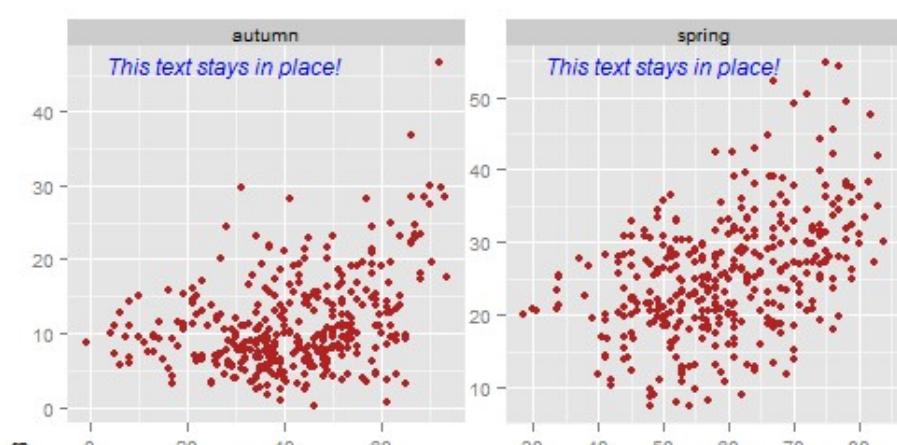


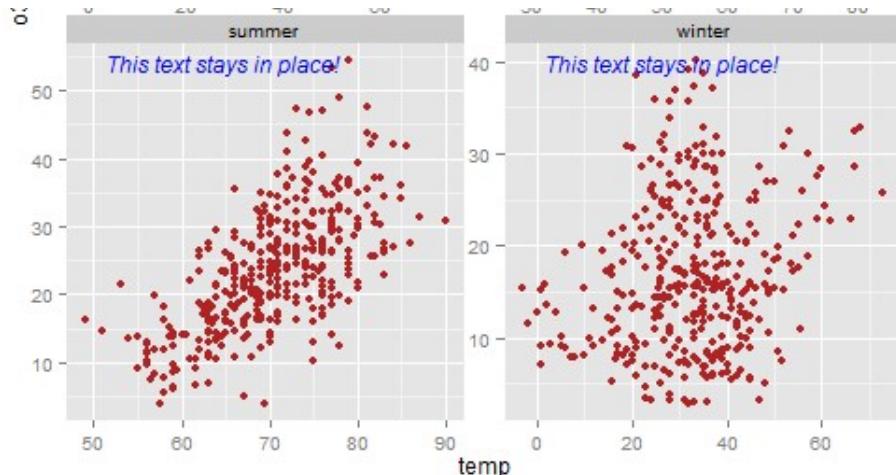
'Big deal' you say!? It is a big deal. The value here is particularly evident when you have multiple plots with **different scales**. In the plot below you see that the axis scales vary yet the same code as above can be used to put the annotation in the same place on each facet. Nice!

```
library(grid)

my_grob = grobTree(textGrob("This text stays in place!", x=0.1, y=0.95, hjust=0,
  gp=gpar(col="blue", fontsize=12, fontface="italic")))

ggplot(nmmmaps, aes(temp, o3))+geom_point(color="firebrick")+facet_wrap(~season, scales="free")+
  annotation_custom(my_grob)
```



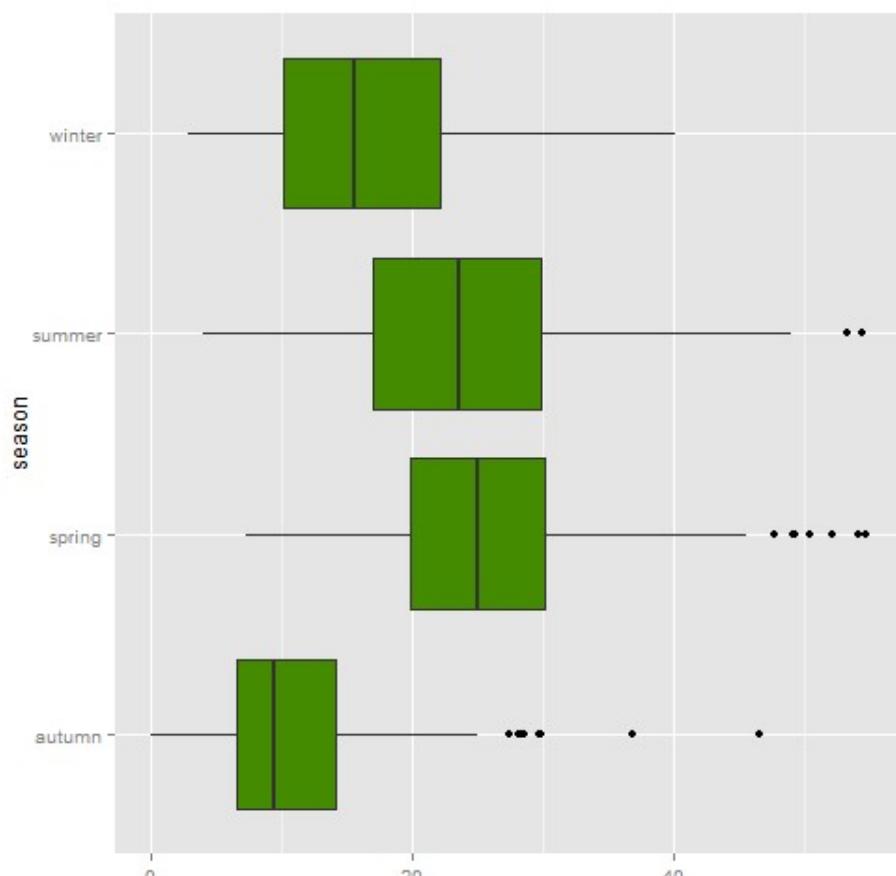


Working with coordinates

Flip a plot on it's side (`coord_flip()`)

It is incredibly easy to flip your plot on its side. Here I've added the `coord_flip()` which is all you need to flip the plot.

```
ggplot(nmmaps, aes(x=season, y=o3))+geom_boxplot(fill="chartreuse4")+coord_flip()
```



