

Data Visualization in R with `ggplot2`

The Structure of `ggplot2` (Part 4)

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Photo by Richard Strozyński

Part 4

Visual Themes

ggplot2: Build a data MASTERpiece



Illustration by Allison Horst (github.com/allisonhorst/stats-illustrations)

The Structure of `ggplot2`

Layer	Function	Explanation
Data	<code>ggplot(data)</code>	The raw data that you want to visualise.
Aesthetics	<code>aes()</code>	Aesthetic mappings of the geometric and statistical objects.
Layers	<code>geom_*</code> () and <code>stat_*</code> ()	The geometric shapes and statistical summaries representing the data.
Scales	<code>scale_*</code> ()	Maps between the data and the aesthetic dimensions.
Coordinate System	<code>coord_*</code> ()	Maps data into the plane of the data rectangle.
Facets	<code>facet_*</code> ()	The arrangement of the data into a grid of plots.
Visual Themes	<code>theme()</code> and <code>theme_*</code> ()	The overall visual defaults of a plot.
Annotations	<code>annotate()</code>	Add additional labels, geometries or images to a plot.

Visual Themes

`theme()` and `theme_*`

`theme_*`()

- Themes control the display of all non-data elements of the plot
 - titles
 - labels
 - fonts
 - background + borders
 - gridlines
 - legends
- Themes can be modified for each plot by calling `theme()` and `element_` functions
- Themes can be used to give plots a consistent customized look by defining a custom theme using `theme_update()` or `theme_set()`

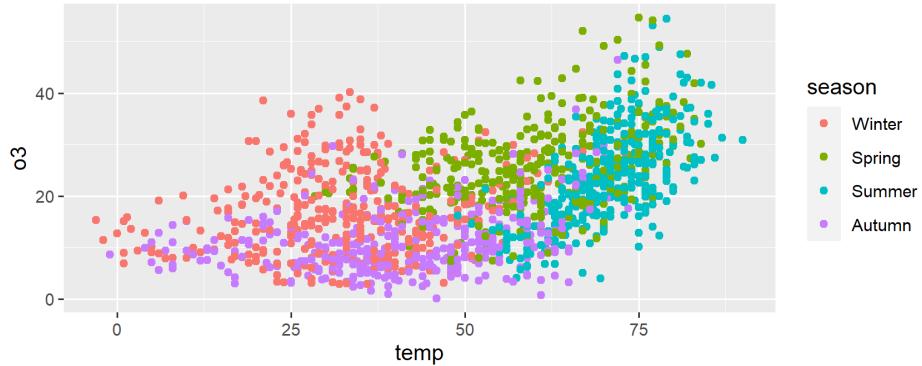
Visual Themes

theme_*(**)** and **theme**(**)**

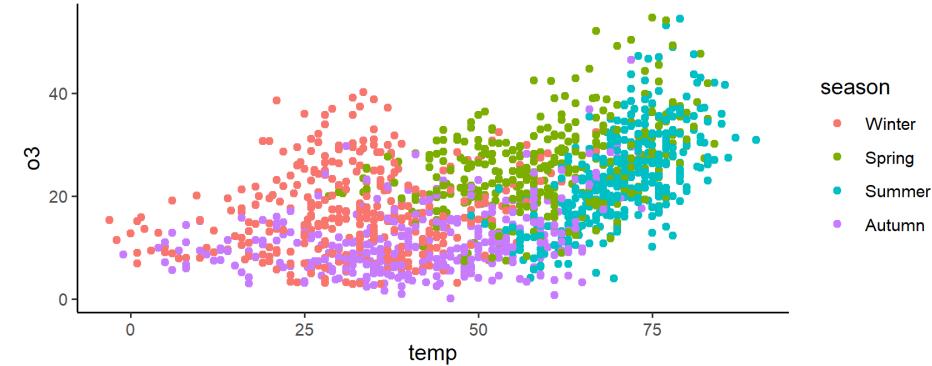
theme_*()

We have already seen several build-in theme examples in the first `ggplot2` lecture:

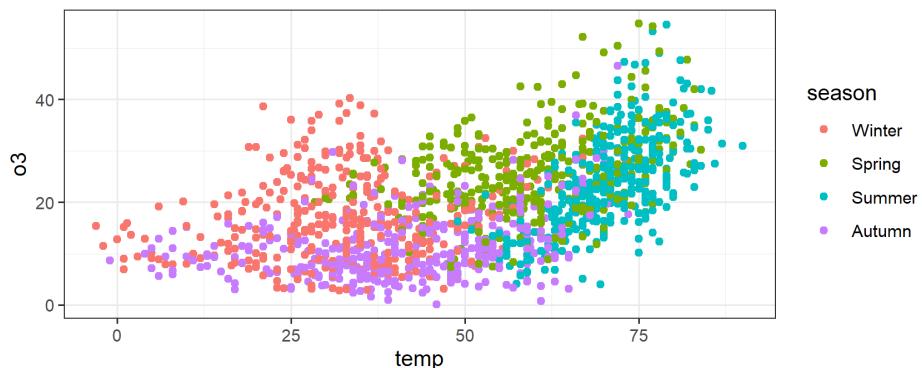
`theme_grey()` or `theme_gray()`



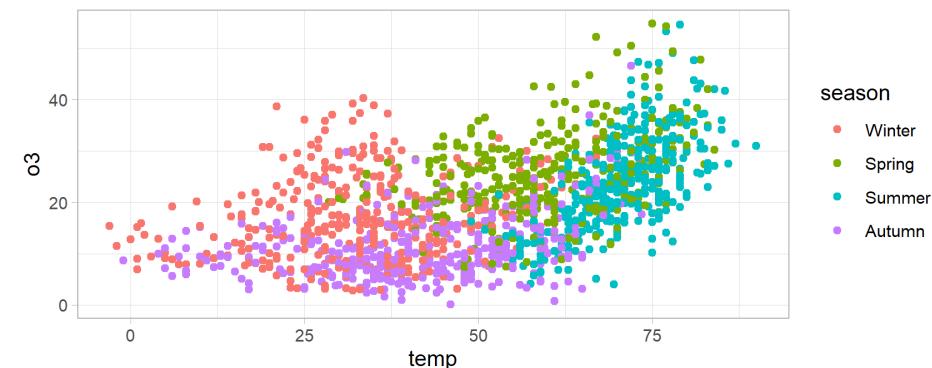
`theme_classic()`



`theme_bw()`



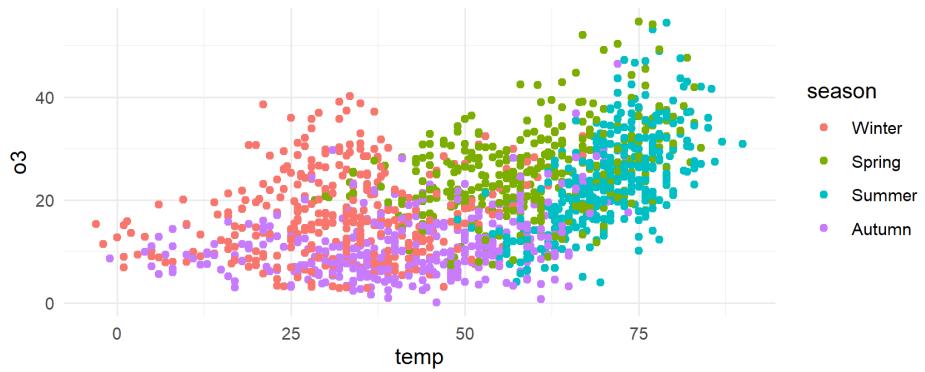
`theme_light()`



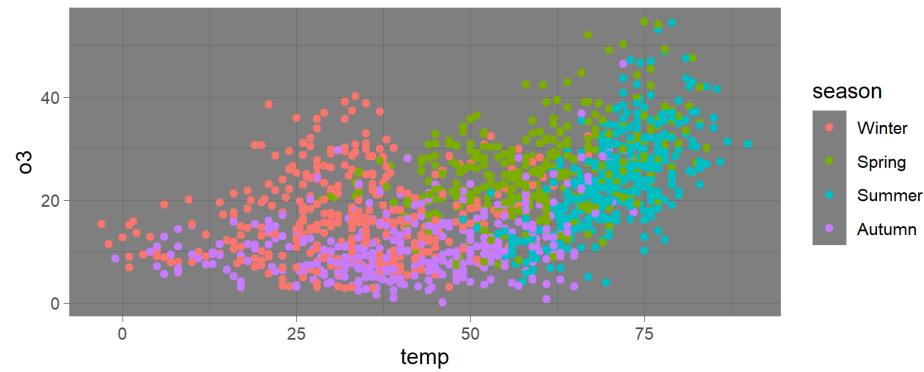
theme_*()

We have already seen several build-in theme examples in the first `ggplot2` lecture:

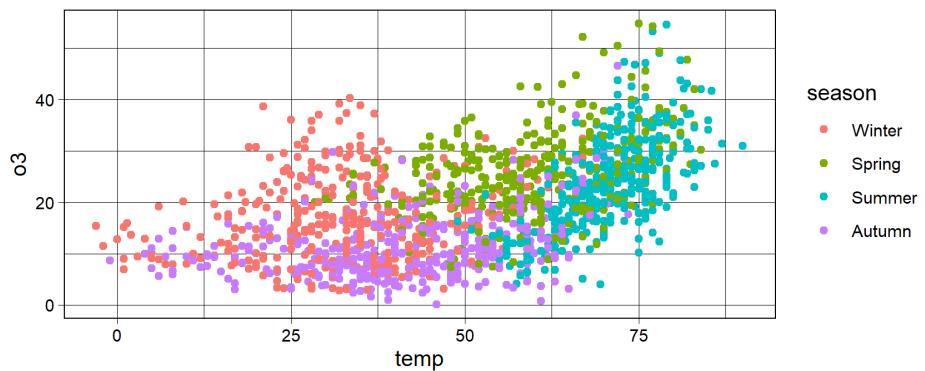
`theme_minimal()`



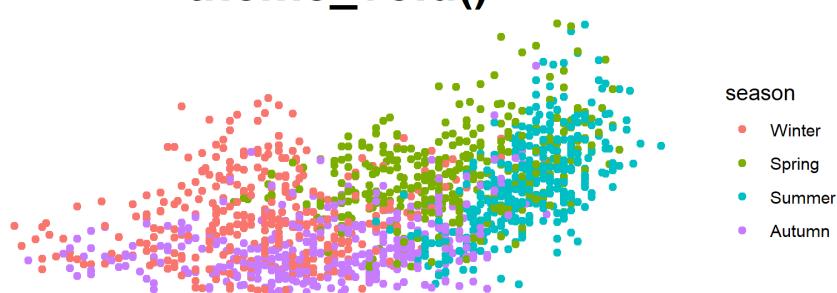
`theme_dark()`



`theme_linedraw()`



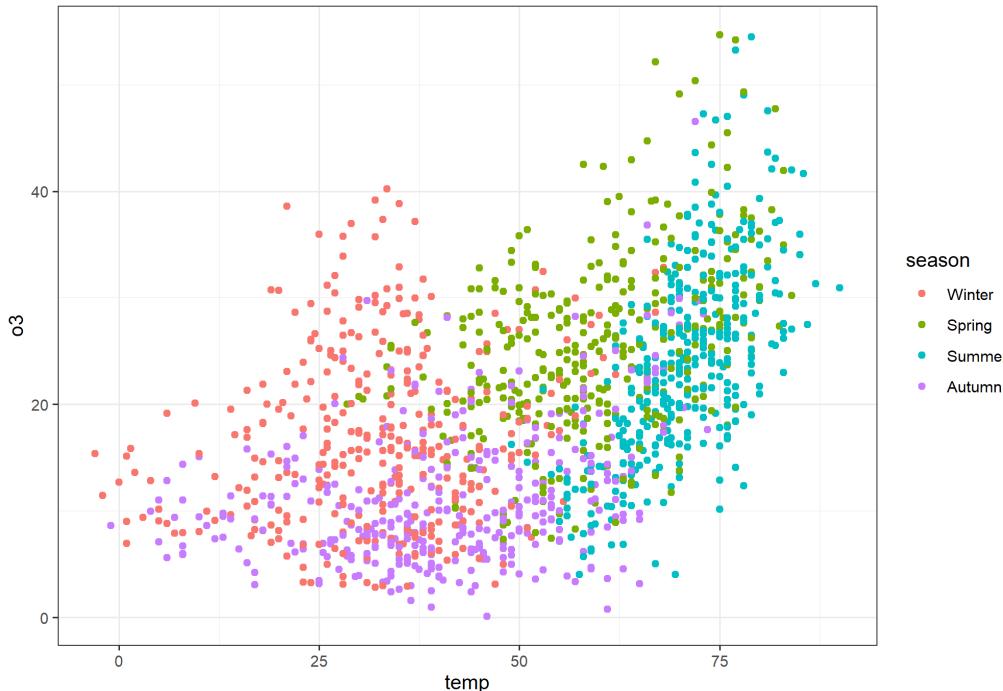
`theme_void()`



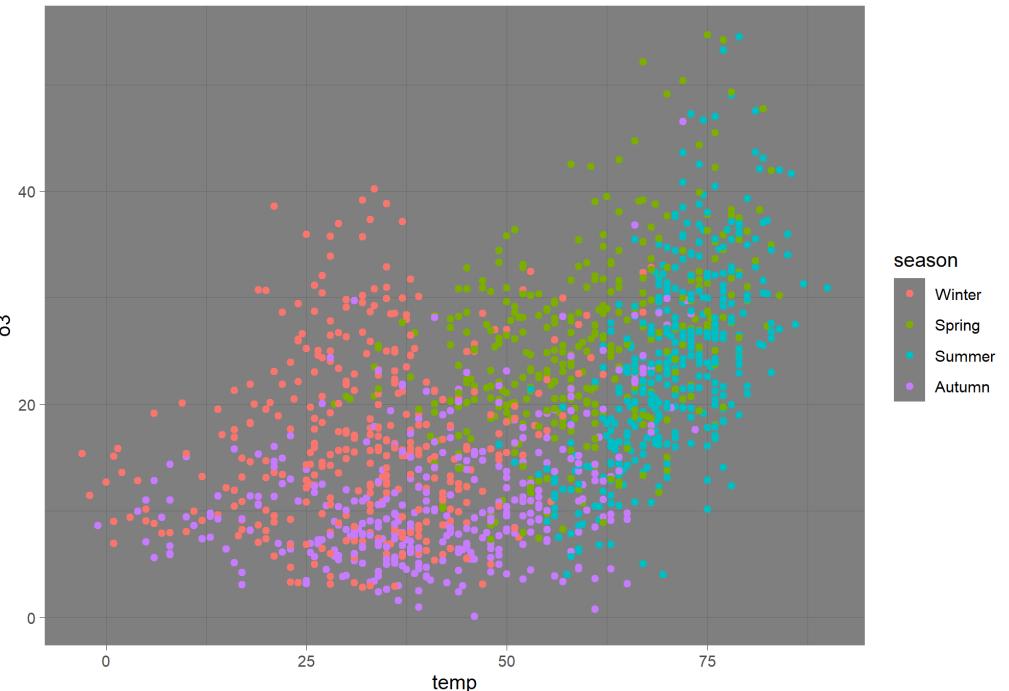
theme_*()

