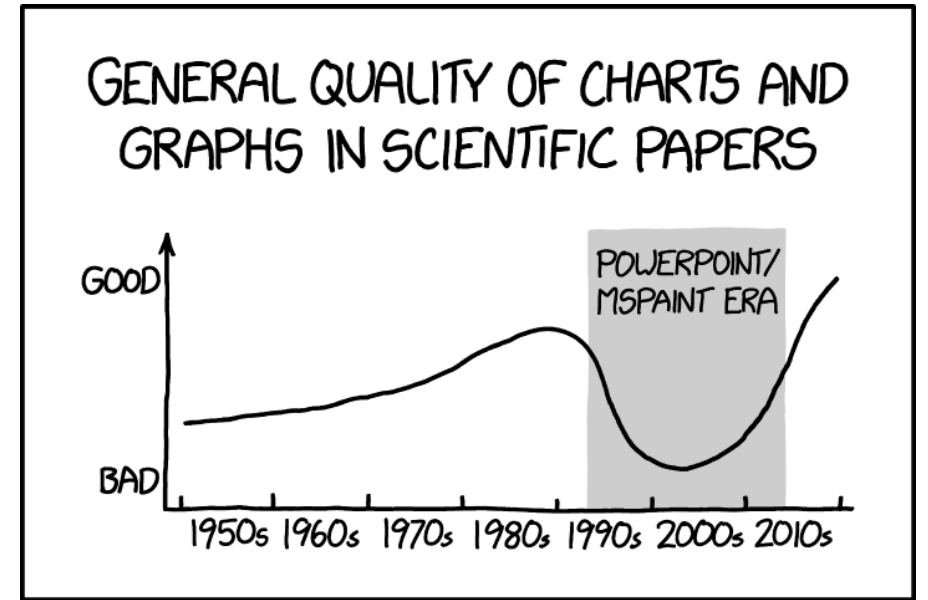




Introducción a {ggplot2}

José Luis Texcalac Sangrador

Procesamiento y visualización de datos espaciales en R





clase_r

⊕ New ▾ | 📁 Open ▾ | 💾 📄 | 🔍 Search ▾ | R 4.5.1 | 📁 clase_r ▾

CONSOLE | TERMINAL | PROBLEMS | OUTPUT | ... | + ▾ | - | × | 📄 | 📄 | 📄

R 4.5.1 started.

R version 4.5.1 (2025-06-13) -- "Great Square Root"
Copyright (C) 2025 The R Foundation for Statistical Computing
Platform: aarch64-apple-darwin20

R is free software and comes with ABSOLUTELY NO WARRANTY.
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Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

>

Abra Positron y verifique que está dentro de su folder de trabajo **clase_r**

Si no está dentro de su folder entonces haga clic en la barra de menú **File/Open Folder...**



Su turno...

- Genere un nuevo script
- Agregue encabezado
- Active en su sesión la librería tidyverse

```
S04_Tex.R ×  
▶  
code > R S04_Tex.R > ...  
1 # ===== #  
2 # Script de la Sesión 04  
3 # Autor: Tex  
4 # Curso: "Procesamiento y visualización de datos espaciales en R"  
5 # Fecha: 24 de septiembre de 2025  
6 # ===== #  
7  
8 # Activo paquetes a utilizar en mi sesión  
9 library(tidyverse)  
10
```



Exploremos la malla `airquality` (1)

```
aire <- airquality
```

Genera copia de `airquality`, nombra al objeto como `aire`

```
is(aire)
```

¿qué tipo de objeto es `aire`?

```
[1] "data.frame" "list"      "oldClass"  "vector"
```

```
aire
```

Imprimimos en pantalla el data frame `aire`

```
str(aire)
```

Reviso la estructura del data frame `aire`

```
'data.frame':  153 obs. of  6 variables:
 $ Ozone   : int  41 36 12 18 NA 28 23 19 8 NA ...
 $ Solar.R: int  190 118 149 313 NA NA 299 99 19 194 ...
 $ Wind    : num  7.4 8 12.6 11.5 14.3 14.9 8.6 13.8 20.1 8.6 ...
 $ Temp    : int  67 72 74 62 56 66 65 59 61 69 ...
 $ Month   : int  5 5 5 5 5 5 5 5 5 5 ...
 $ Day     : int  1 2 3 4 5 6 7 8 9 10 ...
```



Exploremos la malla airquality (2)

```
head(air)
```

	Ozone	Solar.R	Wind	Temp	Month	Day
1	41	190	7.4	67	5	1
2	36	118	8.0	72	5	2
3	12	149	12.6	74	5	3
4	18	313	11.5	62	5	4
5	NA	NA	14.3	56	5	5
6	28	NA	14.9	66	5	6