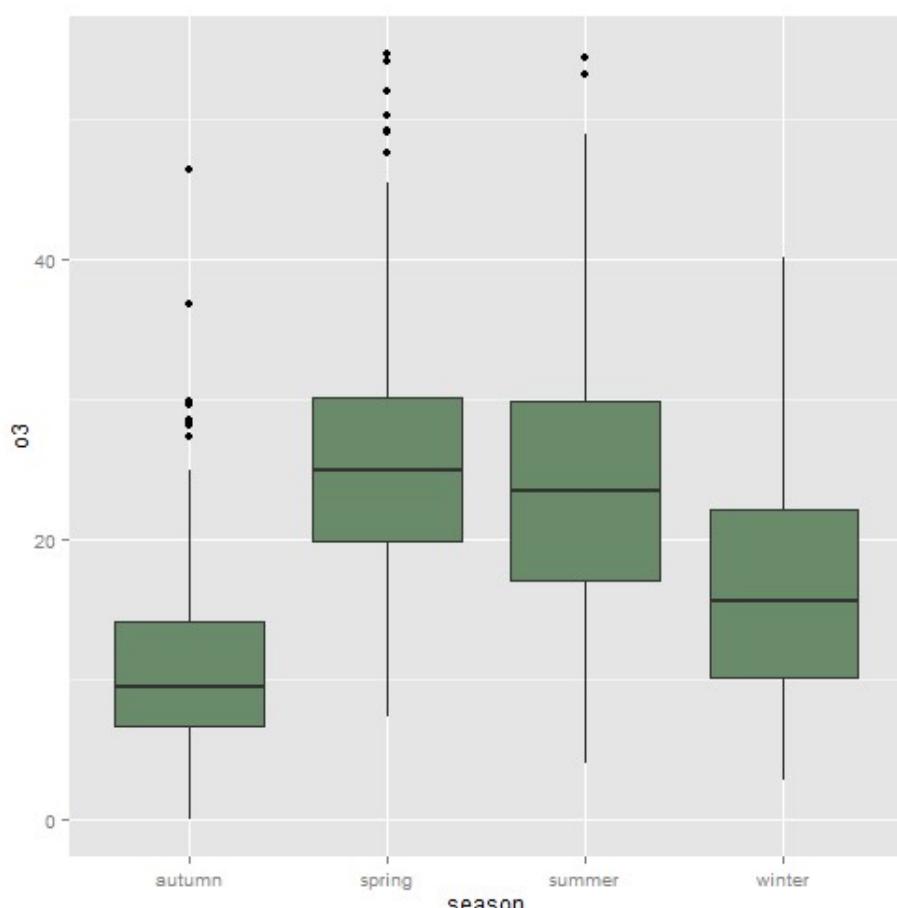
Working with plot types

Alternatives to the box plot (`geom_jitter()` and `geom_violin()`)

Start with a box plot

Box plots are great, but they can be so incredibly boring. There are alternatives, first – a box plot:

```
g<-ggplot(nmmaps, aes(x=season, y=o3))  
g+geom_boxplot(fill="darkseagreen4")
```

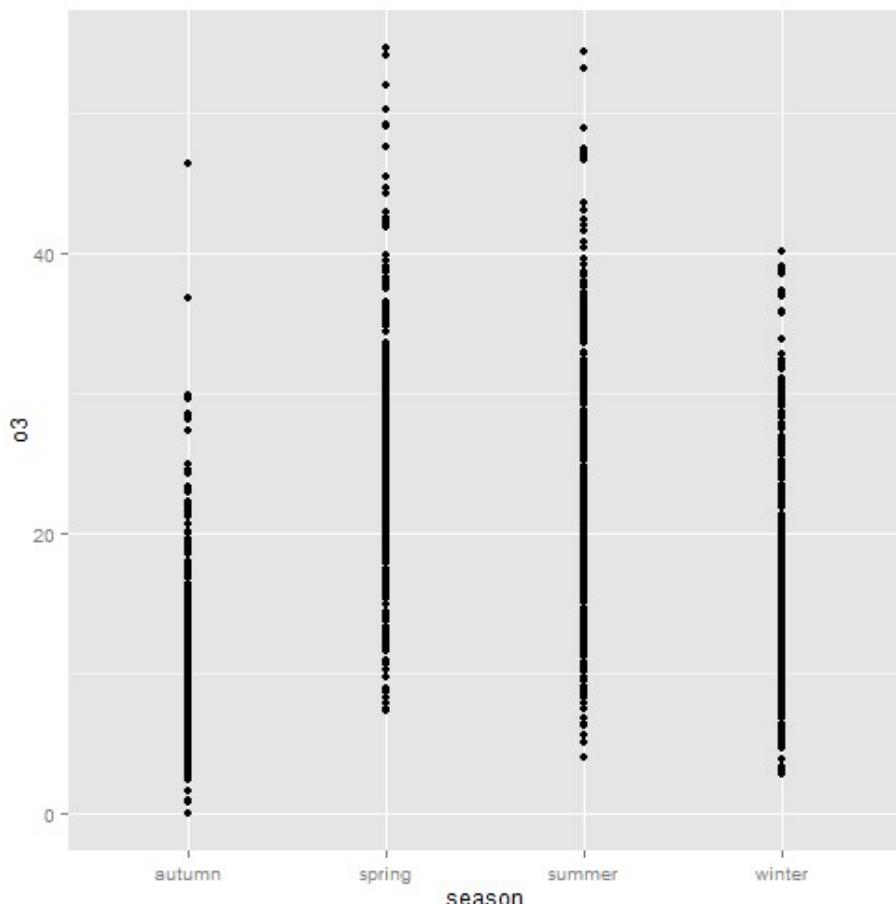


Effective, yes. Interesting, no.

Alternative to a box plot: plot of points

What if we plot the points themselves?

```
g+geom_point()
```

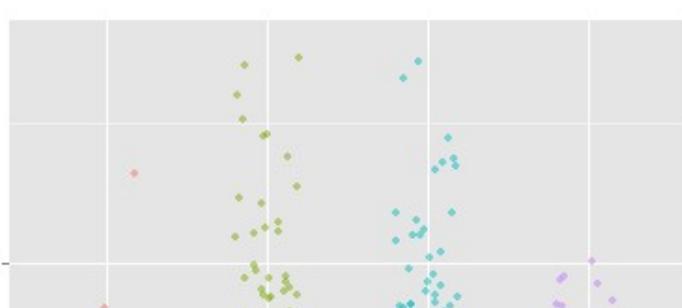


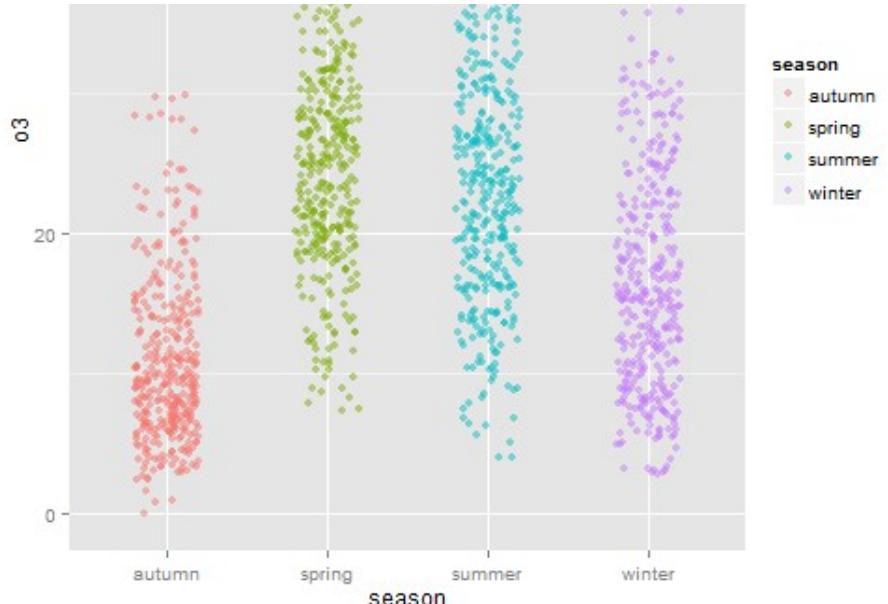
Not only boring but uninformative, you could add transparency to deal with overplotting, but this is not good either. Let's try something else.