You can set themes for each plot or globally for the current session with `theme_set()`:

```
ggplot(chic, aes(temp, o3)) +  
  geom_point(aes(color = season)) +  
  theme_bw()
```



```
ggplot(chic, aes(temp, o3)) +  
  geom_point(aes(color = season)) +  
  theme_dark()
```

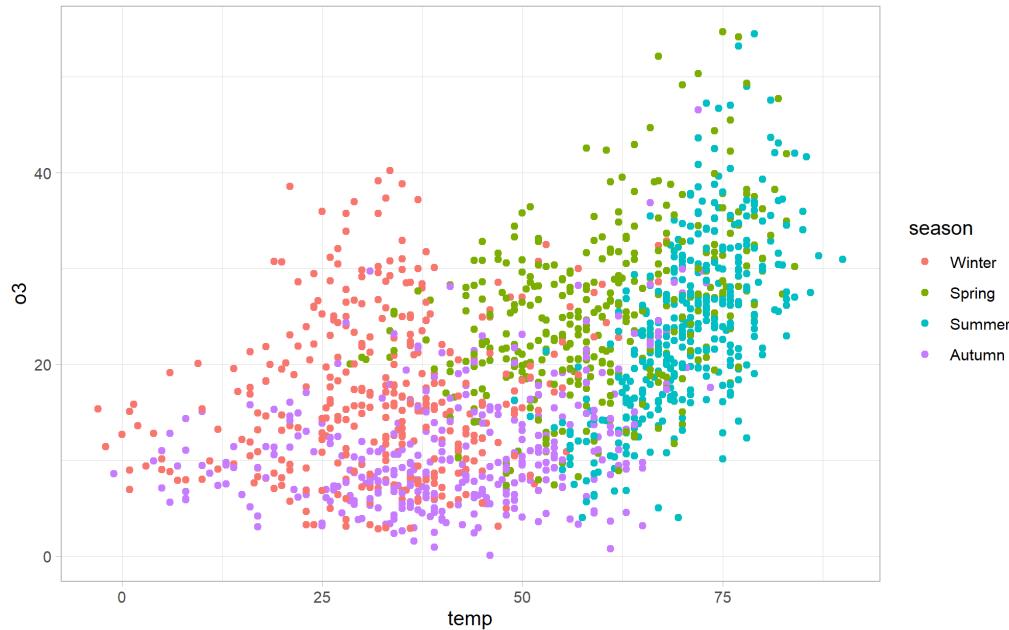


theme_set()

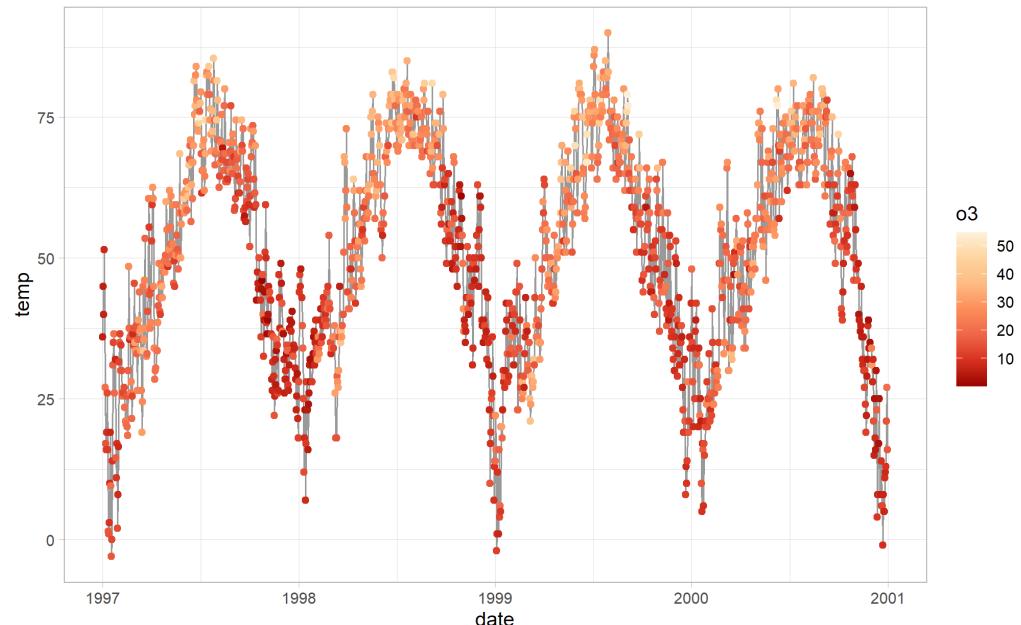
You can set themes for each plot or globally for the current session and thus all following plots with `theme_set()`:

```
theme_set(theme_light())
```

```
(g <- ggplot(chic, aes(temp, o3)) +  
  geom_point(aes(color = season)))
```



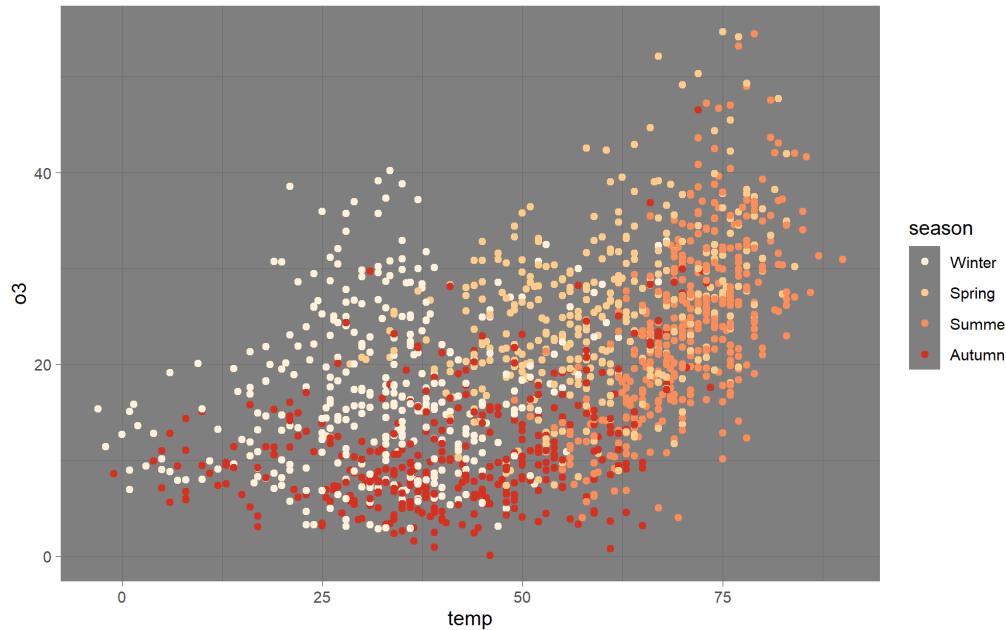
```
ggplot(chic, aes(date, temp)) +  
  geom_line(color = "grey60") +  
  geom_point(aes(color = o3)) +  
  scale_color_distiller(palette = 8)
```



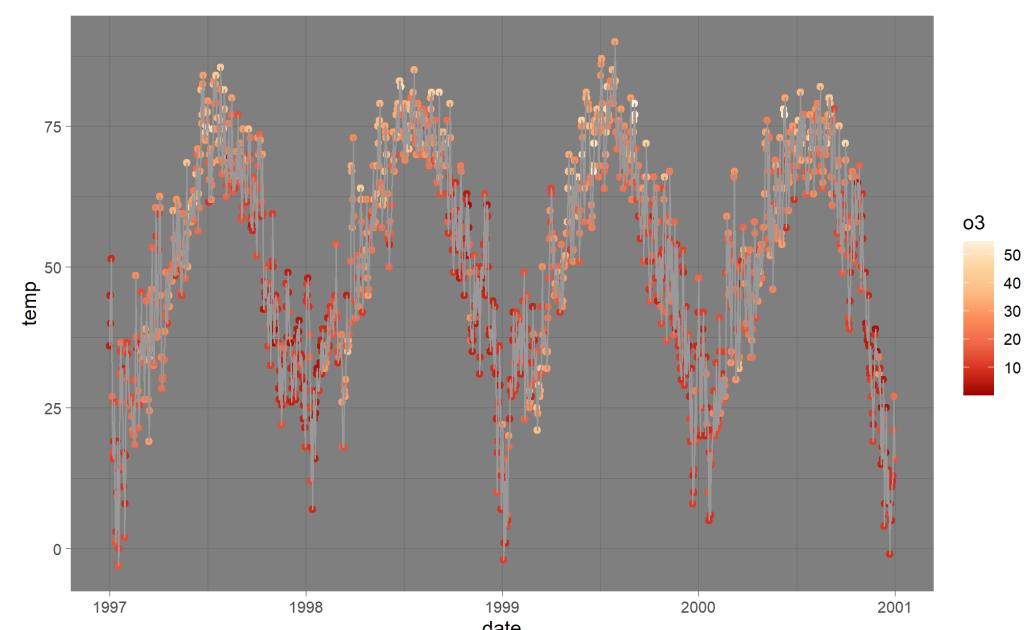
theme_set()

You can set themes for each plot or globally for the current session and thus all following plots with `theme_set()`:

```
old_theme <- theme_set(theme_dark())
g +
  scale_color_brewer(palette = 8)
```



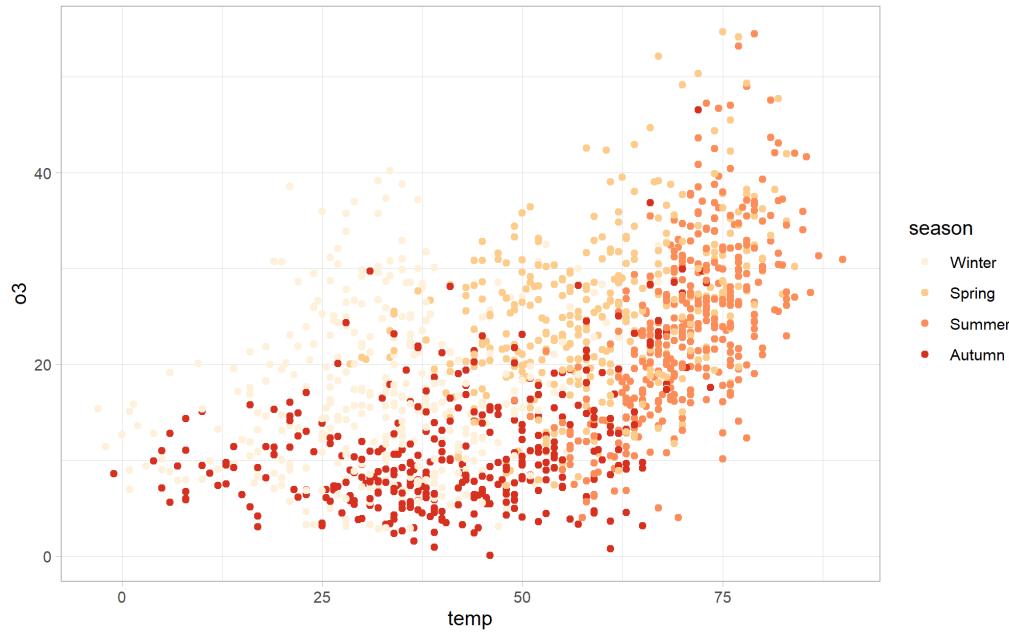
```
ggplot(chic, aes(date, temp)) +
  geom_point(aes(color = o3)) +
  geom_line(color = "grey60") +
  scale_color_distiller(palette = 8)
```