Revisamos el encabezado del data frame **air**

```
summary(air)
```

Ozone		Solar.R		Wind		Temp		Month		Day	
Min.	: 1.00	Min.	: 7.0	Min.	: 1.700	Min.	:56.00	Min.	:5.000	Min.	: 1.0
1st Qu.:	18.00	1st Qu.:	115.8	1st Qu.:	7.400	1st Qu.:	72.00	1st Qu.:	6.000	1st Qu.:	8.0
Median :	31.50	Median :	205.0	Median :	9.700	Median :	79.00	Median :	7.000	Median :	16.0
Mean :	42.13	Mean :	185.9	Mean :	9.958	Mean :	77.88	Mean :	6.993	Mean :	15.8
3rd Qu.:	63.25	3rd Qu.:	258.8	3rd Qu.:	11.500	3rd Qu.:	85.00	3rd Qu.:	8.000	3rd Qu.:	23.0
Max.	:168.00	Max.	:334.0	Max.	:20.700	Max.	:97.00	Max.	:9.000	Max.	:31.0
NA's	:37	NA's	:7								

Genera estadísticas descriptivas de la malla de datos

```
aire_tbl <- as_tibble(aire)
```

data frame

VS

tibble

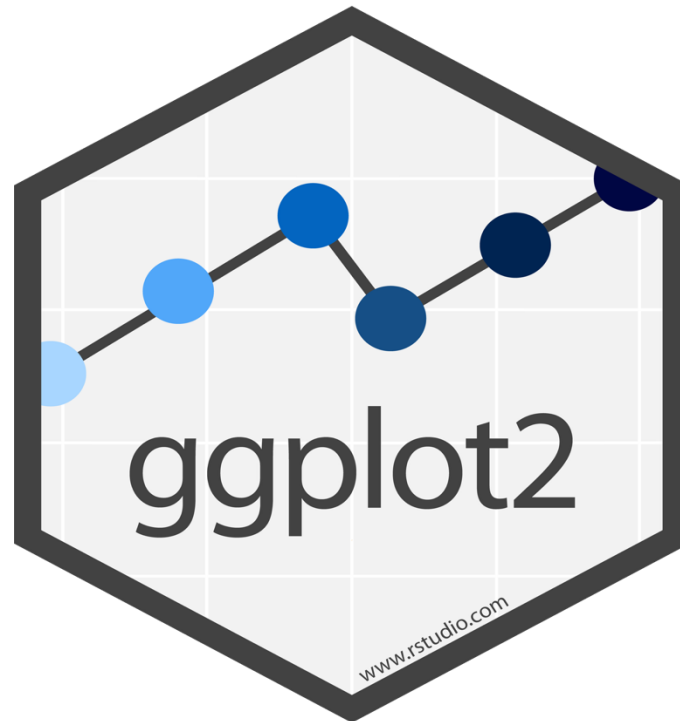
```
> aire
  Ozone Solar.R Wind Temp Month Day
1    41    190  7.4  67    5    1
2    36    118  8.0  72    5    2
3    12    149 12.6  74    5    3
4    18    313 11.5  62    5    4
5    NA     NA 14.3  56    5    5
6    28     NA 14.9  66    5    6
7    23    299  8.6  65    5    7
8    19     99 13.8  59    5    8
9     8     19 20.1  61    5    9
10   NA    194  8.6  69    5   10
11    7     NA  6.9  74    5   11
12   16    256  9.7  69    5   12
13   11    290  9.2  66    5   13
14   14    274 10.9  68    5   14
15   18     65 13.2  58    5   15
16   14    334 11.5  64    5   16
17   34    307 12.0  66    5   17
18    6     78 18.4  57    5   18
19   30    322 11.5  68    5   19
20   11     44  9.7  62    5  20
21    1      8  9.7  59    5  21
22   11    320 16.6  73    5  22
23    4     25  9.7  61    5  23
24   32     92 12.0  61    5  24
25   NA     66 16.6  57    5  25
26   NA    266 14.9  58    5  26
27   NA     NA  8.0  57    5  27
28   23     13 12.0  67    5  28
29   45    252 14.9  81    5  29
30  115    223  5.7  79    5  30
31   37    279  7.4  76    5  31
32   NA    286  8.6  78    6    1
33   NA    287  9.7  74    6    2
34   NA    242 16.1  67    6    3
```

```
> aire_tbl
# A tibble: 153 × 6
  Ozone Solar.R Wind Temp Month Day
  <int>   <int> <dbl> <int> <int> <int>
1    41    190  7.4    67     5    1
2    36    118  8.0    72     5    2
3    12    149 12.6    74     5    3
4    18    313 11.5    62     5    4
5    NA     NA 14.3    56     5    5
6    28     NA 14.9    66     5    6
7    23    299  8.6    65     5    7
8    19     99 13.8    59     5    8
9     8     19 20.1    61     5    9
10   NA    194  8.6    69     5   10
# i 143 more rows
# i Use `print(n = ...)` to see more rows
```

“The greatest value of a picture is when
it forces us to notice what we never
expected to see.”