Alternative to a box plot: jitter the points (geom_jitter())

Try adding a little jitter to the data. I like this for in-house visualization but be careful using jittering because you're purposely adding noise to your data and this can result in misinterpretation of your data.

```
g+geom_jitter(alpha=0.5, aes(color=season), position = position_jitter(width = .2))
```



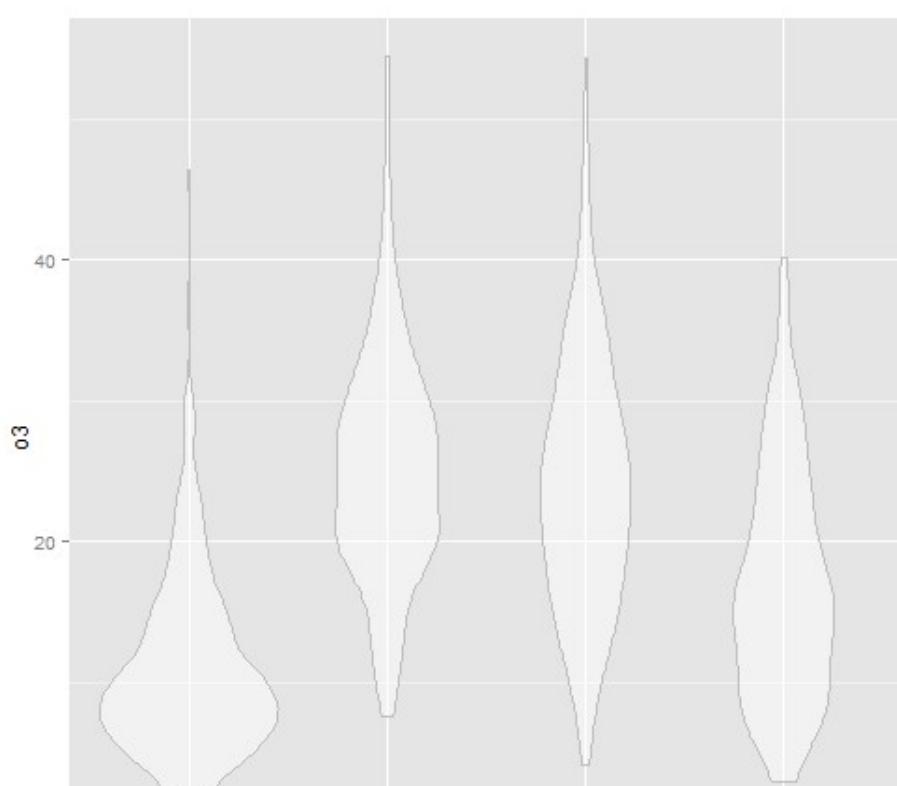


This is better and I think since we're working with season, a variable everyone will be familiar with, the extra noise will not likely lead to confusion.

Alternative to a box plot: violin plot perhaps (geom_violin())

Violin plots, similar to box plots except you're using a kernel density to show where you have the most data, are a useful visualization.

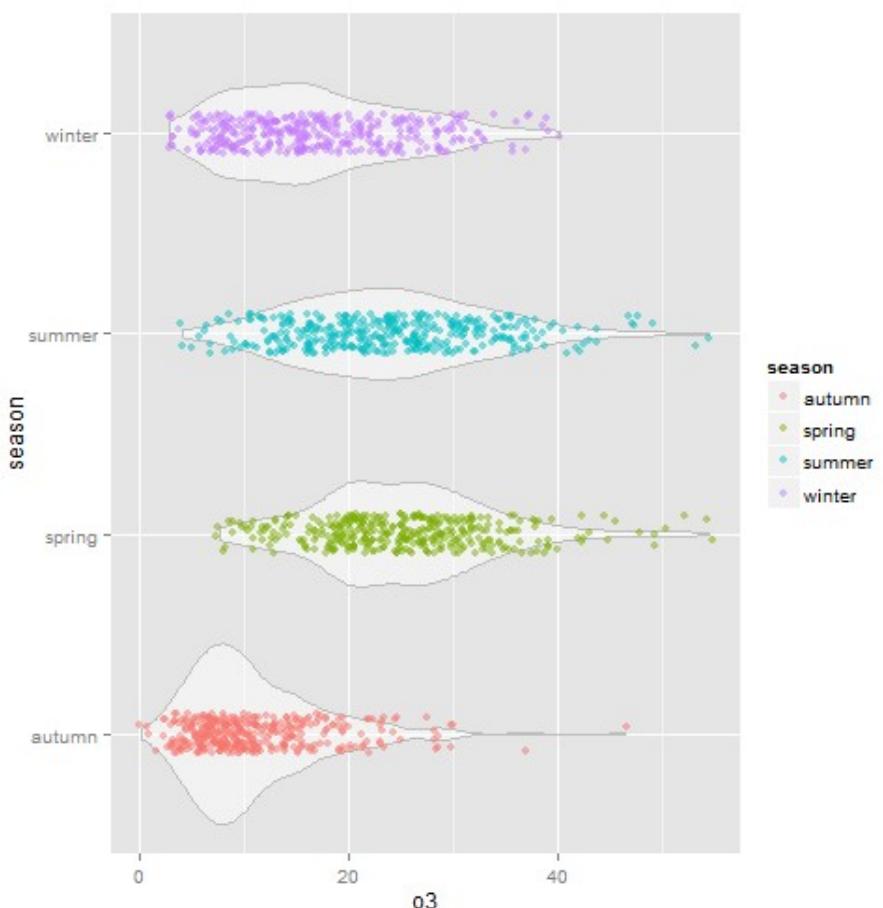
```
g+geom_violin(alpha=0.5, color="gray")
```





What if we rotated and added the jittered points.

```
g+geom_violin(alpha=0.5, color="gray") + geom_jitter(alpha=0.5, aes(color=season),
position = position_jitter(width = 0.1)) + coord_flip()
```



This is nice and I like it. But be wary of using unusual plot types, they take more time for your users to understand.