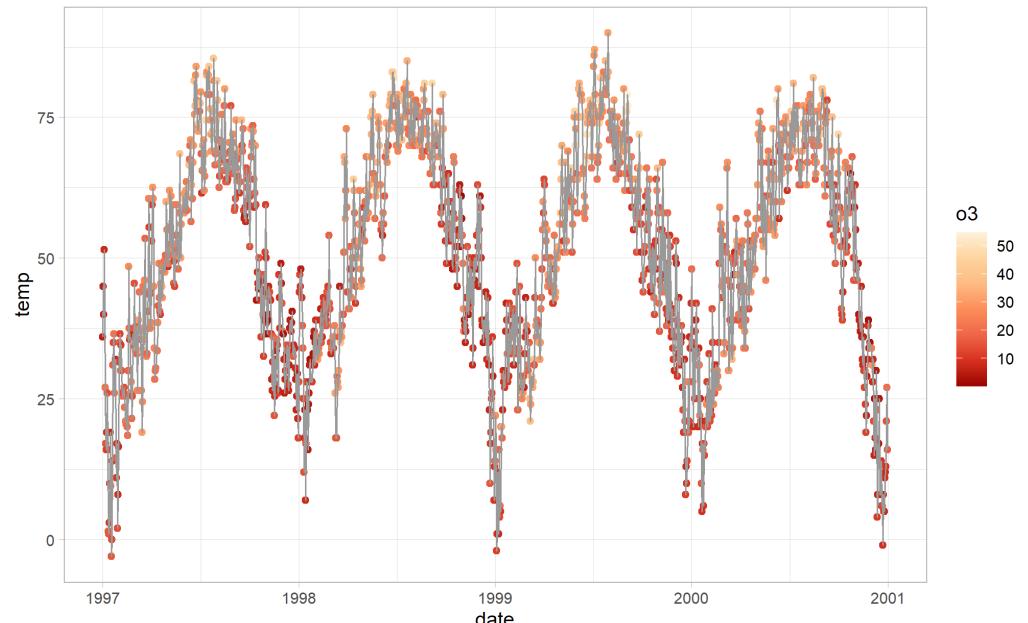
theme_set()

`theme_set()` invisibly returns the previous theme so you can easily save it, then later restore it:

```
theme_set(old_theme)  
g +  
  scale_color_brewer(palette = 8)
```



```
ggplot(chic, aes(date, temp)) +  
  geom_point(aes(color = o3)) +  
  geom_line(color = "grey60") +  
  scale_color_distiller(palette = 8)
```

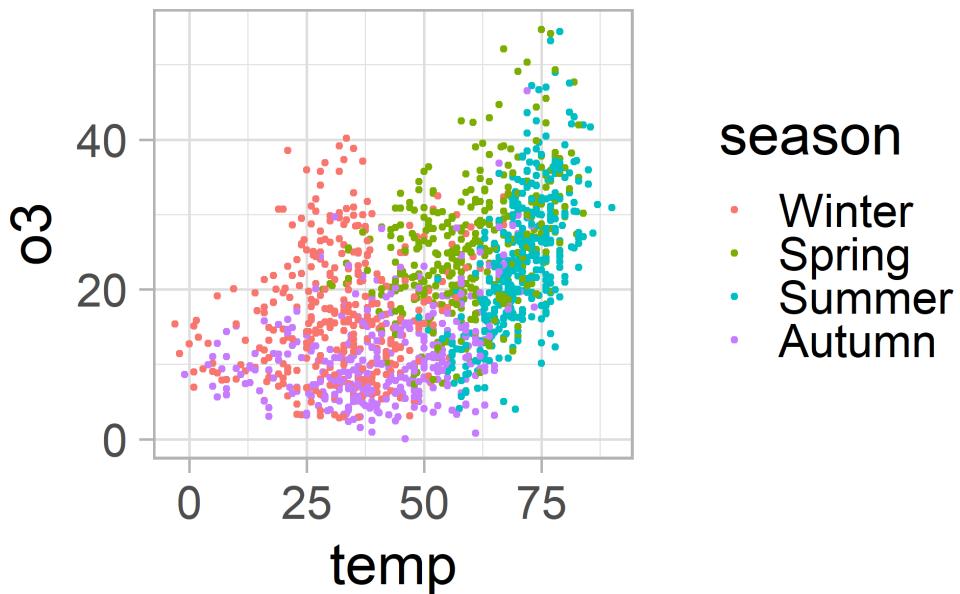


theme_*(base_size)

Themes have a `base_size` argument which is a simple way to increase or decrease the font size:

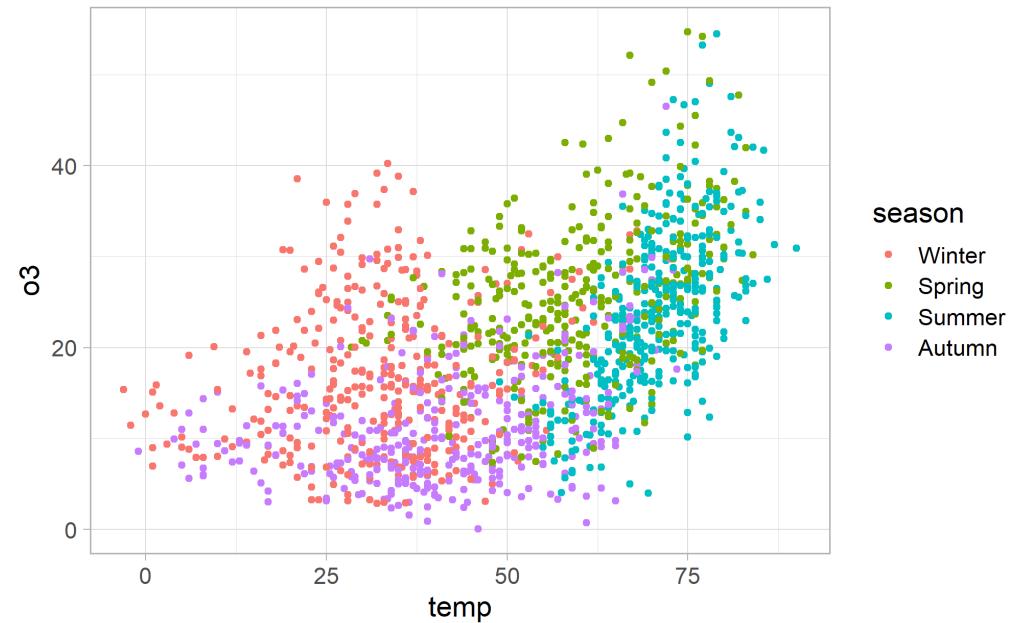
```
theme_set(theme_light(base_size = 32))
```

```
g
```



```
theme_set(theme_light(base_size = 16))
```

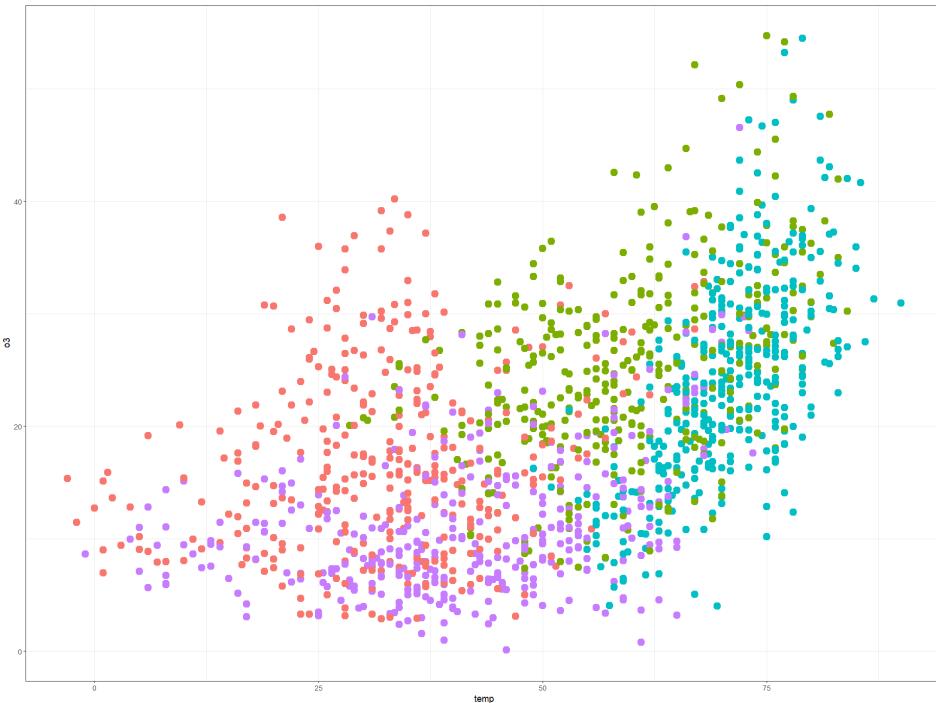
```
g
```



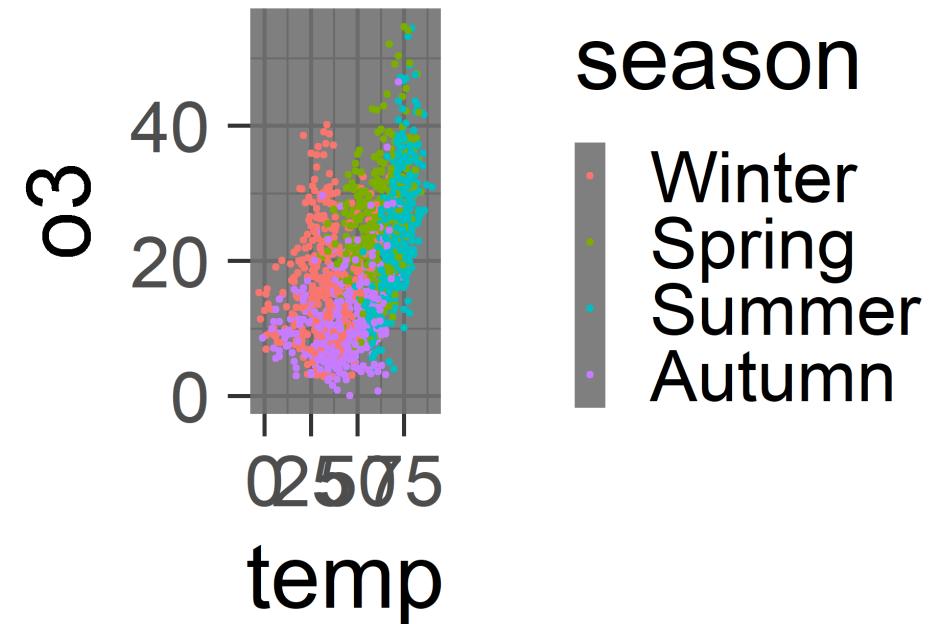
theme_*(base_size)

Themes have a `base_size` argument which is a simple way to increase or decrease the font size:

```
g +  
  theme_bw(base_size = 5)
```



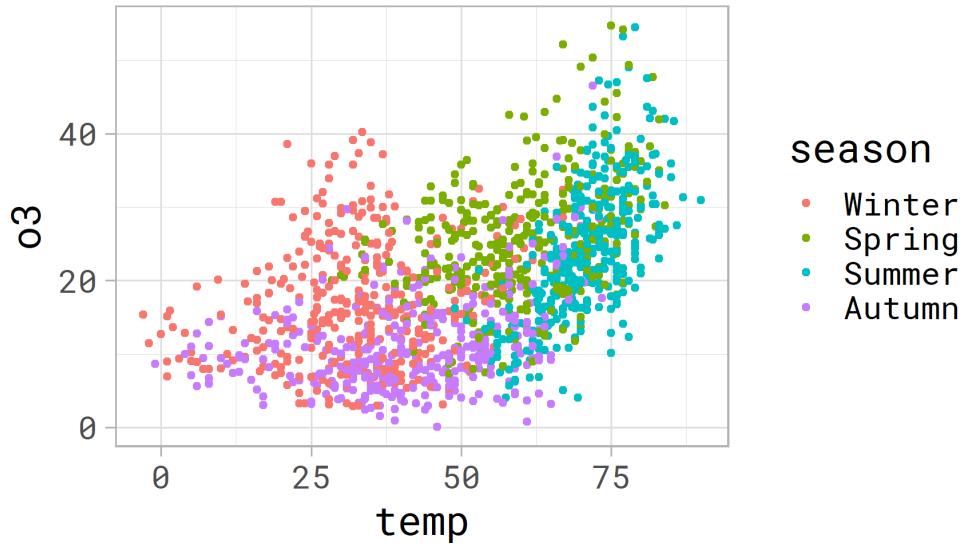
```
g +  
  theme_dark(base_size = 50)
```



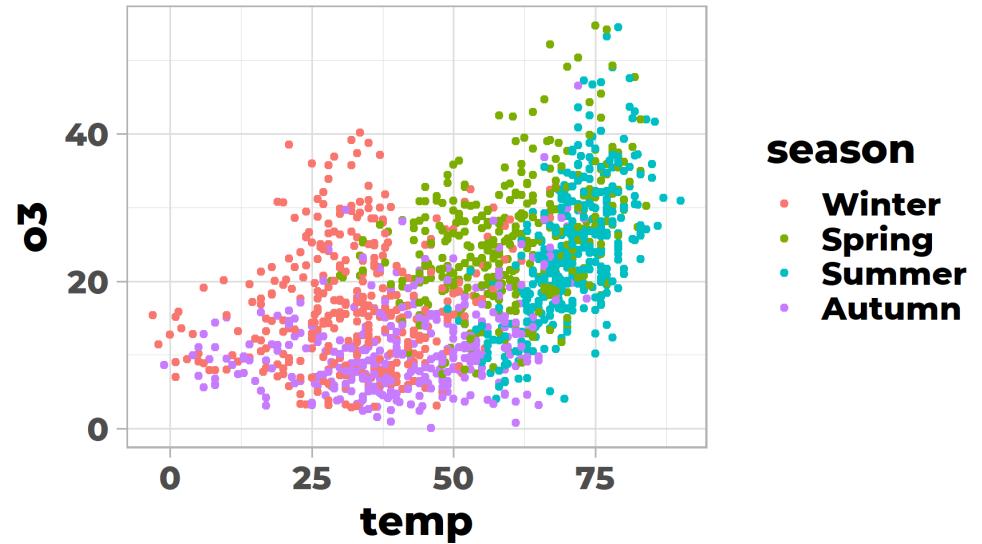
theme_*(base_family)

You can also set the font of the theme via `base_family`:

```
theme_set(theme_light(  
  base_size = 20,  
  base_family = "Roboto Mono"  
)  
g
```



```
theme_set(theme_light(  
  base_size = 20,  
  base_family = "Montserrat ExtraBold"  
)  
g
```



Fonts: The `extrafont` Package

Fonts that are imported into `extrafont` can be used with PDF or PostScript output files. On Windows, `extrafont` will also make system fonts available for bitmap output.

```
install.packages("extrafont")
library(extrafont)

## import your system fonts
## (only 1 time)
font_import() ## press "y"
loadfonts()
```

Fonts: The `extrafont` Package

Fonts that are imported into extrafont can be used with PDF or PostScript output files. On Windows, extrafont will also make system fonts available for bitmap output.