– John Tukey

Tidyverse {ggplot}





Elementos gráficos necesarios en {ggplot2}

Elemento	Descripción
Malla de datos <code>data</code>	Conjunto de datos para la visualización gráfica
La estética <code>aesthetics</code> , <code>aes</code>	Las escalas en las que representamos nuestros datos (x , y)
La geometría <code>geom_line</code> , <code>geom_point</code> , <code>geom_boxplot</code>	El diseño visual a utilizar para nuestros datos

Malla de datos

- Misma función que el pipe
- Sustituye al pipe
- Siempre al final de la línea, NO al inicio

```
ggplot(data = dataset) +  
  geom_col(mapping = aes(x = x_var, y = y_var))
```

Tipo de geometría

aesthetics

Columna del eje X

Columna del eje Y

Forma resumida
de redacción

```
ggplot(dataset) +  
  geom_col(aes(x_var, y_var))
```

Malla de datos

- Misma función que el pipe
- Sustituye al pipe
- Siempre al final de la línea, NO al inicio

```
ggplot(data = dataset) +  
  geom_col(mapping = aes(x = x_var, y = y_var))
```

Tipo de geometría

aesthetics

Columna del eje X

Columna del eje Y

Forma resumida
de redacción

```
ggplot(dataset, aes(x_var, y_var)) +  
  geom_col()
```

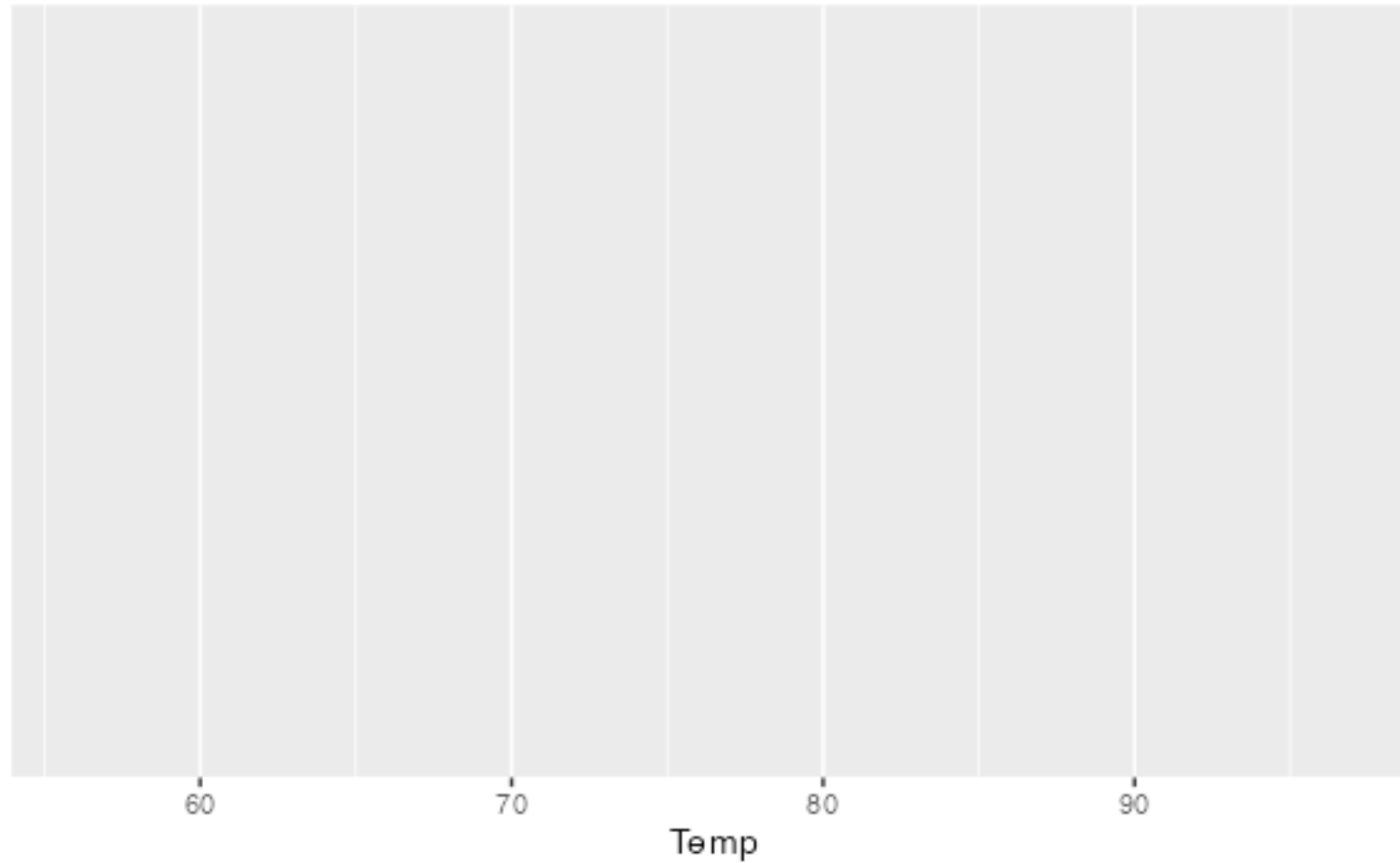


ggplot(aire_tbl)