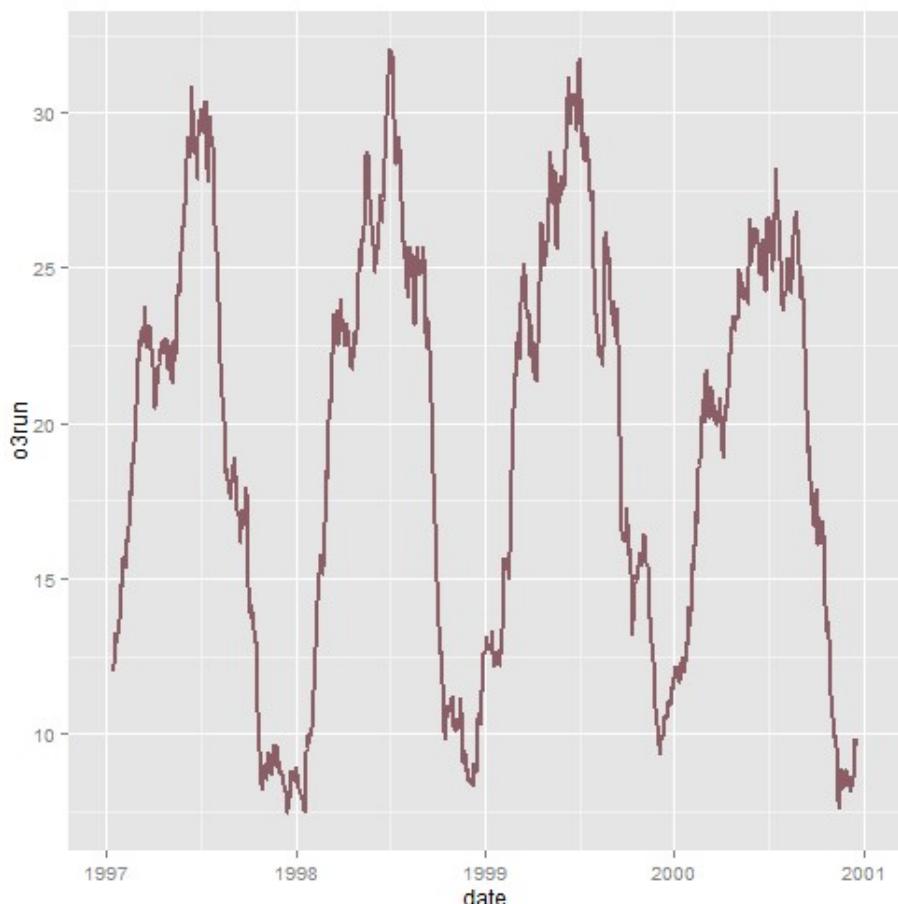
Sometimes the simplest and most conventional plot type is your best bet when sharing with others. Box plots may be boring but people know how to interpret them immediately.

Add a ribbon to your plot (geom_ribbon())

This is not the perfect dataset for this, but using ribbon can be useful. In this example we will create a 30-day running average using the `filter()` function so that our ribbon is not too noisy.

```
# add a filter
nmmaps$o3run<-as.numeric(filter(nmmaps$o3, rep(1/30,30), sides=2))
```

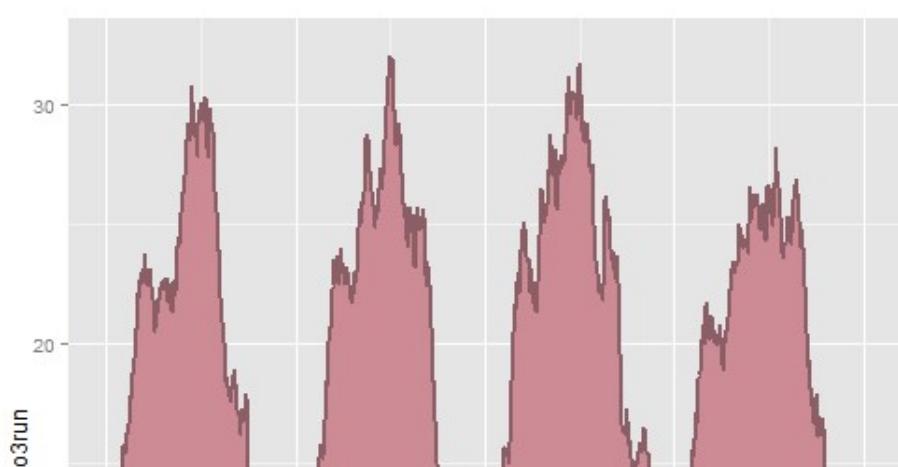
```
ggplot(nmmaps, aes(date, o3run))+geom_line(color="lightpink4", lwd=1)
```

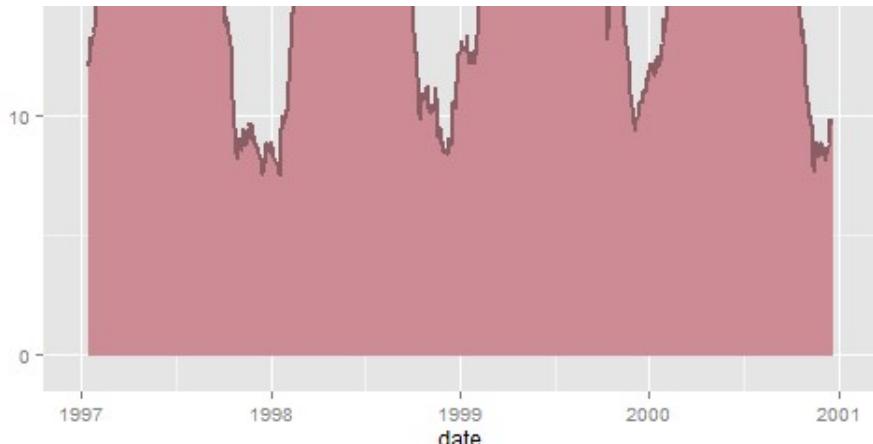


How does it look if we fill in the area below the curve using the `geom_ribbon()` function?

```
# add a filter
```

```
ggplot(nmmaps, aes(date, o3run))+geom_ribbon(aes(ymin=0, ymax=o3run), fill="lightpink3", color="lightpink4", lwd=1)+geom_line(color="lightpink4", lwd=1)
```