Fonts: The `showtext` Package

The `showtext` package, is able to support more font formats and more graphics devices, and avoids using external software such as Ghostscript. `showtext` makes it even easier to use various types of fonts (TrueType, OpenType, Type 1, web fonts, etc.) in R graphs.

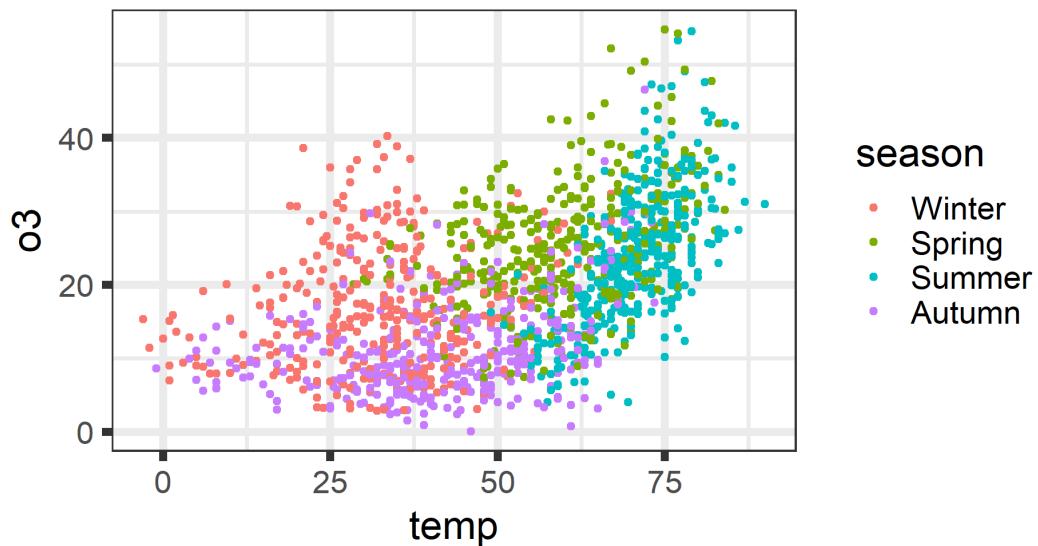
```
install.packages("showtext")
library(showtext)

## Loading Google fonts
## (https://fonts.google.com/)
## installed on your system,
font_add_google("Roboto", "Roboto")
font_add_google("Roboto Mono", "Roboto Mono")
```

theme_*(base_line_size)

... and change the size of geometric elements via `base_line_size` and `base_rect_size`:

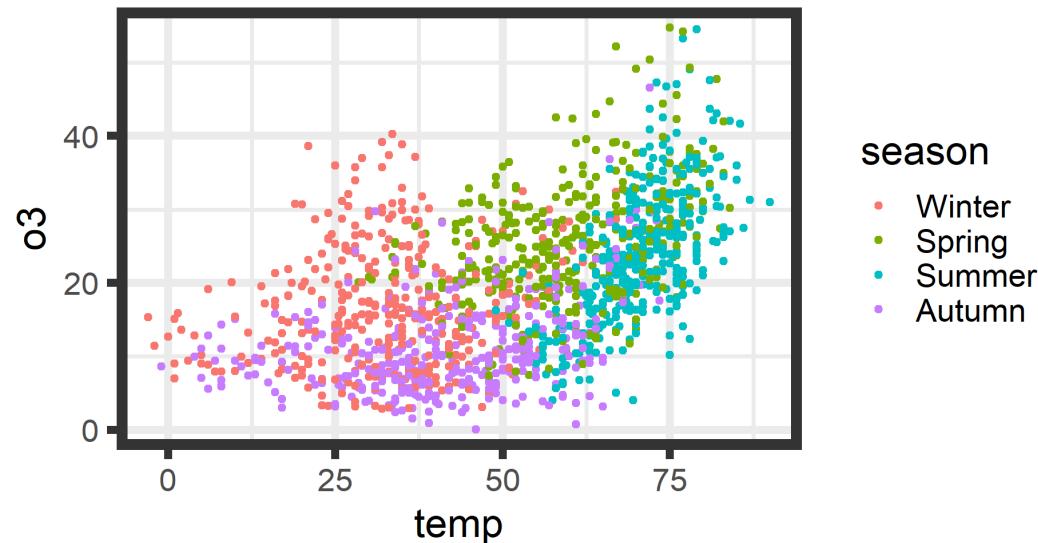
```
g +
  theme_bw(
    base_size = 20,
    base_line_size = 2
  )
```



theme_*(base_rect_size)

... and change the size of geometric elements via `base_line_size` and `base_rect_size`:

```
g +
  theme_bw(
    base_size = 20,
    base_line_size = 2,
    base_rect_size = 5
  )
```



theme_*()

- `theme_set()` completely overrides the current theme.
- `theme_update()` modifies a particular element of the current theme using the `+` operator.
- `theme_replace()` modifies a particular element of the current theme using the `%+replace%` operator.

For the last two, you first need to know what is available to *update* or *replace*...

```
theme_grey
## function (base_size = 11, base_family = "", base_line_size = base_size/22,
##           base_rect_size = base_size/22)
## {
##     half_line <- base_size/2
##     t <- theme(line = element_line(colour = "black", size = base_line_size,
##                                   linetype = 1, lineend = "butt"), rect = element_rect(fill = "white",
##                                         colour = "black", size = base_rect_size, linetype = 1),
##                text = element_text(family = base_family, face = "plain",
##                                  colour = "black", size = base_size, lineheight = 0.9,
##                                  hjust = 0.5, vjust = 0.5, angle = 0, margin = margin(),
##                                  debug = FALSE), axis.line = element_blank(), axis.line.x = NULL,
##                axis.line.y = NULL, axis.text = element_text(size = rel(0.8),
##                                              colour = "grey30"), axis.text.x = element_text(margin = margin(t = 0.8
## half_line/2), vjust = 1), axis.text.x.top = element_text(margin = margin(r
## half_line/2), vjust = 0), axis.text.y = element_text(margin = margin(r
## half_line/2), hjust = 1), axis.text.y.right = element_text(margin = margin(r
## half_line/2), hjust = 0), axis.ticks = element_line(colour = "grey20"),
##                axis.ticks.length = unit(half_line/2, "pt"), axis.ticks.length.x = NULL,
##                axis.ticks.length.x.top = NULL, axis.ticks.length.x.bottom = NULL,
##                axis.ticks.length.y = NULL, axis.ticks.length.y.left = NULL,
##                axis.ticks.length.y.right = NULL, axis.title.x = element_text(margin = margin(b
## vjust = 1), axis.title.x.top = element_text(margin = margin(b = half_li
## vjust = 0), axis.title.y = element_text(angle = 90,
```

theme() Arguments

There are many elements you can customize. You can either group them by their type or by their category:

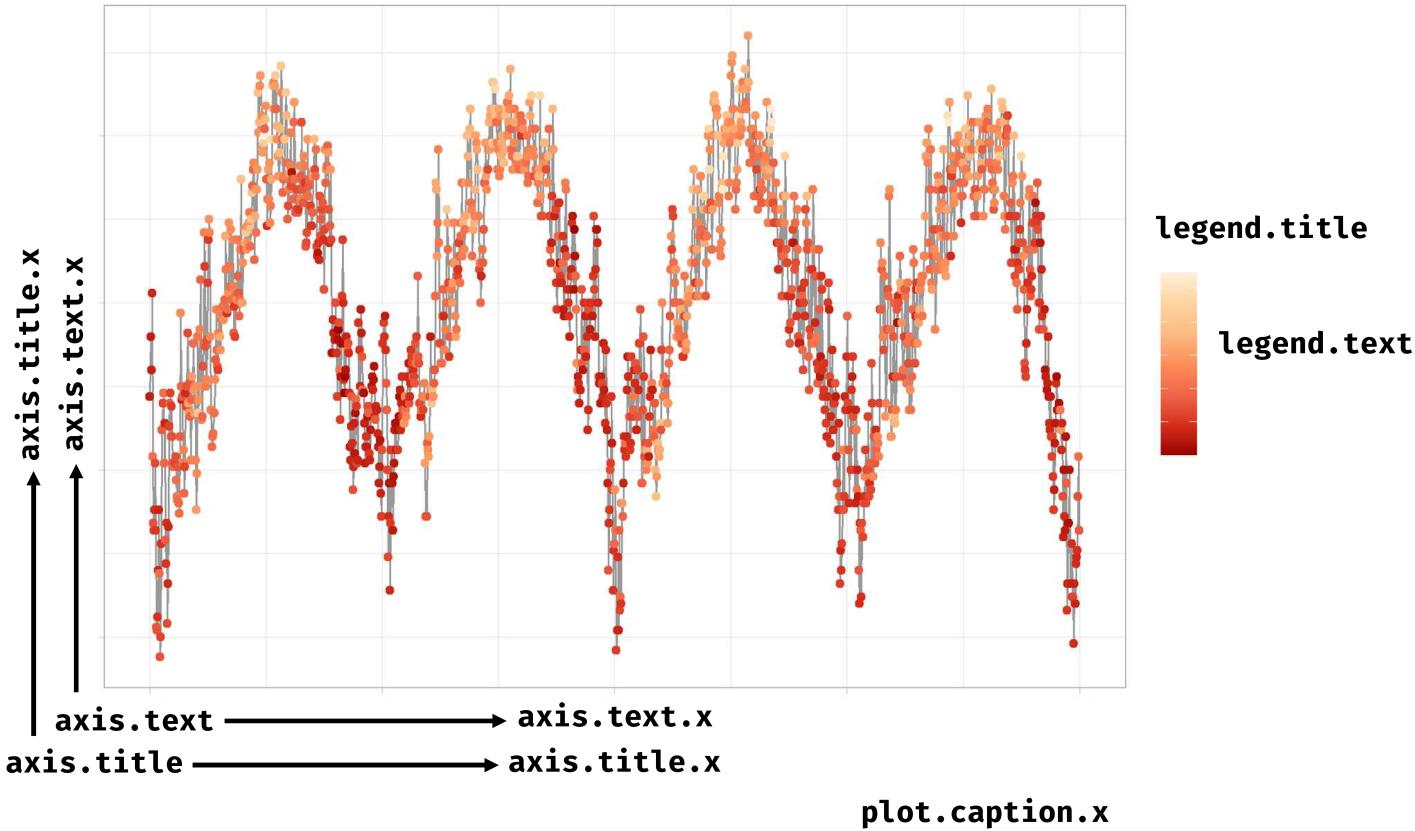
- element types:
 - **text** → all labels, axis text, legend title and text
 - **line** → axis lines, ticks, grid lines
 - **rect** → plot area, panel area, legend and legend keys, facets
- element category:
 - **axis.*** → titles, text, ticks, lines
 - **legend.*** → background, margin, spacing, keys, text, title, position, direction, box
 - **panel.*** → background, border, margin, spacing, grid (major and minor)
 - **plot.*** → background, title, subtitle, caption, tag, margin
 - **strip.*** → background, placement, text

Text Elements via `element_text()`

`plot.tag`

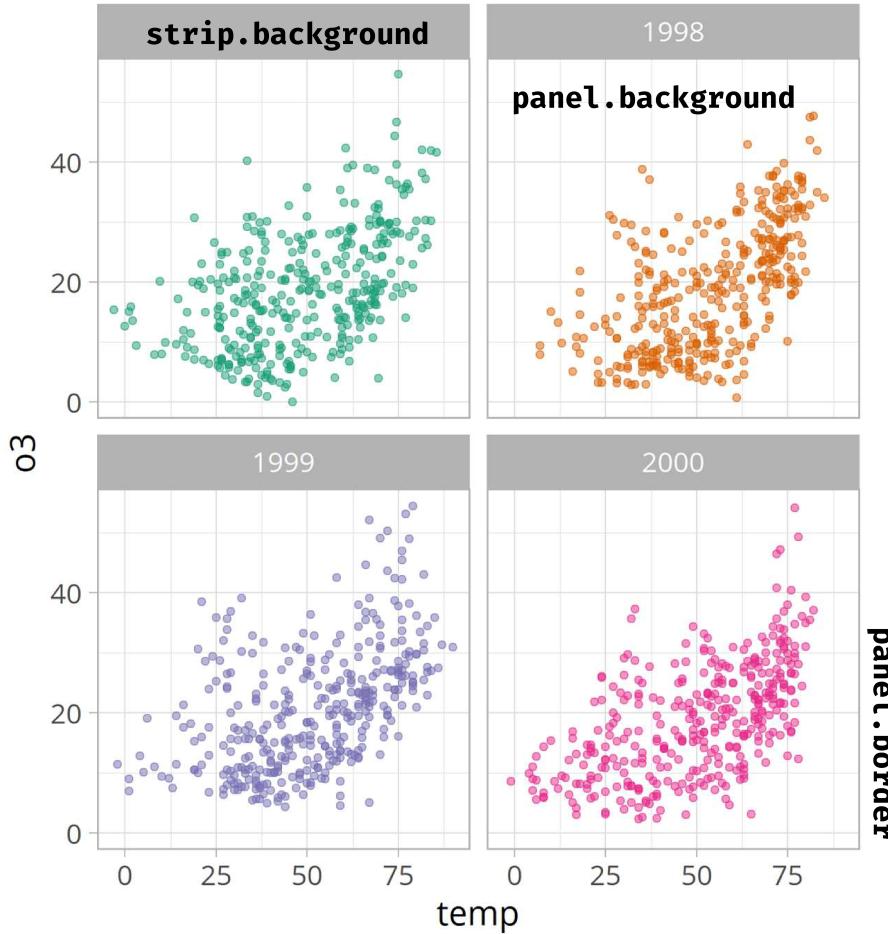
`plot.title`

`plot.subtitle`



Text Elements via `element_text()`

`plot.background`



`legend.box`

year

`legend.key`

.