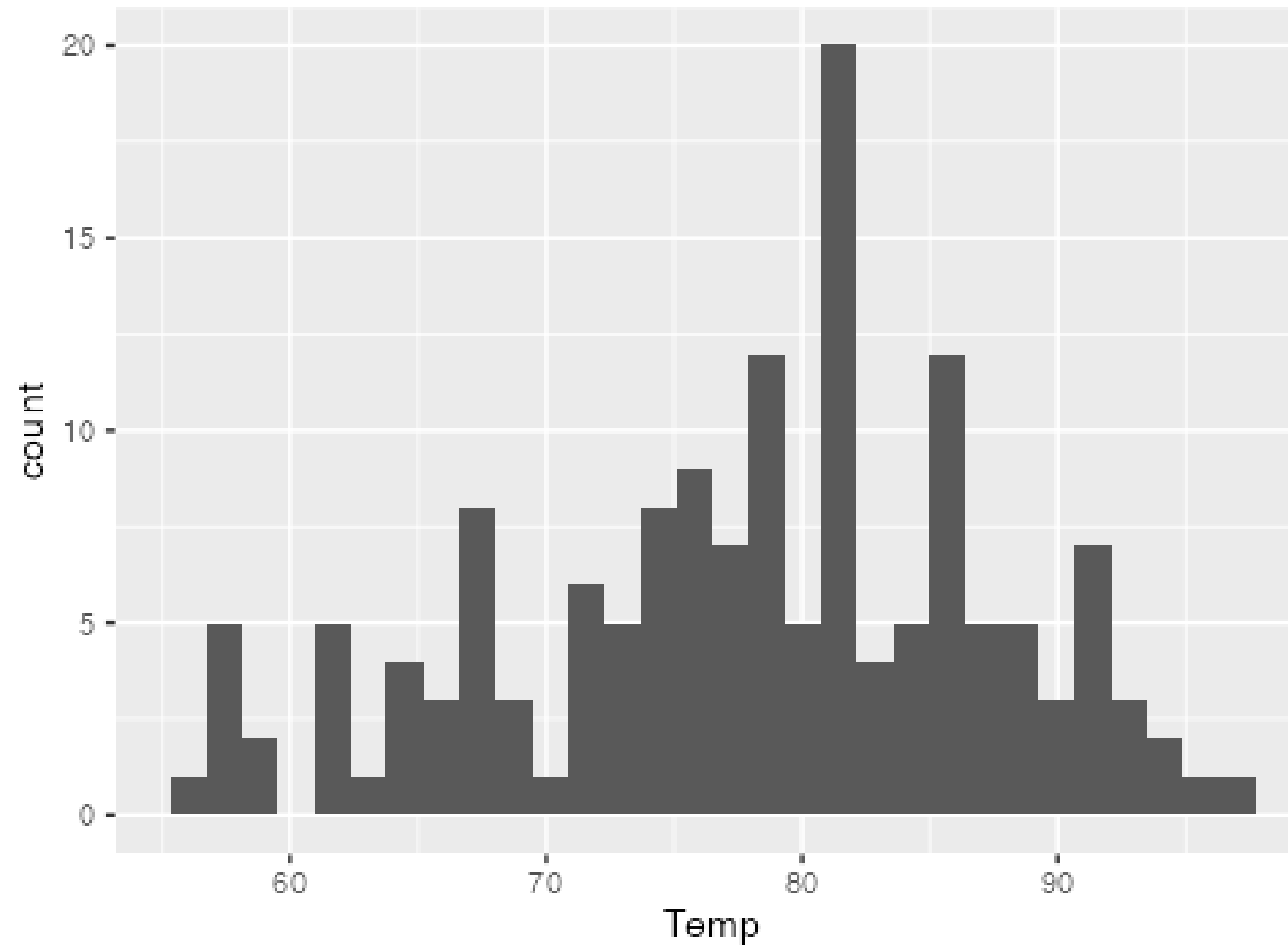




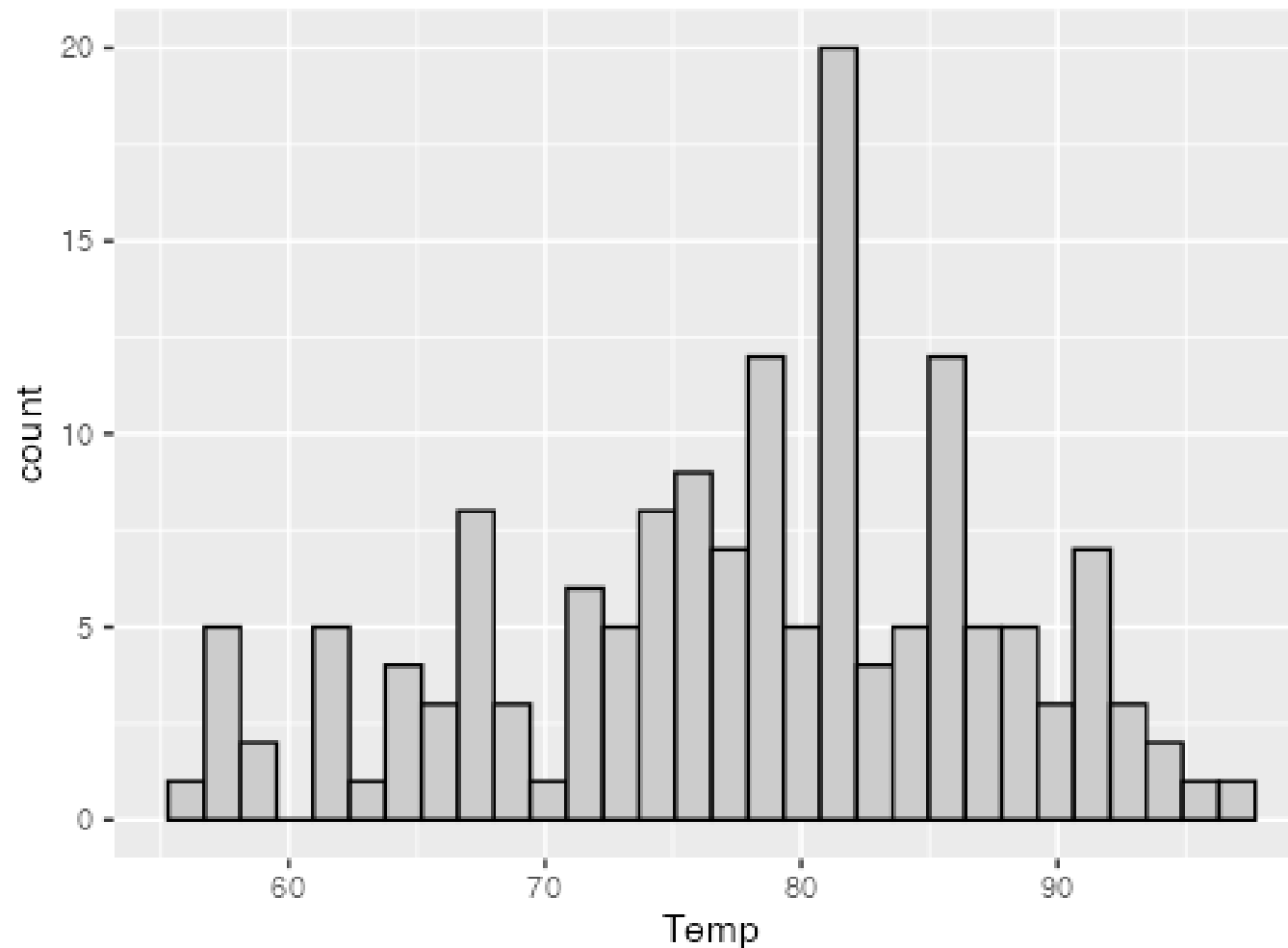
```
ggplot(aire_tbl, aes(Temp))
```



```
ggplot(aire_tbl, aes(Temp)) +  
  geom_histogram()
```



```
ggplot(aire_tbl, aes(Temp)) +  
  geom_histogram(color = "black", fill = "grey80")
```