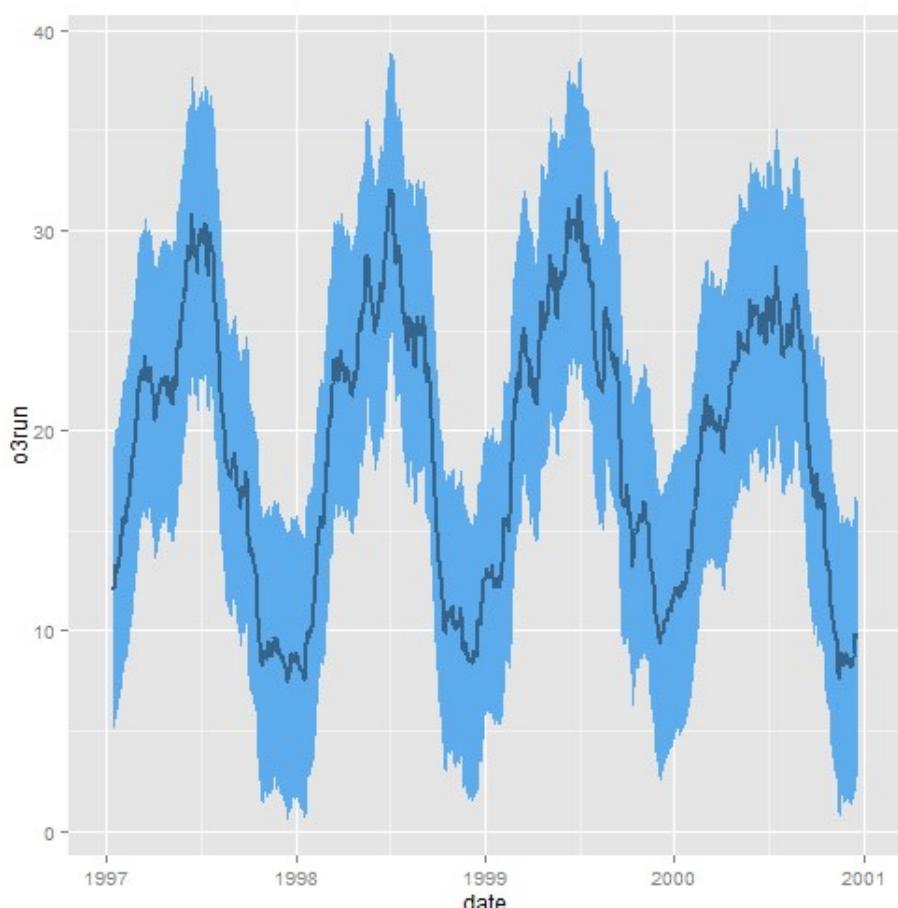




Above is not really the conventional way to use `geom_ribbon()`. Instead, why don't we draw a ribbon that gives us one standard deviation above and below our data:

```
nmmaps$mino3<-nmmaps$o3run-sd(nmmaps$o3run, na.rm=T)
nmmaps$maxo3<-nmmaps$o3run+sd(nmmaps$o3run, na.rm=T)

ggplot(nmmaps, aes(date, o3run))+geom_ribbon(aes(ymin=mino3, ymax=maxo3), fill="steelblue2", color="steelblue4", lwd=1)
  geom_line(color="steelblue4", lwd=1)
```



Create a tiled correlation plot (`geom_tile()`)

I'll admit that I find creating tiled correlation plots a bit cumbersome, I always have to copy and paste code from a previous project. Nevertheless, it's a useful plot type so I'm posting the code here.

First step is to create the correlation matrix. I'm using Pearson because all the variables are fairly normally distributed – you may want to consider Spearman if your variables follow a different pattern. Note that since a correlation matrix has redundant information I'm setting half of it to NA.

```
#careful, I'm sorting the field names so that the ordering in the final plot is correct
thecor<-round(cor(nmmmaps[,sort(c("death", "temp", "dewpoint", "pm10", "o3"))]), method="pearson",
thecor[lower.tri(thecor)]<-NA
thecor
##           death  dewpoint    o3 pm10   temp
## death      1     -0.47 -0.24  0.00 -0.49
## dewpoint   NA     1.00  0.45  0.33  0.96
## o3         NA     NA     1.00  0.21  0.53
## pm10       NA     NA     NA     1.00  0.37
## temp       NA     NA     NA     NA     1.00
```

Now I'm going to put it in “long” format using the `melt` function from the `reshape2` package and I'll drop the records with NA values.

```
library(reshape2)

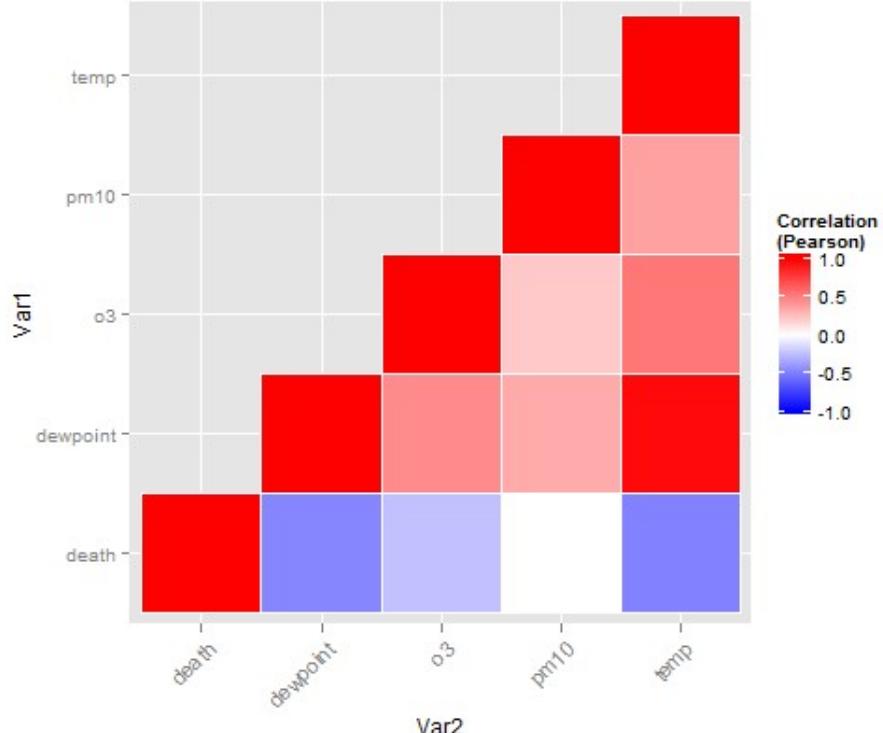
thecor<-melt(thecor)
thecor$Var1<-as.character(thecor$Var1)
thecor$Var2<-as.character(thecor$Var2)
thecor<-na.omit(thecor)
head(thecor)
##           Var1     Var2 value
## 1     death    death  1.00
## 6     death   dewpoint -0.47
## 7   dewpoint   dewpoint  1.00
## 11    death        o3 -0.24
## 12   dewpoint        o3  0.45
## 13        o3        o3  1.00
```

Now for the plot. I'm using `geom_tile` but if you have a lot of data you might consider `geom_raster` which can be much faster.

```
ggplot(thecor, aes(Var2, Var1))+
```

```
geom_tile(data=thecor, aes(fill=value), color="white")+
  scale_fill_gradient2(low="blue", high="red", mid="white",
    midpoint=0, limit=c(-1,1), name="Correlation\n(Pearson)")+
  theme(axis.text.x = element_text(angle=45, vjust=1, size=11, hjust=1))+
```

coord_equal()



[Back to table of contents](#)