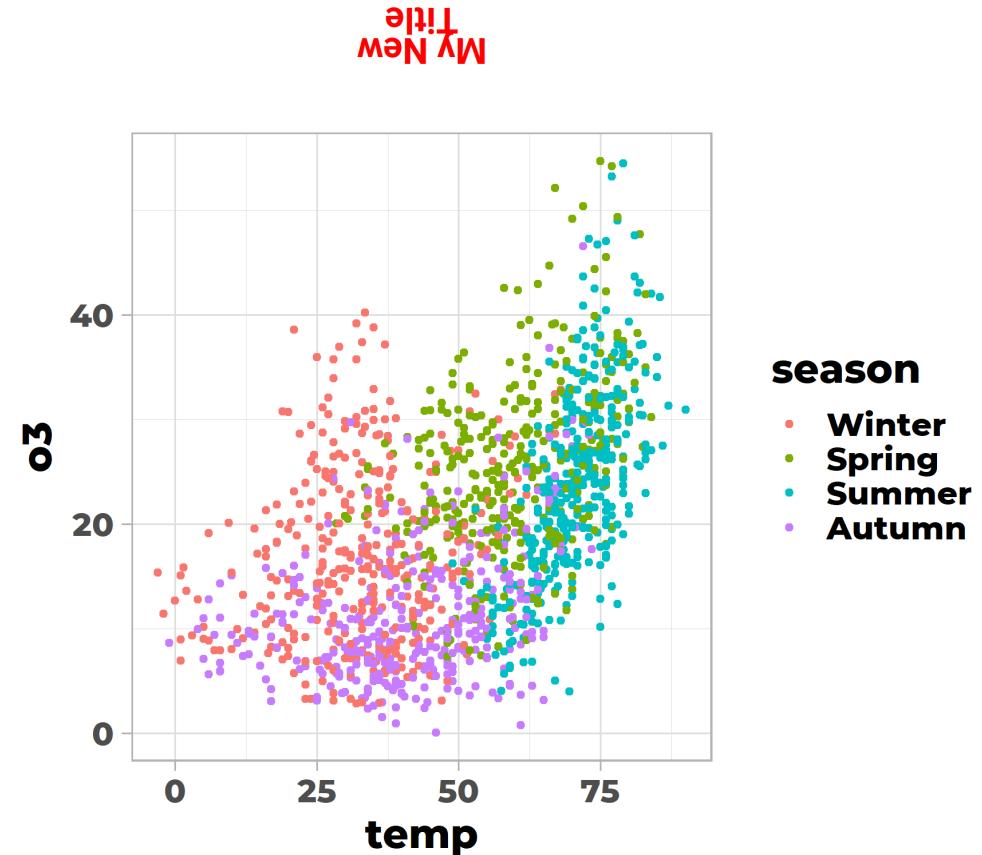
Text Elements via `element_text()`

```
element_text(  
  family = "Roboto",  
  face = "bold", ## plain, italic, bolditalic  
  size = 18,  
  color = "red",  
  lineheight = .7,  
  angle = 180,  
  hjust = .5,  
  vjust = .0,  
  margin = margin(  
    10, ## t (top)  
    0, ## r (right)  
    30, ## b (bottom)  
    0 ## l (left)  
  )  
)
```

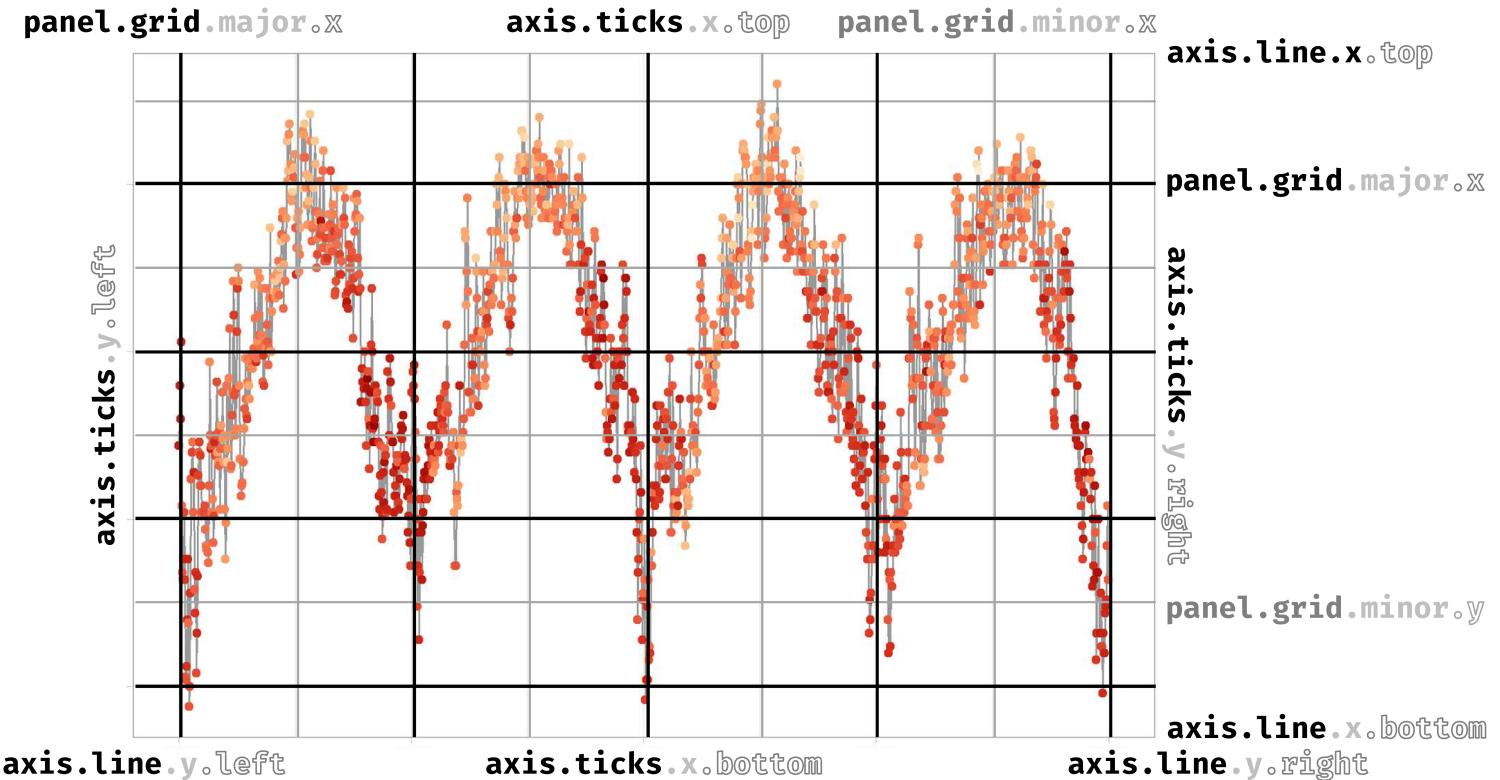
Text Elements via `element_text()`

You can directly alter the appearance by adding `theme()` to a ggplot:

```
g +
  ggtitle("My New\nTitle") +
  theme(
    plot.title = element_text(
      family = "Roboto",
      face = "bold", ## plain, italic, bo
      size = 18,
      color = "red",
      lineheight = .7,
      angle = 180,
      hjust = .5,
      vjust = .0,
      margin = margin(10, 0, 30, 0)
    )
  )
```



Line Elements via `element_line()`



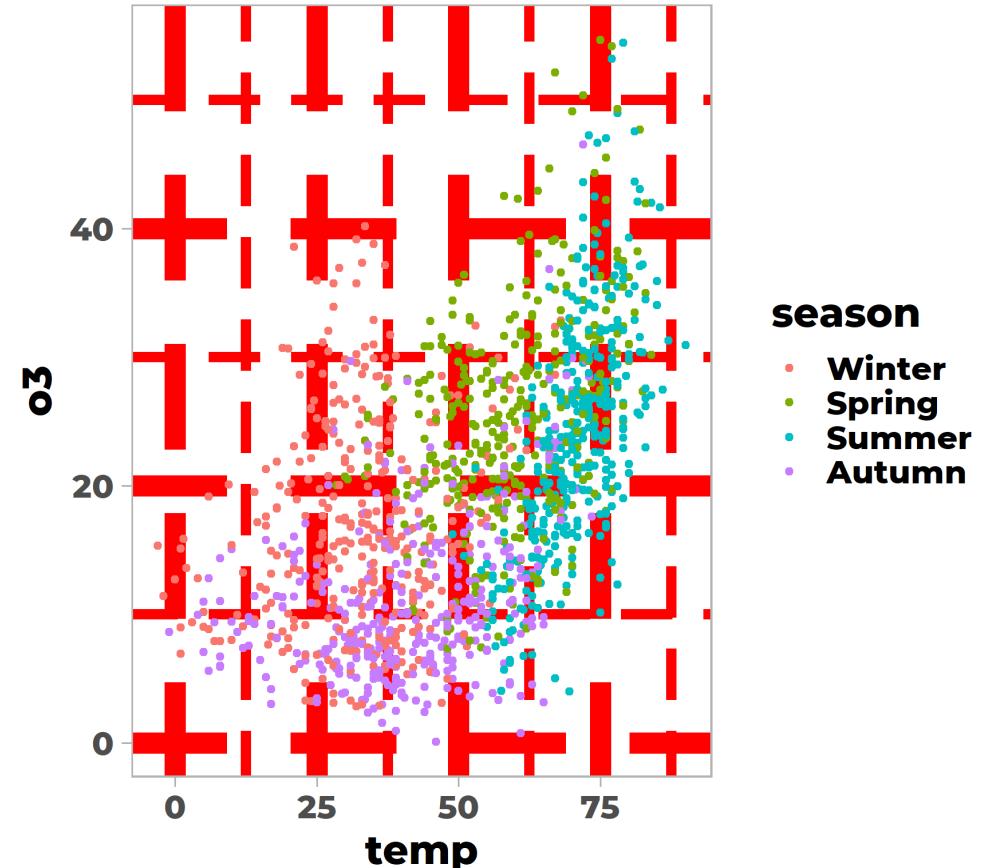
Line Elements via `element_line()`

```
element_line(  
  color = "red",  
  size = 10,  
  linetype = "dashed",  
  lineend = "round", # square, butt  
  arrow = arrow(  
    angle = 30,  
    length = unit(0.25, "inches")  
  )  
)
```