Colores por nombre y hexcode

white	coral4	deepskyblue	gray28	gray88	gray40	gray100	lightpink2	mistyrose2	plum	slategray2
aliceblue	cornflowerblue	deepskyblue1	gray29	gray89	gray41	honeydew	lightpink3	mistyrose3	plum1	slategray3
antiquewhite	cornsilk	deepskyblue2	gray30	gray90	gray42	honeydew1	lightpink4	mistyrose4	plum2	slategray4
antiquewhite1	cornsilk1	deepskyblue3	gray31	gray91	gray43	honeydew2	lightsalmon	moccasin	plum3	slategrey
antiquewhite2	cornsilk2	deepskyblue4	gray32	gray92	gray44	honeydew3	lightsalmon1	navajowhite	plum4	snow
antiquewhite3	cornsilk3	dimgray	gray33	gray93	gray45	honeydew4	lightsalmon2	navajowhite1	powderblue	snow1
antiquewhite4	cornsilk4	dimgray	gray34	gray94	gray46	hotpink	lightsalmon3	navajowhite2	purple	snow2
aquamarine	cyan	dodgerblue	gray35	gray95	gray47	hotpink1	lightsalmon4	navajowhite3	purple1	snow3
aquamarine1	cyan1	dodgerblue1	gray36	gray96	gray48	hotpink2	lightseagreen	navajowhite4	purple2	snow4
aquamarine2	cyan2	dodgerblue2	gray37	gray97	gray49	hotpink3	lightskyblue	navy	purple3	springgreen
aquamarine3	cyan3	dodgerblue3	gray38	gray98	gray50	hotpink4	lightskyblue1	navyblue	purple4	springgreen1
aquamarine4	cyan4	dodgerblue4	gray39	gray99	gray51	indianred	lightskyblue2	oldlace	red	springgreen2
azure	darkblue	firebrick	gray40	gray100	gray52	indianred1	lightskyblue3	olivedrab	red1	springgreen3
azure1	darkcyan	firebrick1	gray41	gray101	gray53	indianred2	lightskyblue4	olivedrab1	red2	springgreen4
azure2	darkgoldenrod	firebrick2	gray42	gray102	gray54	indianred3	lightslateblue			
azure3	darkgoldenrod1	firebrick3	gray43	gray103	gray55	indianred4	lightslategray	olivedrab3	red4	steelblue1
azure4	darkgoldenrod2	firebrick4	gray44	gray104	gray56	ivory	lightslategray	olivedrab4	rosybrown	steelblue2
beige	darkgoldenrod3	floralwhite	gray45	gray105	gray57	ivory1	lightsteelblue	orange	rosybrown1	steelblue3
bisque	darkgoldenrod4	forestgreen	gray46	gray106	gray58	ivory2	lightsteelblue1	orange1	rosybrown2	steelblue4
bisque1	darkgray	gainsboro	gray47	gray107	gray59	ivory3	lightsteelblue2	orange2	rosybrown3	tan
bisque2	darkgreen	ghostwhite	gray48	gray108	gray60	ivory4	lightsteelblue3	orange3	rosybrown4	tan1
bisque3	darkgray	ghostwhite	gray49	gray109	gray61	khaki	lightsteelblue4	orange4	royalblue	tan2
bisque4	darkkhaki	gold1	gray50	gray110	gray62	khaki1	lightyellow	orange1	royalblue1	tan3
black	darkmagenta	gold2	gray51	gray111	gray63	khaki2	lightyellow1	orange2	royalblue2	tan4
blanchedalmond	darkolivegreen	gold3	gray52	gray112	gray64	khaki3	lightyellow2	orange3	royalblue3	thistle
blue	darkolivegreen1	gold4	gray53	gray113	gray65	khaki4	lightyellow3	orange4	royalblue4	thistle1
blue1	darkolivegreen2	goldenrod	gray54	gray114	gray66	lavender	lightyellow4	orange1	saddlebrown	thistle2
blue2	darkolivegreen3	goldenrod1	gray55	gray115	gray67	lavenderblush	limegreen	orchid	salmon	thistle3
blue3	darkolivegreen4	goldenrod2	gray56	gray116	gray68	lavenderblush1	linen	orchid1	salmon1	thistle4
blue4	darkorange	goldenrod3	gray57	gray117	gray69	lavenderblush2	magenta	orchid2	salmon2	tomato