Working with smooths

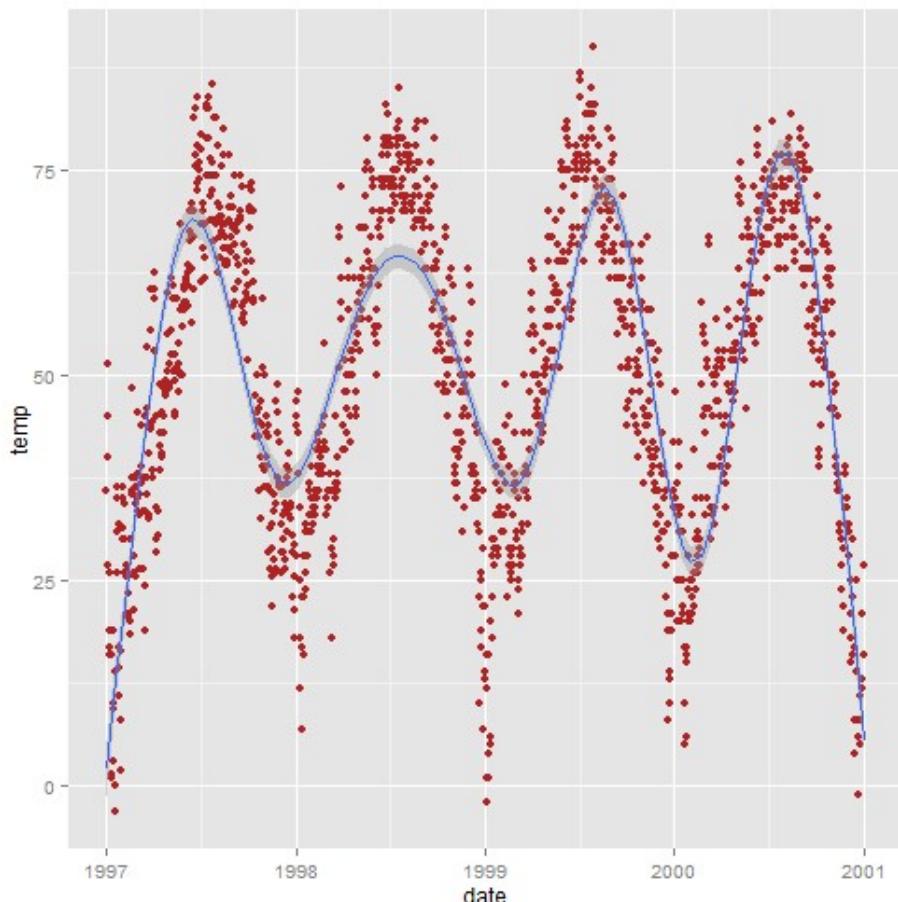
You've likely already learned how amazingly easy it is to add a smooth to your data using `ggplot2`. You can simply use `stat_smooth()` which will add a LOESS smooth if you have fewer than 1000 points or a GAM otherwise. Since we have more than 1000 points the smooth is a GAM.

Default – adding LOESS or GAM (`stat_smooth()`)

Here it is at its simplest – no formula required:

```
ggplot(nmmaps, aes(date, temp))+geom_point(color="firebrick")+
```

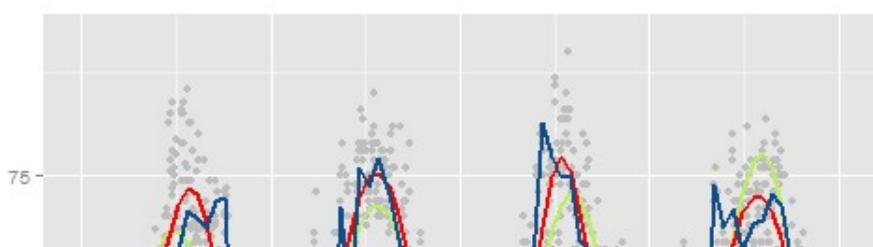
```
stat_smooth()
```

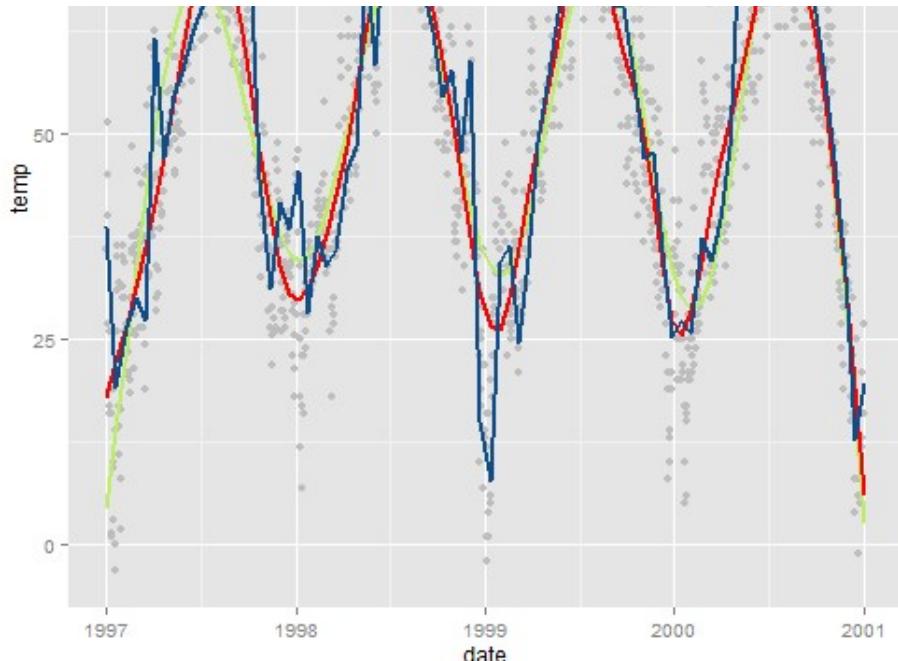


Specifying the formula (stat_smooth(formula=))

But ggplot2 allows you to specify the model you want it to use. For example, let's say you want to increase the GAM dimension (add some additional wiggles to the smooth):

```
ggplot(nmmaps, aes(date, temp))+  
  geom_point(color="grey") +  
  stat_smooth(method="gam", formula=y~s(x,k=10), col="darkolivegreen2", se=FALSE, size=1) +  
  stat_smooth(method="gam", formula=y~s(x,k=30), col="red", se=FALSE, size=1) +  
  stat_smooth(method="gam", formula=y~s(x,k=500), col="dodgerblue4", se=FALSE, size=1)
```