Line Elements via `element_line()`

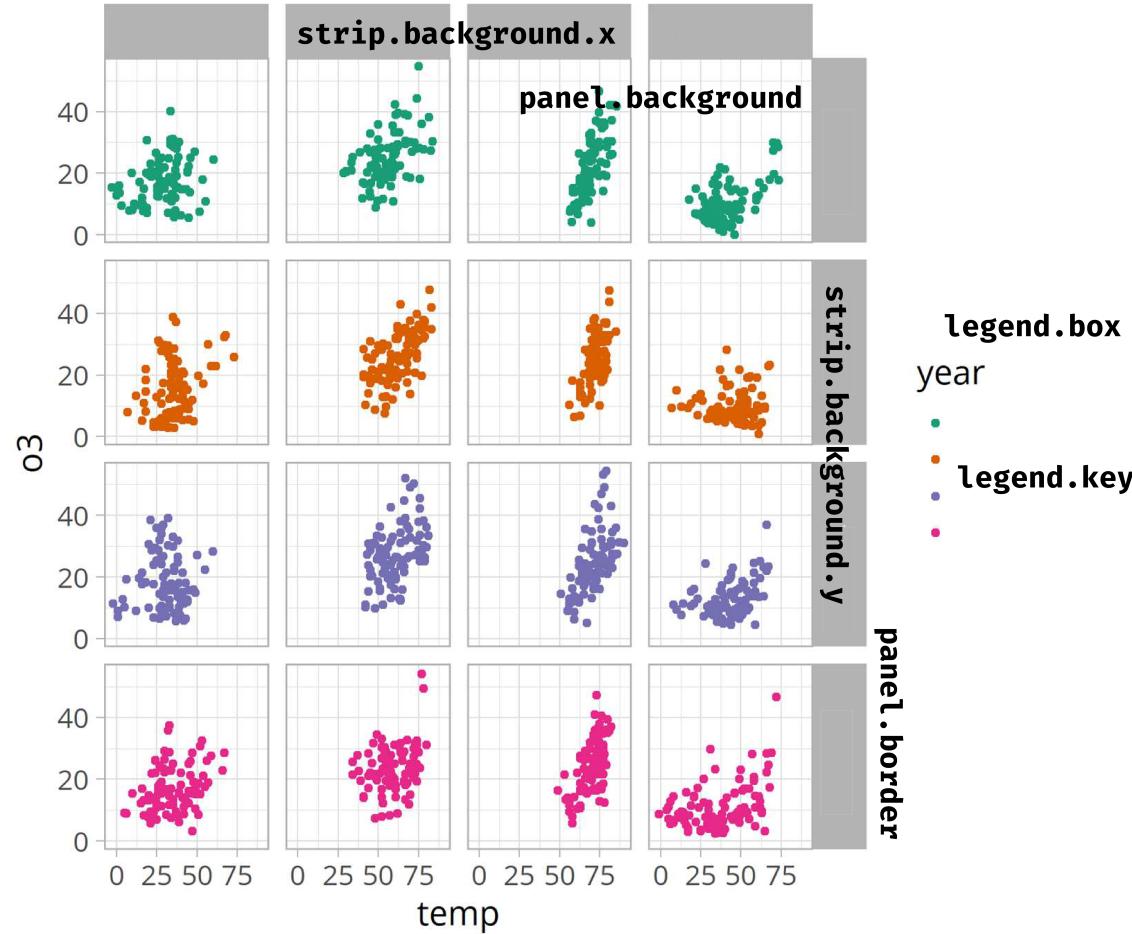
You can directly alter the appearance by adding `theme()` to a ggplot:

```
g +
  theme(
    panel.grid = element_line(
      color = "red",
      size = 10,
      linetype = "dashed",
      lineend = "square", # round, butt
      arrow = arrow(
        angle = 30,
        length = unit(0.25, "inches"))
    )
  )
```



Rectangular Elements via `element_rect()`

`plot.background`



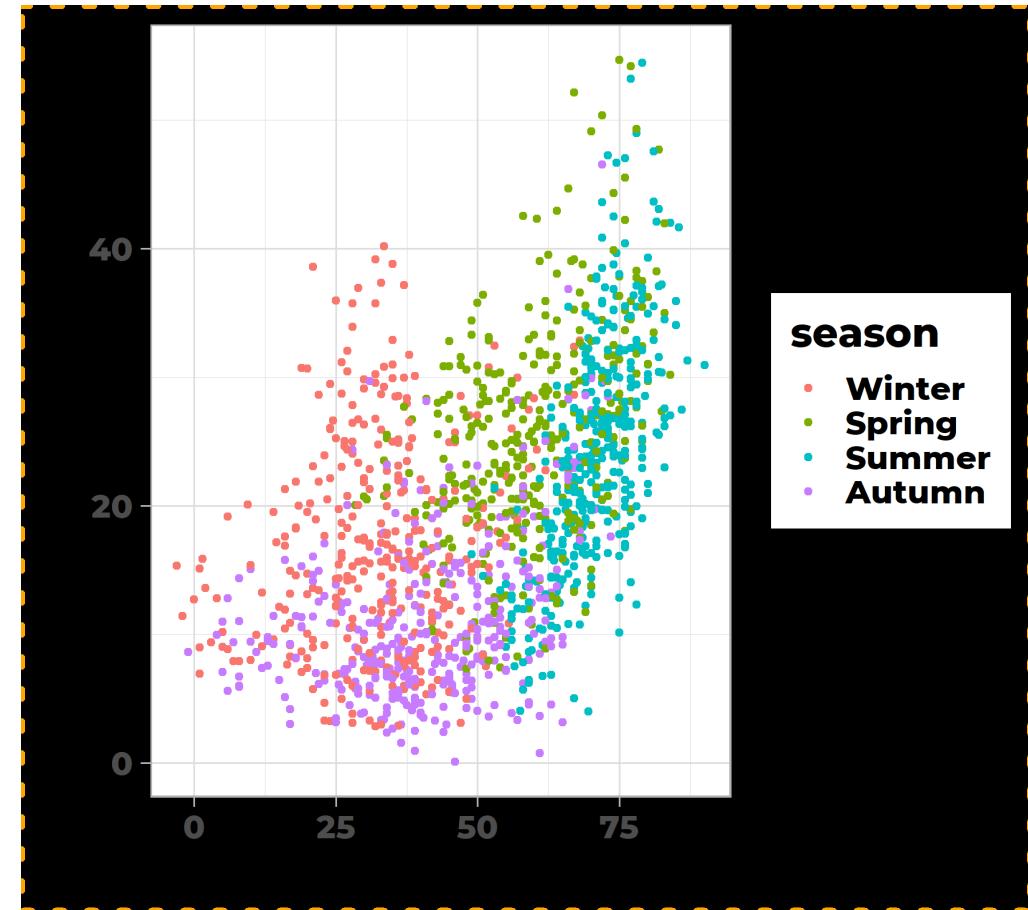
Rectangular Elements via `element_rect()`

```
element_rect(  
  color = "orange",  
  fill = "black",  
  size = 2,  
  linetype = "dotted"  
)
```

Rectangular Elements via `element_rect()`

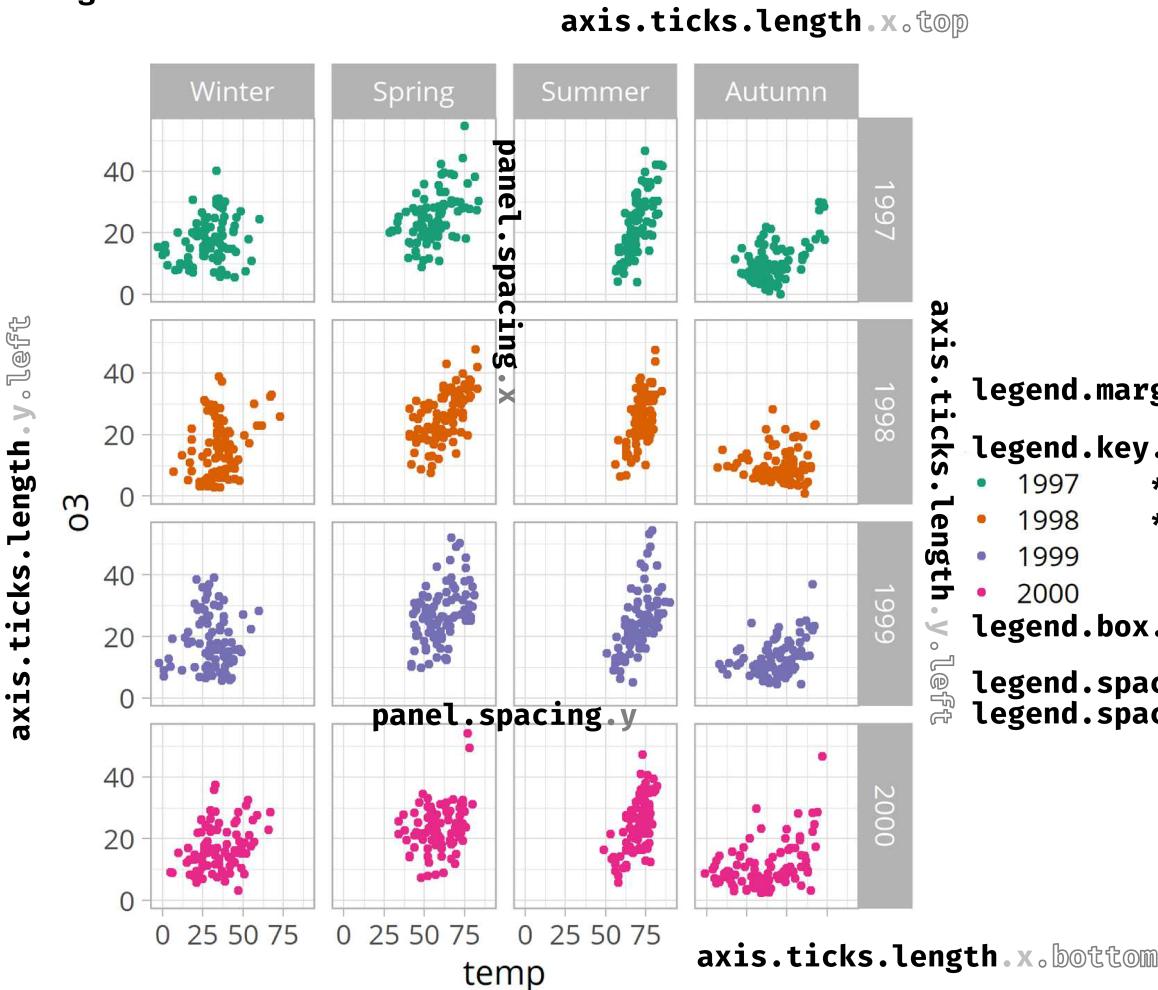
You can directly alter the appearance by adding `theme()` to a ggplot:

```
g +
  theme(
    plot.background = element_rect(
      color = "orange",
      fill = "black",
      size = 2,
      linetype = "dotted"
    )
  )
```



Other Elements: Positions

`plot.margin`



`legend.margin`

`legend.key.size`

• 1997 *.`width`

• 1998 *.`height`

• 1999

• 2000

`legend.box.spacing`

`legend.spacing.x`

`legend.spacing.y`

Other Elements: Positions

```
legend.position = "top" # bottom, right, left  
legend.position = "none"  
legend.position = c(.2, .8) # x, y  
  
plot.title.position = "plot" # panel  
plot.caption.position = "plot"
```

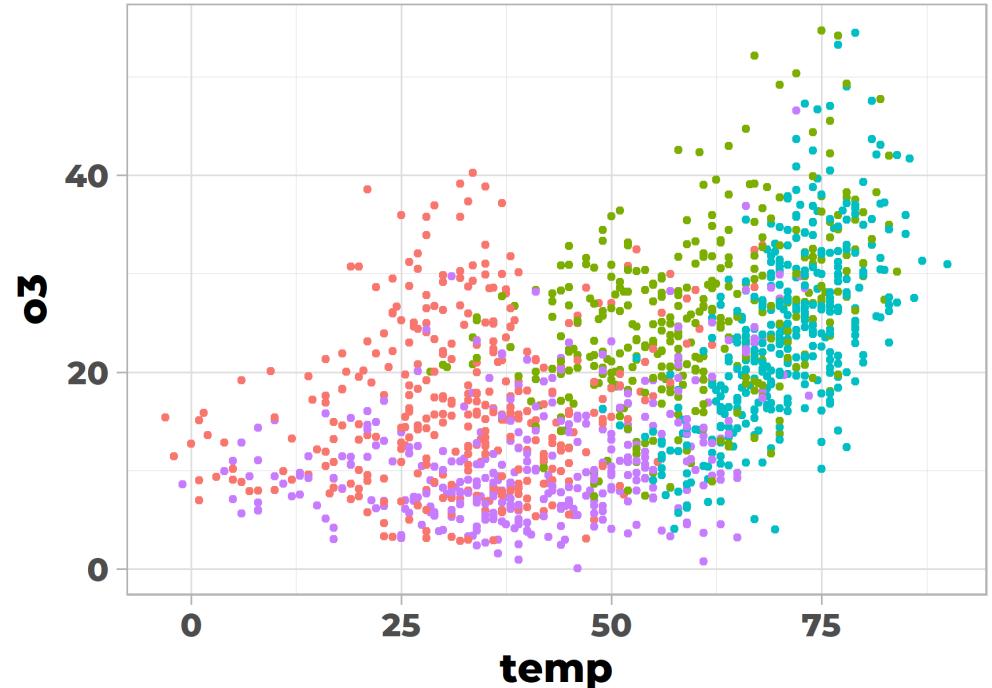
Other Elements: Positions

You can directly alter the appearance by adding `theme()` to a ggplot:

```
g +
  ggtitle("A very short title.") +
  theme(
    legend.position = "top",
    plot.title.position = "plot"
  )
```

A very short title.

season • Winter • Spring • Summer • Autumn

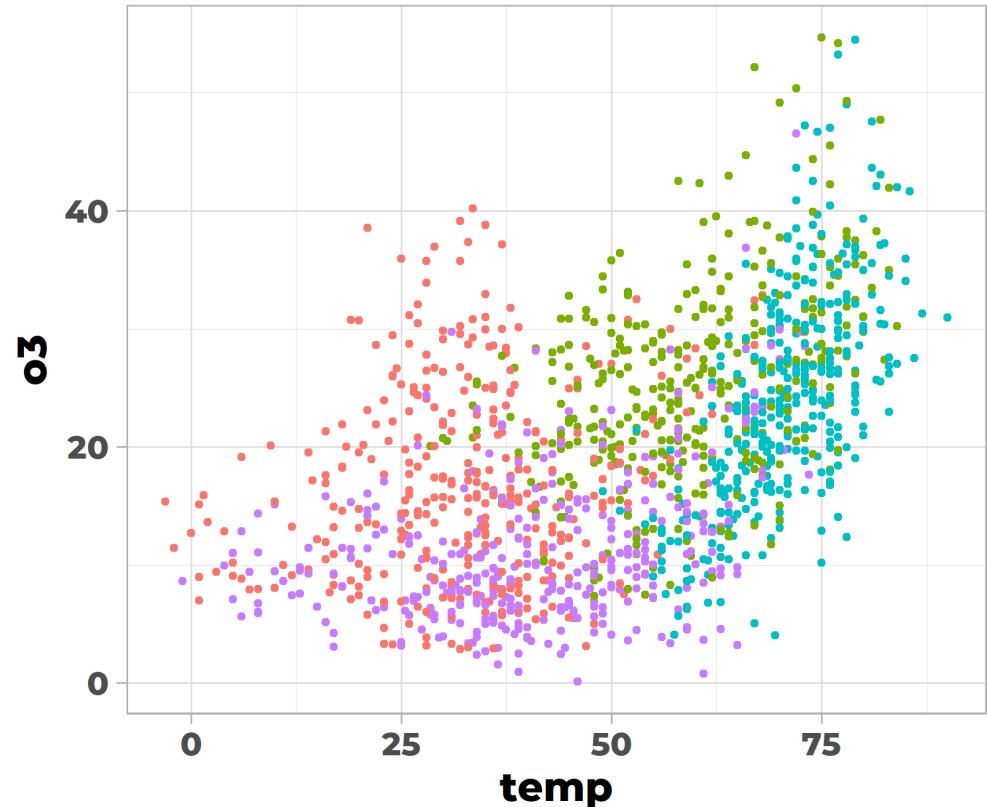


Other Elements: Positions

You can directly alter the appearance by adding `theme()` to a ggplot:

```
g +
  ggtitle("A very short title.") +
  theme(
    legend.position = "none",
    plot.title.position = "panel"
  )
```

A very short title.