blueviolet	darkorange1	goldenrod4	gray58	gray118	gray70	lavenderblush3	magenta1	orchid3	salmon3	tomato1
brown	darkorange2		gray59	gray119	gray71	lavenderblush4	magenta2	orchid4	salmon4	tomato2
brown1	darkorange3		gray60	gray120	gray72		magenta3	palegoldenrod	sandybrown	tomato3
brown2	darkorange4		gray61	gray121	gray73	lemonchiffon	magenta4	palegreen	seagreen	turquoise
brown3	darkorchid		gray62	gray122	gray74	lemonchiffon1	maroon	palegreen1	seagreen1	turquoise1
brown4	darkorchid1		gray63	gray123	gray75	lemonchiffon2	maroon1	palegreen2	seagreen2	turquoise2
burlwood	darkorchid2		gray64	gray124	gray76	lemonchiffon3	maroon2	palegreen3	seagreen3	turquoise3
burlwood1	darkorchid3		gray65	gray125	gray77	lemonchiffon4	maroon3	palegreen4	seagreen4	turquoise4
burlwood2	darkorchid4		gray66	gray126	gray78	lightblue	mediumaquamarine	paleturquoise	seashell	violet
burlwood3	darkred		gray67	gray127	gray79	lightblue1	mediumblue	paleturquoise1	seashell1	violet1
burlwood4	darksalmon		gray68	gray128	gray80	lightblue2	mediumblue1	paleturquoise2	seashell2	violet2
cadetblue	darkseagreen		gray69	gray129	gray81	lightblue3	mediumorchid	paleturquoise3	seashell3	violet3
cadetblue1	darkseagreen1		gray70	gray130	gray82	lightblue4	mediumorchid1	paleturquoise4	seashell4	violet4
cadetblue2	darkseagreen2		gray71	gray131	gray83	lightcoral	mediumorchid2	palevioletred	sienna	violetred3
cadetblue3	darkseagreen3		gray72	gray132	gray84	lightcyan	mediumorchid3	palevioletred1	sienna1	violetred4
cadetblue4	darkseagreen4		gray73	gray133	gray85	lightcyan1	mediumorchid4	palevioletred2	sienna2	wheat
chartreuse	darkslateblue		gray74	gray134	gray86	lightcyan2	mediumpurple	palevioletred3	sienna3	wheat1
chartreuse1	darkslategray		gray75	gray135	gray87	lightcyan3	mediumpurple1	palevioletred4	sienna4	wheat2
chartreuse2	darkslategray1		gray76	gray136	gray88	lightcyan4	mediumpurple2	papayawhip	skyblue	wheat3
chartreuse3	darkslategray2		gray77	gray137	gray89	lightgoldenrod	mediumpurple3	peachpuff	skyblue1	wheat4
chartreuse4	darkslategray3		gray78	gray138	gray90	lightgoldenrod1	mediumpurple4	peachpuff1	skyblue2	whitesmoke
chocolate	darkslategray4		gray79	gray139	gray91	lightgoldenrod2	mediumpurple5	peachpuff2	yellow	yellow1
chocolate1	darkslategray		gray80	gray140	gray92	lightgoldenrod3	mediumslateblue	peachpuff3	skyblue4	yellow2
chocolate2	darkturquoise		gray81	gray141	gray93	lightgoldenrod4	mediumspringgreen	peachpuff4	slateblue	yellow3
chocolate3	darkviolet		gray82	gray142	gray94	lightgoldenrodyellow	mediumturquoise	peru	slateblue1	yellow4
chocolate4	deeppink		gray83	gray143	gray95	lightgray	mediumvioletred	pink	slateblue2	yellowgreen
coral	deeppink1		gray84	gray144	gray96	lightgreen	midnightblue	pink1	slateblue3	
coral1	deeppink2		gray85	gray145	gray97	lightgray	mintcream	pink2	slateblue4	
coral2	deeppink3		gray86	gray146	gray98	lightpink	mistyrose	pink3	slategray	
coral3	deeppink4		gray87	gray147	gray99	lightpink1	mistyrose1	pink4	slategray1	