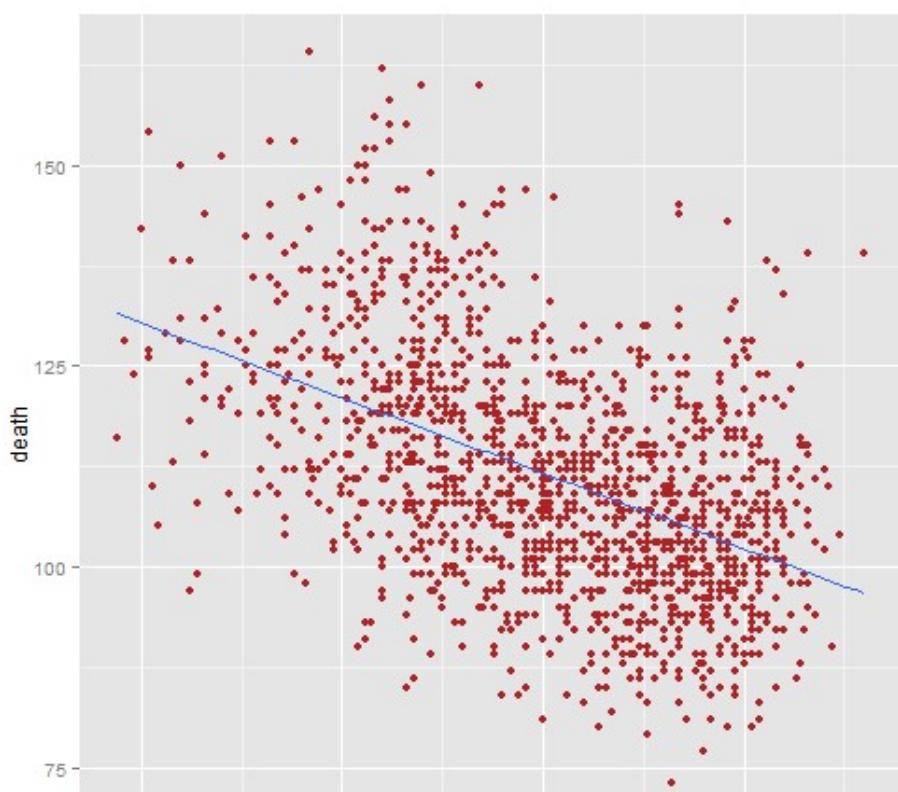




Adding a linear fit (`stat_smooth(method="lm")`)

Though the default is a smooth, it is also easy to add a standard linear fit:

```
ggplot(nmmaps, aes(temp, death))+geom_point(color="firebrick")+
  stat_smooth(method="lm", se=FALSE)
```





Note that the same could be achieved using the more cumbersome:

```
lmTemp<-lm(death~temp, data=nmmaps)
ggplot(nmmaps, aes(temp, death))+geom_point(col="firebrick")+
  geom_abline(intercept=lmTemp$coef[1], slope=lmTemp$coef[2])
```

Convert your plots to online, interactive graphics using Plot.ly

Plot.ly is a great tool for easily creating online, interactive graphics directly from your ggplot2 plots. The process is surprisingly easy, and can be done from within R, but there are enough steps that I describe how to create graphics like the one below in a [separate post](#).

Note that I have been using a free plot.ly account for this one plot which limits to 500 views per day. After 500 views plot.ly sends an incredible number of e-mails about the exceedance (sometimes more than 15 per day). So for now I have turned off the plot below and you'll have to imagine it!

This post created in RStudio using knitr. R version 3.0.2 (2013-09-25) and ggplot2 version 0.9.3.1.

Posted in [Data Visualization](#), [ggplot2](#), [R](#)

49 responses



pssguy

August 5, 2014 at 12:25 pm

This is fantastic

Looking forward to the ggviz version!



zev@zevross.com

August 5, 2014 at 1:08 pm

Coming soon!



Tung

August 8, 2014 at 8:09 pm

Hi Zev,

Awesome job! One of the most comprehensive tutorials on ggplot2 I've ever come through. By the way, how can you increase the size of x- & y-axis legend? Sorry if I missed it in your post. Thank you so much!

Cheers,



zev@zevross.com

August 11, 2014 at 9:27 am

Do you mean the x & y axis label? If so take a look at my "Move the labels away from the plot" and then look at the help for element_text (?element_text).



Tung

August 11, 2014 at 1:44 pm

I meant the size of numbers on x- & y-axis e.g. 0, 25, 50, 75 & 1997 to 2001 in your plot. Thanks!



zev@zevross.com

August 11, 2014 at 2:27 pm

I added a new example under 'Change size of tick text'



Tung

August 11, 2014 at 3:10 pm

Awesome! Thanks so much!



Spyros

August 22, 2014 at 7:16 am

Hi, this looks really good, but I am not sure how to get hold of the data you are using. Any hints apart from consulting Dr Peng's book?



zev@zevross.com

August 29, 2014 at 10:37 am

I added a link to the CSV file used in the post.



Gloria

July 27, 2015 at 11:23 am

This is a very nice an illustrative way to show ggplot possibilities
thank you very much
Gloria



Jalem Raj Rohit

July 30, 2015 at 6:56 am

A great post; but a small mistake:

It should be: `stat_smooth(method="lm", se=False)` instead of: `stat_smooth(method="lm", se=FALSE)`

in the section adding a linear fit.



zev@zevross.com

August 10, 2015 at 2:00 pm

No "FALSE" is correct, not "False" try it:

```
x<-data.frame(a=1:10, b=1:10) ggplot(x, aes(a, b))+geom_point(color="firebrick")+ stat_smooth(method="lm",  
se=FALSE)
```



Karl

August 4, 2015 at 9:03 pm

Great help, thanks!



Bob

August 31, 2015 at 3:37 pm

You are my new R hero.

Thank you



zev@zevross.com

August 31, 2015 at 4:09 pm

Thanks!



Anand

September 6, 2015 at 7:35 am

I have ~ 14,000 points for my XY scatter, so I have to necessarily use low alpha=0.025 or it will become too dark. However, when I want to display just 7 points of interest, they are not visible because of the low alpha. I am assuming that it is possible to retain alpha for the XY scatter points, and change alpha for just my points of interest? I just dont know how though, could you help please? Thanks!

My syntax so far, using the awesome examples on your website, looks like this:

```
>input=read.table("PfamAseeds_SeqIdnty_Stats_R_Annotated_ScatterPlot.txt",sep="\t",header=TRUE)
>df=as.data.frame(input)
>summary(df)
PfamA_ID SeqIdentityMean SeqIdentityStdDev
:14823 Min. :0.0718 Min. :0.00000
:14823 1st Qu.:0.2510 1st Qu.:0.02910
:
:
:
(Other) :3
>trial trial
```



zev@zevross.com

September 8, 2015 at 9:41 am

I'm not going to be able to give you complete code for this right now given time constraints but it would probably be best to do something like this. Keep in mind this is pseudo-code...

```
alldata <- ...
just7points <- ...
ggplot()+
  geom_point(data=alldata, aes(...), alpha= 0.25)+
  geom_point(data=just7points, aes(...), alpha=1)
```

Once you have the code worked out, send it to me and I'll post.



Anand

September 6, 2015 at 7:36 am

Sorry, got truncated in earliest message
> trial trial



Lucy

September 26, 2015 at 9:53 am

thank you!!!



Pinar

November 22, 2015 at 8:03 am

Thanks a lot for this fantastic cheatsheet!



Amao

December 17, 2015 at 12:08 pm

Wow... This is just wonderful, you must be from another planet because it takes patience and skills to explain the way you did. Thank you, i really appreciate this !!!