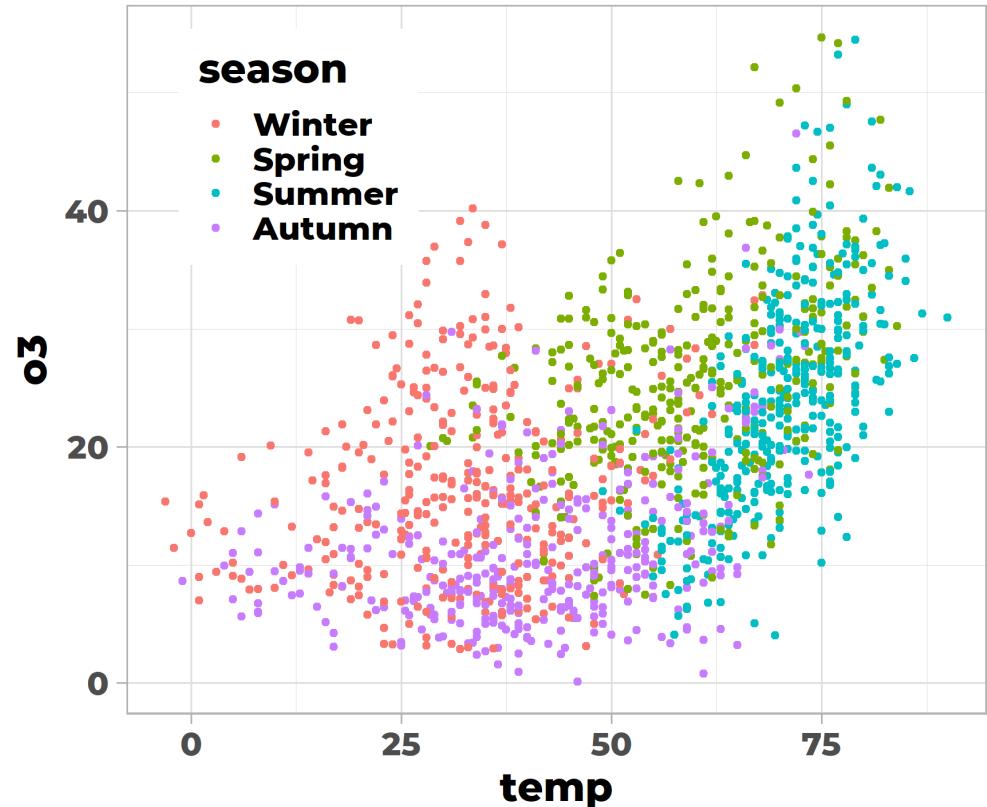


Other Elements: Positions

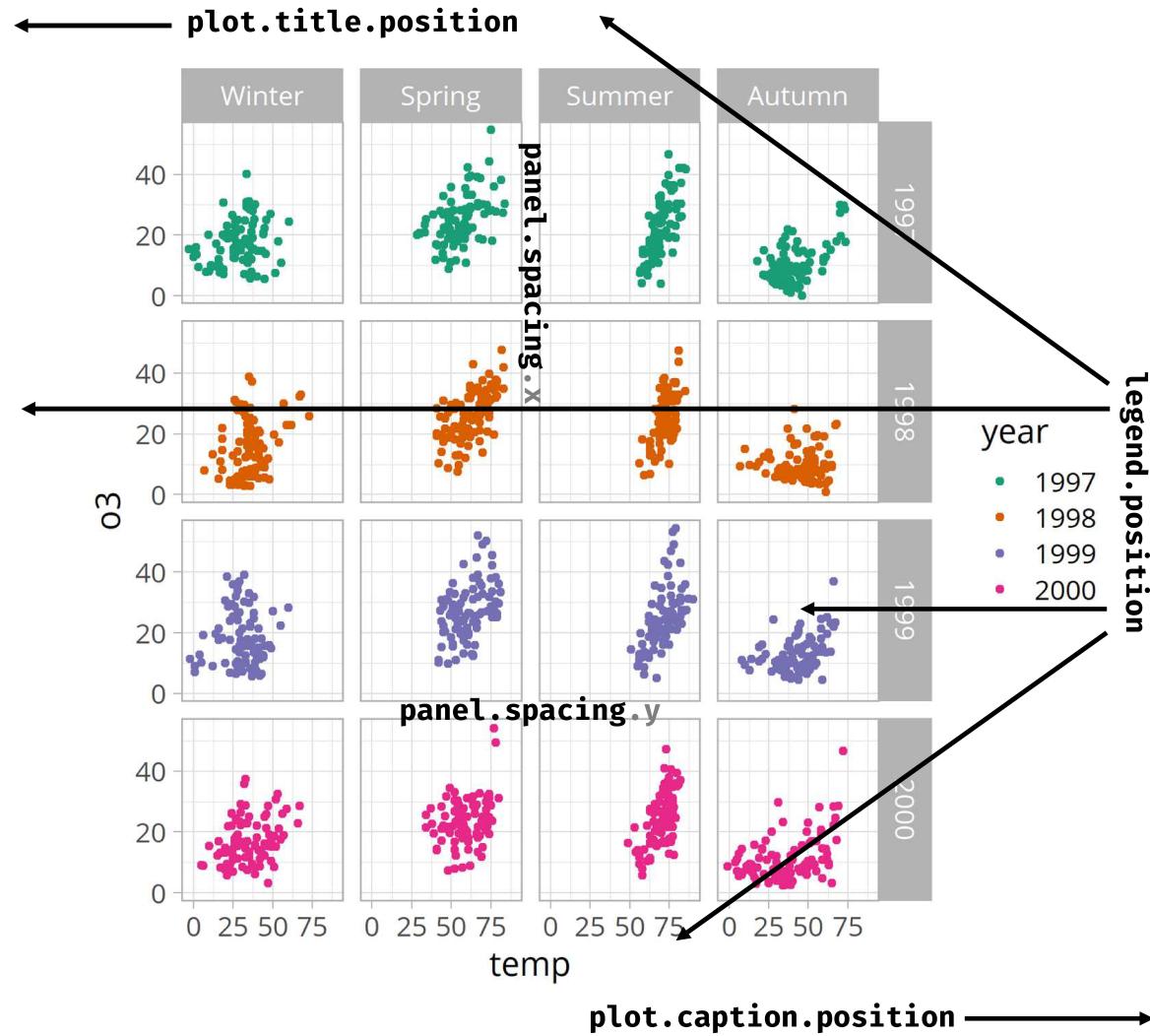
You can directly alter the appearance by adding `theme()` to a ggplot:

```
g +
  ggtitle("A very short title.") +
  theme(
    legend.position = c(.2, .8),
    plot.title.position = "plot"
  )
```

A very short title.



Other Elements: Spacing, Length, Size etc.



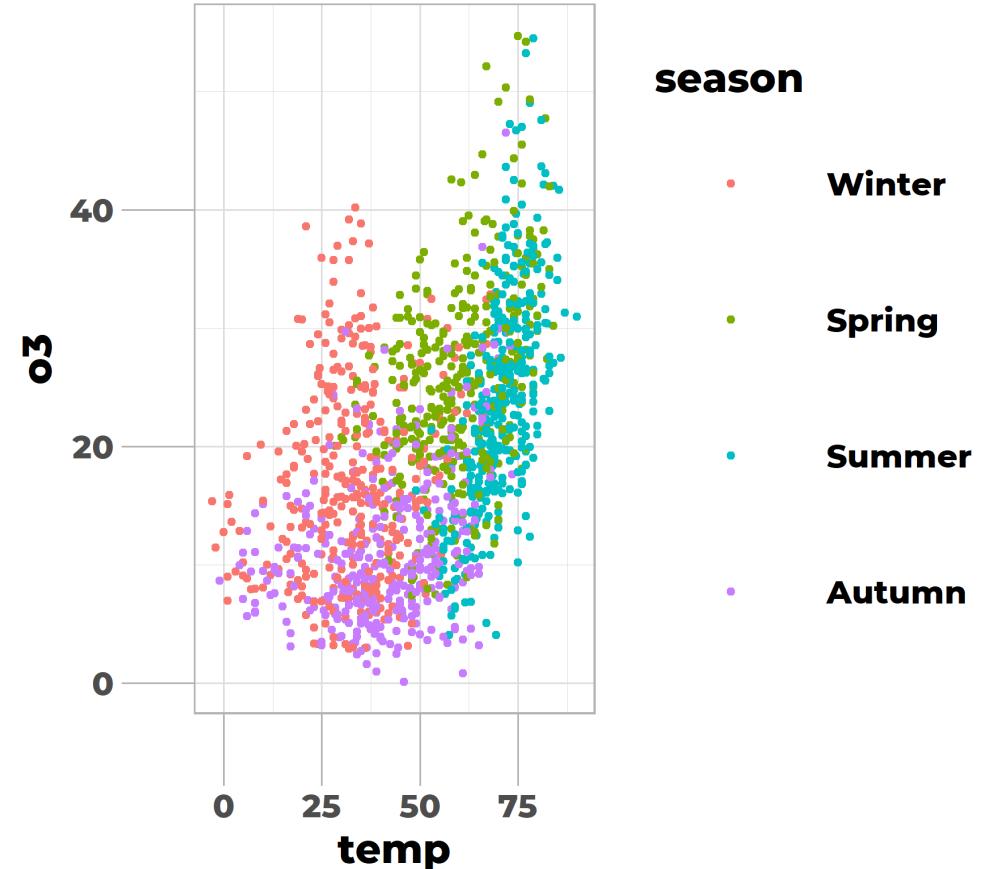
Other Elements: Spacing, Length, Size etc.

```
## ?grid::unit
unit(50, "pt")
unit(10, "mm")
unit(2.5, "lines")
unit(.15, "npc") ## Normalised Parent Coordinates
```

Other Elements: Positions

You can directly alter the appearance by adding `theme()` to a ggplot:

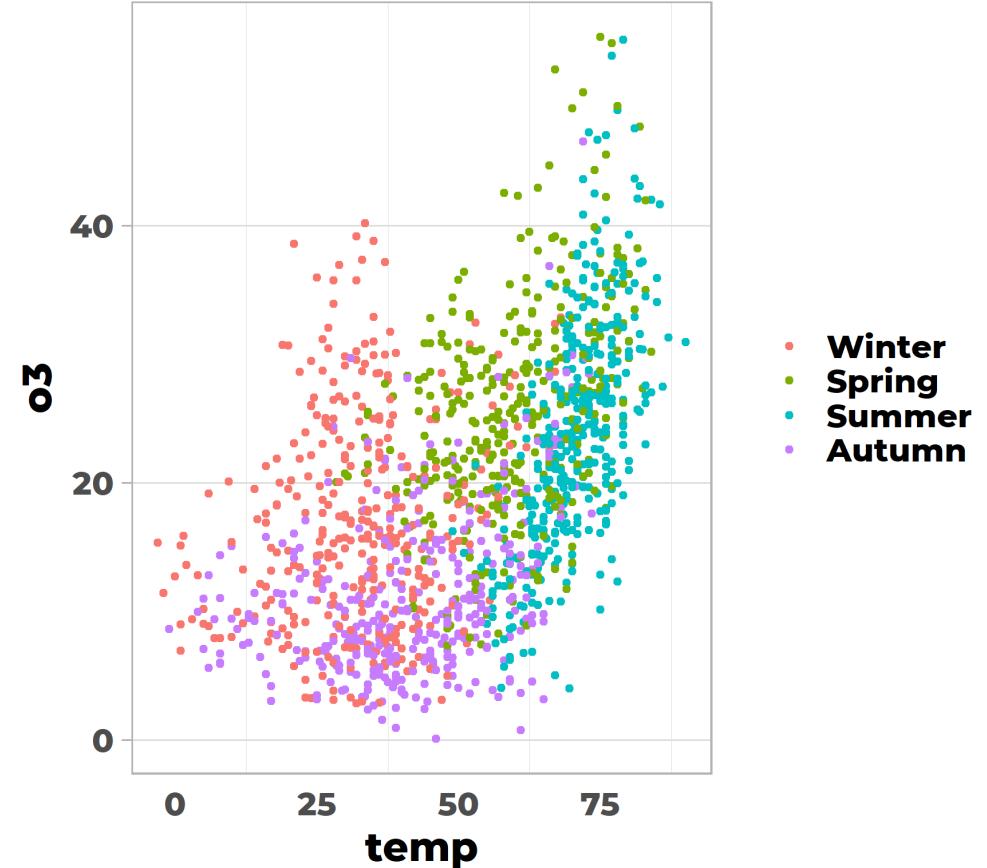
```
g +
  theme(
    axis.ticks.length =
      unit(2.5, "lines"),
    legend.key.size =
      unit(.15, "npc")
  )
```