mistyrose2	plum	slategray2
mistyrose3	plum1	slategray3
mistyrose4	plum2	slategray4
moccasin	plum3	slategrey
navajowhite	plum4	snow
navajowhite1	powderblue	snow1
navajowhite2	purple	snow2
navajowhite3	purple1	snow3
navajowhite4	purple2	snow4
navy	purple3	springgreen
navyblue	purple4	springgreen1
oldlace	red	springgreen2
olivedrab	red1	springgreen3
olivedrab1	red2	springgreen4

#EED5D2	#DDA0DD	#B9D3EE
#CDB7B5	#FFB6C1	#98FB98
#8B7D7B	#EEEEE0	#6C7B8B
#FFE4B5	#CD96CD	#708090
#FFDEAD	#8B688B	#FFA07A
#FFDEAD	#B0E0E6	#FFA07A
#EECFA1	#A020F0	#EEE9E9
#CDB38B	#9B30FF	#CDC9C9
#8B795E	#912CEE	#8B8989
#000080	#7D26CD	#00FF7F
#000080	#551A8B	#00FF7F
#FDF5E6	#FF0000	#00EE76
#6B8E23	#FF0000	#00CD66
#C0FF3E	#EE0000	#008B45



Colores en R

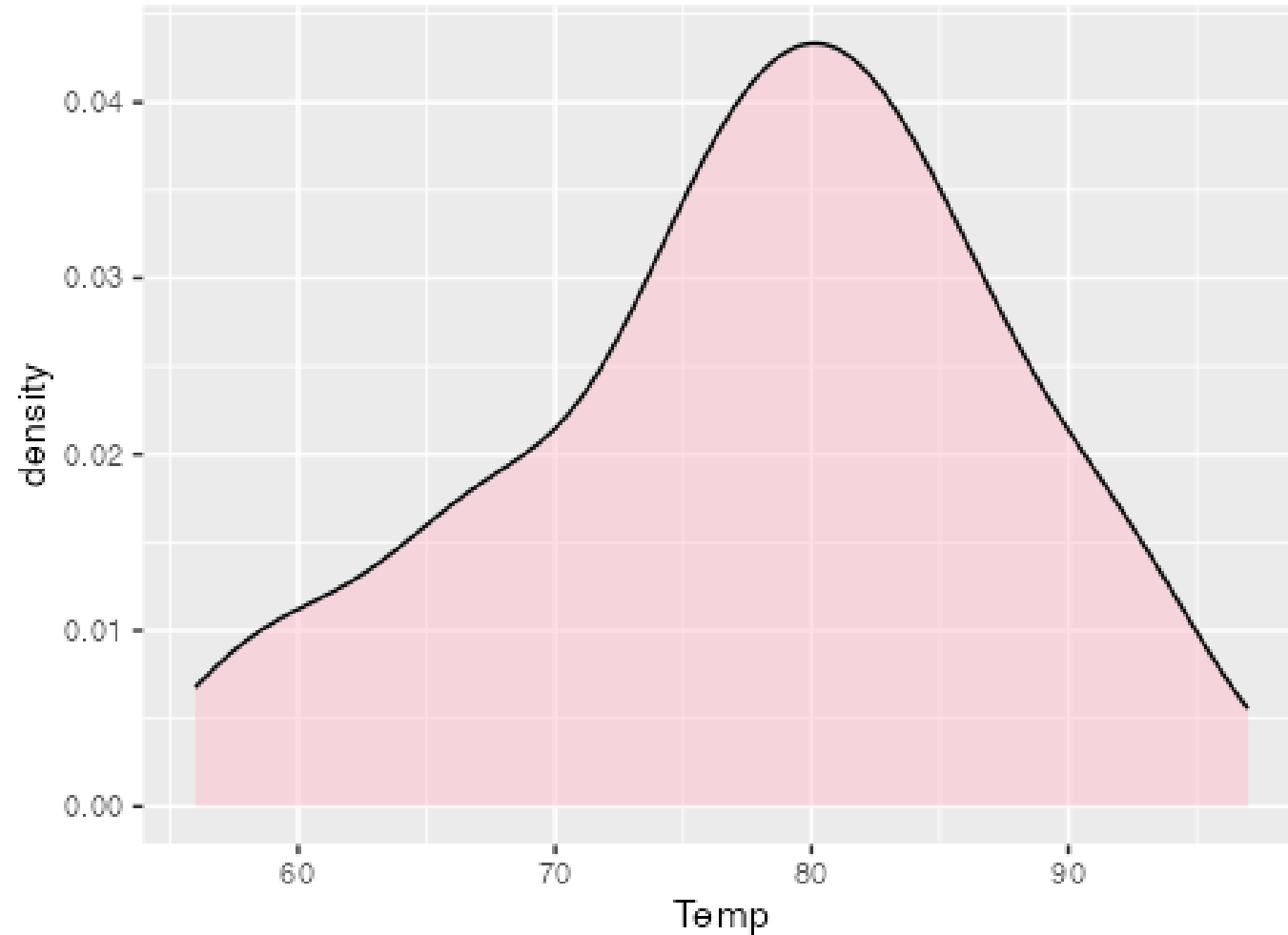
- Argumentos **fill** y **color**
 - **fill**: Define el color de relleno usando paletas de colores:
`scale_fill_brewer`, `scale_fill_viridis`
 - **color**: Define el color de relleno usando paletas de colores:
`scale_color_brewer`,
`scale_color_viridis`