Kristina

December 29, 2015 at 7:54 pm

The vjust and hjust arguments are deprecated. What are the updates to increase spacing between the axes and axis text?

Thank you



zev@zevross.com

December 30, 2015 at 9:07 am

I hadn't heard this, can you give me a link to where this is described? In any case, I'm likely going to need to do an update for ggplot2 v 2.0 because it has some nice new features.



Tung

January 19, 2016 at 6:18 pm

Someone asked over here and Hadley replied

vjust was always a hack that I never thought should work. The margins parameter is the correct way to solve this problem as of ggplot2 2.0.0.

<http://r.789695.n4.nabble.com/vjust-unresponsive-ggplot2-td4715828.html>



zev@zevross.com

January 20, 2016 at 9:44 am

This is great! Thanks for the help, I have updated the post.



rose

December 30, 2015 at 6:38 pm

really such a great tutorial! thanks.



Tung

January 25, 2016 at 7:04 pm

Hi Zev,

Is there any way to reverse the color drawn by scale_color_grey() from lightest to darkest?

Also in scale_color_brewer(), in several theme (e.g. Blues), there is always the color very close to "white". Is it possible to remove those colors for better visualization?

http://docs.ggplot2.org/current/scale_brewer.html

Thanks!



zev@zevross.com

January 26, 2016 at 8:27 am

If you look at the help for scale_color_grey() you'll see that there are arguments for start and end. So scale_color_grey(start=0.8, end=0.2) will give you light to dark. Regarding scale_color_brewer() those are pre-built scales so if you want to drop a color you'd likely need to use scale_color_manual() after figuring out the colors. To figure out the colors:

```
library(RColorBrewer)  
brewer.pal(5, "Blues")
```



Tung

January 26, 2016 at 6:42 pm

Works great! I ended up using color_gradient <- brewer.pal(9, "Blues")[-c(1:3)]

Thanks again Zev!



jolyonh

January 26, 2016 at 5:58 am

Great tutorial, very clear and concise.



Joyce

February 12, 2016 at 2:44 pm

Helpful, thanks. I find it useful to look at the default text margins to take as a starting point when adjusting. For example, the default plot.title margin (see theme_grey function) is margin = margin(b = half_line * 1.2), where half_line is half the base_size font, or in short the bottom title margin is .5*11*1.2 = 6.6 pt.



zev@zevross.com

February 12, 2016 at 3:27 pm

Thanks for the tip



Megan Jones

February 18, 2016 at 11:31 am

Hi. FYI: the link at the top to “Mapping in R using the ggplot2 package” re-directs directly back to this page instead of to

<http://zevross.com/blog/2014/07/16/mapping-in-r-using-the-ggplot2-package/>



zev@zevross.com

February 22, 2016 at 11:08 am

I really appreciate you reporting this. The bad link must have been there for months! I've fixed it.



Corey

March 15, 2016 at 4:14 pm

Is there any way to customize where the tick marks are along the x-axis? I have a time series, and I'd like to have major tick marks every January, then minor tick marks every quarter (every April, July and October). Preferably, I'd also like the labels to read “Jan 2012”, “Apr 2012”, etc instead of just the numeric year.

Thanks!



zev@zevross.com

March 15, 2016 at 4:18 pm

This would take some work to get right given that you have a couple of different tick types and locations but you should take a look at scale_date (http://docs.ggplot2.org/0.9.3/scale_date.html).



zioZaif

April 30, 2016 at 11:00 pm

Hi there- Anyone else experience the problem on a Mac wherein the plots rendered always have grey lines in the background- that aren't ggplot2 gridlines??

How to get rid of these?

thanks



Laszlo

June 1, 2016 at 9:54 am

Hi!

Unfortunatelly, I just found this site. It is very helpful.

However, I hope someone here, can help me out. I want to annotate differing text to fix position on all faceted plots.

I used this code with + annotate_custom()

```
grob <- grobTree(textGrob(label = paste("N = ", out2[, 6], " (", round(out2[, 7], 2), "%)", sep = ""), x = 0.01, y = 0.75,  
hjust = 0, gp = gpar(col = "black", fontsize = 13, fontface = "bold")))
```

However, it always annotates the first element to all plots.

Any suggestions?

Thanks in advance,

Laszlo



zev@zevross.com

June 1, 2016 at 2:22 pm

Best to see the whole code. Please post to stackoverflow and provide a link.



Laszlo

June 2, 2016 at 6:43 am

Thanks for the fast response.

I posted the problem to stackoverflow.

Link:

<http://stackoverflow.com/questions/37589527/ggplot2-fixed-position-text-annotation-on-facets>

Thanks,

Laszlo



zev@zevross.com

June 2, 2016 at 8:22 am

I provided a link to another post and a gist that might help.



Christine

August 18, 2016 at 4:20 pm

Amazing cheatsheet. I'm new to ggplot2 and it would've made my day a lot easier if I had started here. Thanks for this post!



zev@zevross.com

August 19, 2016 at 9:09 am

Thanks!



adrian

September 6, 2016 at 10:44 pm

I inserted minor ticks in the y-axis of my ggplot graph without labels and I wanted it to be shorter than the tick marks with labels. Wondering how this is done in r or I am looking for a r code to do it. Thanks a lot.



zev@zevross.com

September 8, 2016 at 9:15 am

Off-hand I'm not sure. Perhaps feed a vector to the theme/axis.ticks.length. Why don't you post code to stackoverflow and send the link.



Prakash P. Shenoy

April 25, 2017 at 9:47 am

I have a small dataset (2 variables x and y, 15 instances), and would like a matrix of scatterplots y vs. x, y vs. log(x), y vs. sqrt(x), y vs. $I(1/x)$, log(y) vs. x, log(y) vs. sqrt(x), ..., $I(1/y)$ vs. $I(1/x)$. The 'pairs' command in basic R gives too much (I only want y or some function of y on the vertical axis). How can I get this matrix of 16 scatterplots using ggplot2? Such a plot is useful in searching for transformations of x and y so that the relationship is linear with constant variance (for an analysis using simple linear regression). Thanks!



Catherine

May 4, 2017 at 1:19 pm

Question about the annotation with facet_wrap. Let's say you didn't want them all to say the same thing, but rather something specific per each grid. Can you do that?



zev@zevross.com

May 12, 2017 at 8:22 am

Yes, how to do it depends on what you're trying to do. Probably the easiest thing is to have a new dataset that has the same variable you're using to break on facets with the text you want. But, again, really depends on what you're trying to do. At this link (<https://gist.github.com/kdauria/524eade46135f6348140>) is an example of how to add a custom linear regression formula.



bmwil3

August 19, 2017 at 10:22 pm

Thanks for this! I've been searching for an answer to my legend issues for a while now.

Spatial Analysis & Data Science

Powered by [WordPress](#) &
[Themegraphy](#)

ZevRoss Spatial Analysis

120 N Aurora St, Suite 3A
Ithaca, NY 14850
607-277-0004

info@zevross.com