Draw Nothing: `element_blank()`

You can remove elements via `element_blank()`:

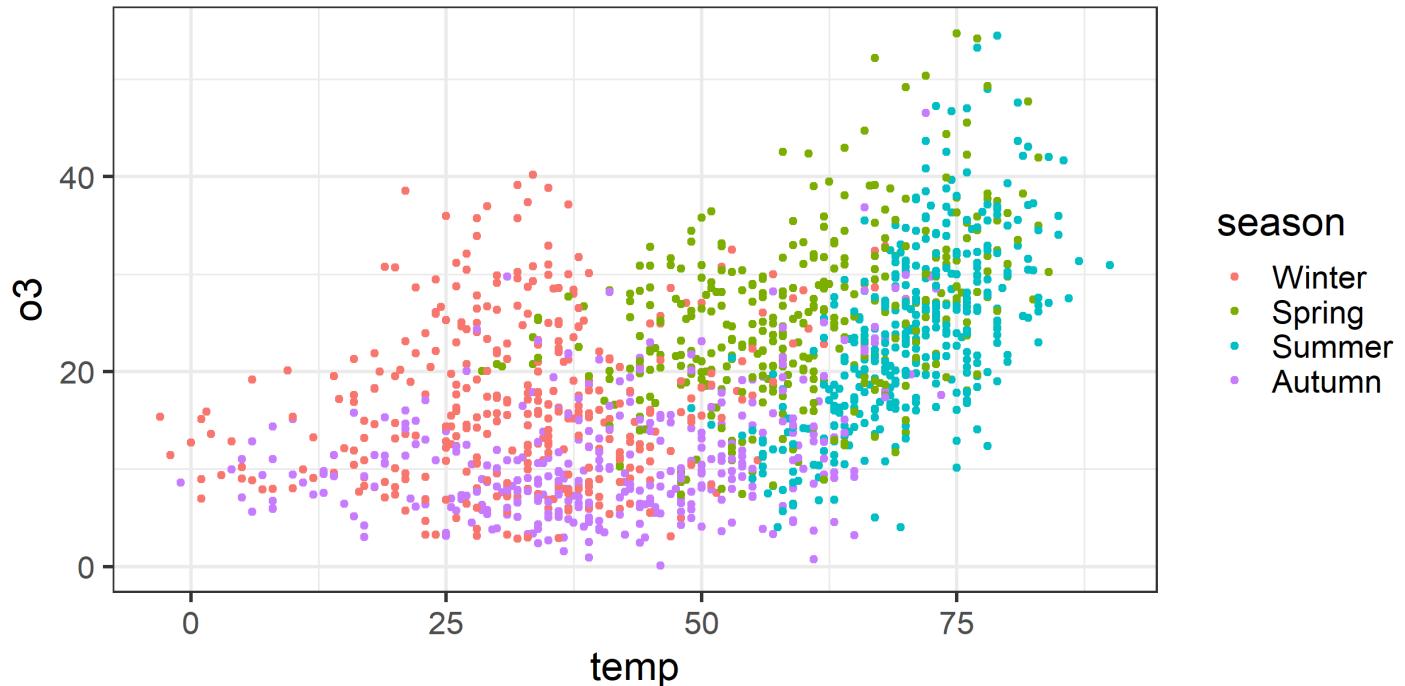
```
g +
  theme(
    axis.ticks.x = element_blank(),
    panel.grid.major.x = element_blank(),
    panel.grid.minor.y = element_blank(),
    legend.title = element_blank()
  )
```



theme_update()

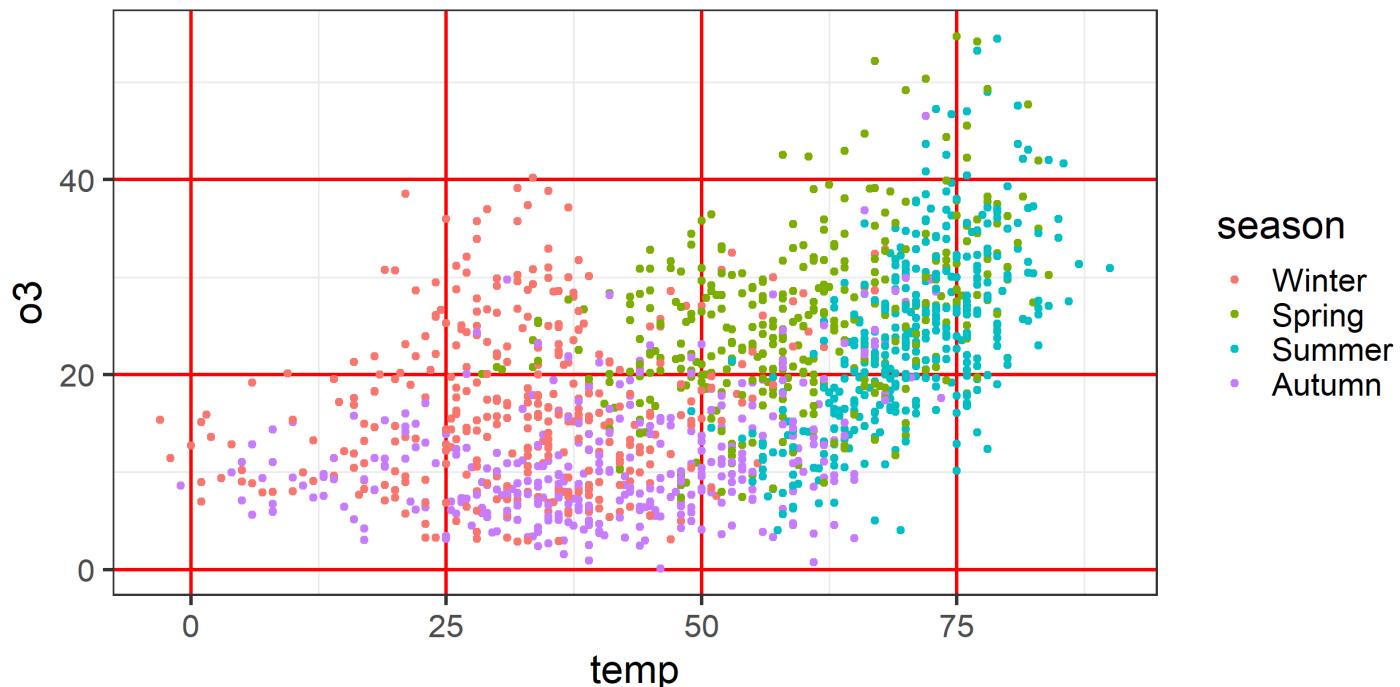
```
theme_set(theme_bw(base_size = 20))
```

```
gg
```



theme_update()

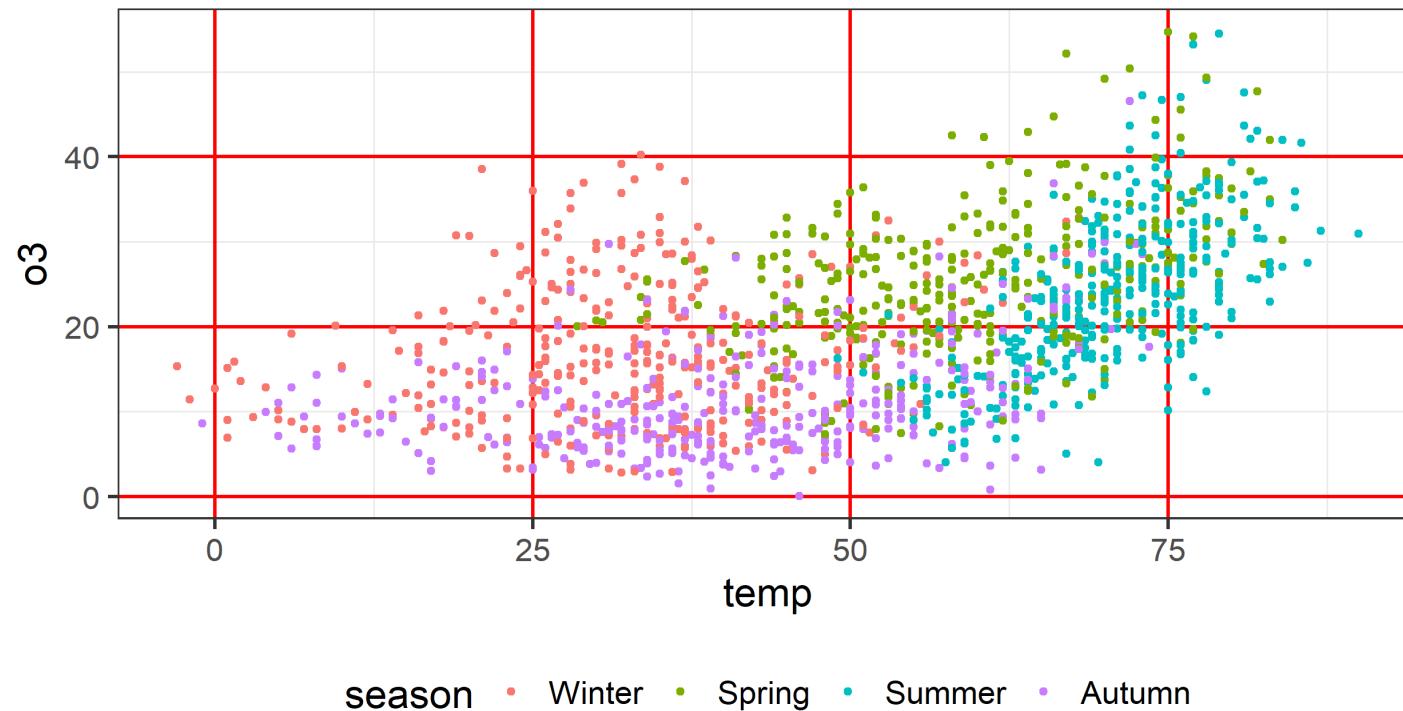
```
theme_update(  
  panel.grid.major = element_line(color = "red")  
)  
g
```



theme()

You can directly alter the appearance by adding `theme()` to a ggplot:

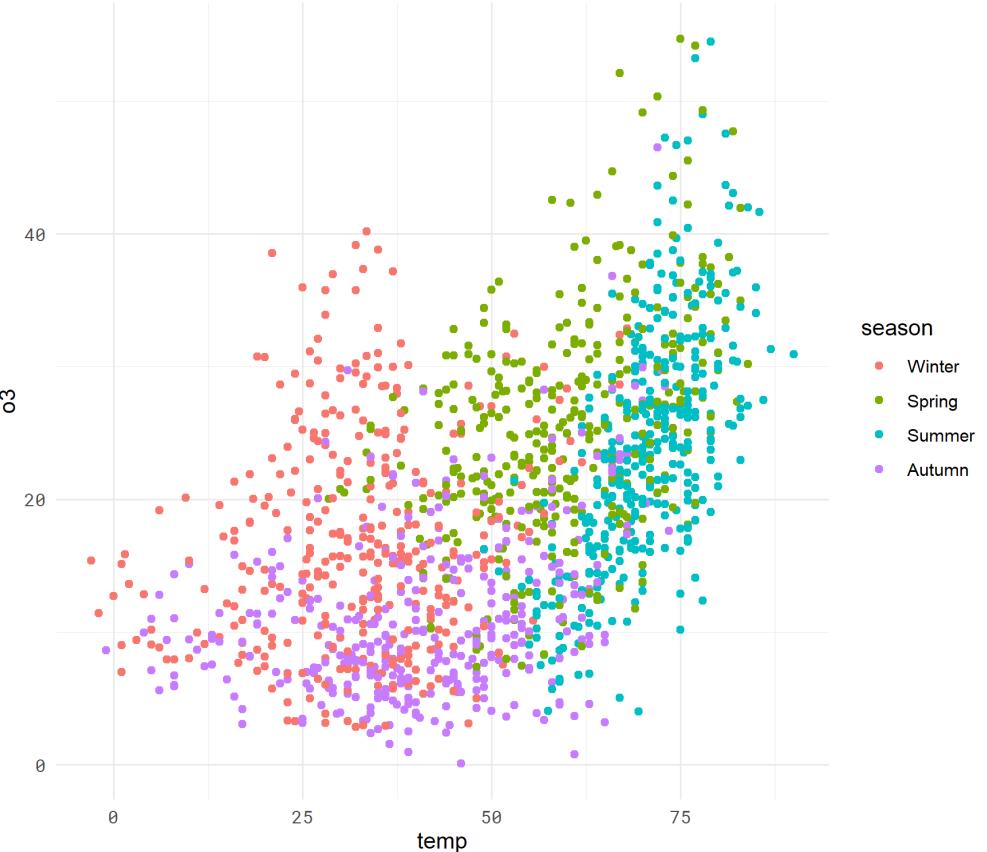
```
g + theme(legend.position = "bottom")
```



Adding Fonts to Your `ggplot2`

```
g +
  labs(
    title = "A very short title"
  ) +
  theme_minimal() +
  theme(
    plot.title =
      element_text(
        family = "Montserrat ExtraBold"
      ),
    axis.text =
      element_text(
        family = "Roboto Mono"
      )
  )
```

A very short title



Your Turn!