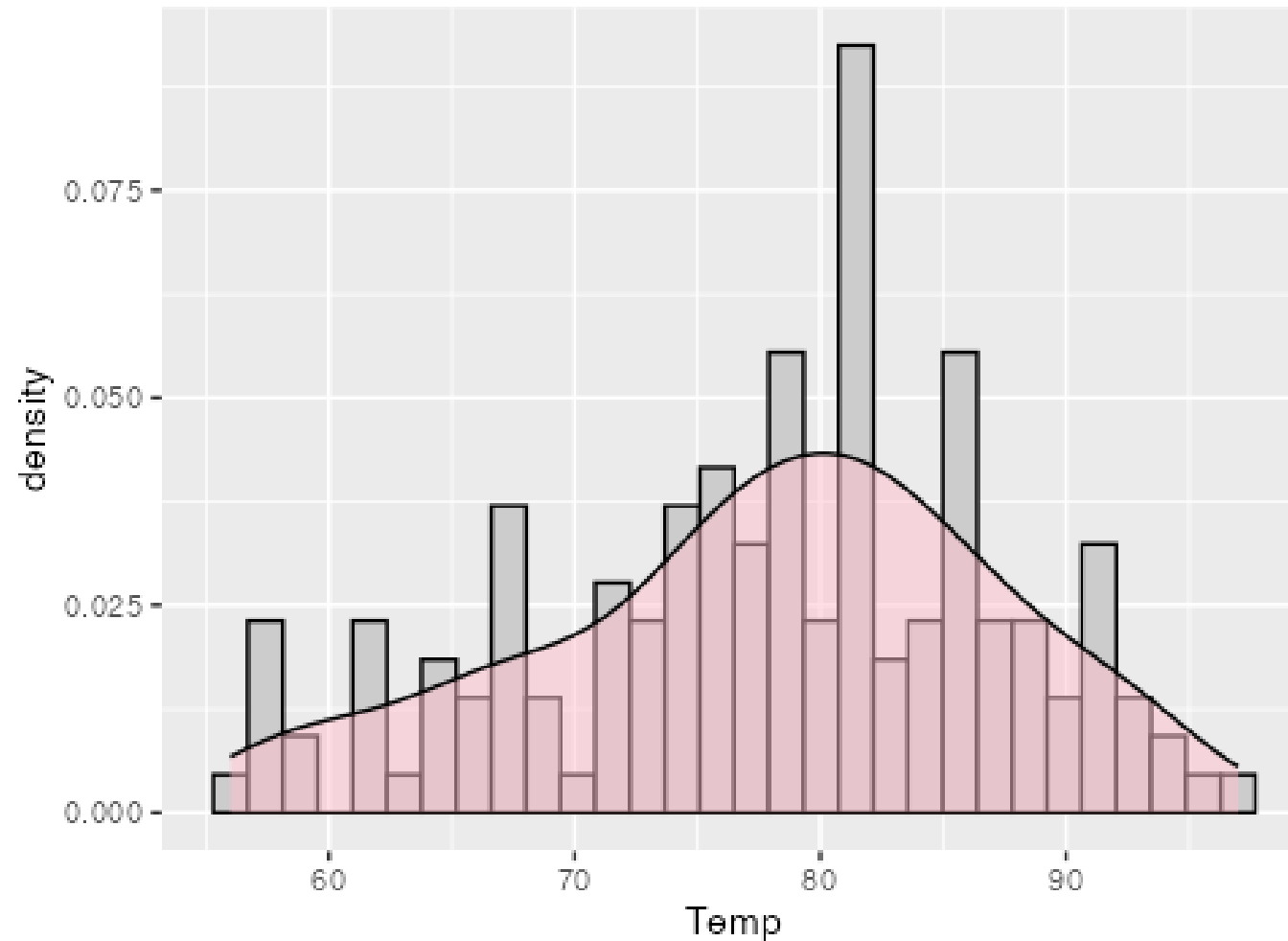
- Colores por nombre y por hex code:
<https://rpubs.com/kylewbrown/r-colors>



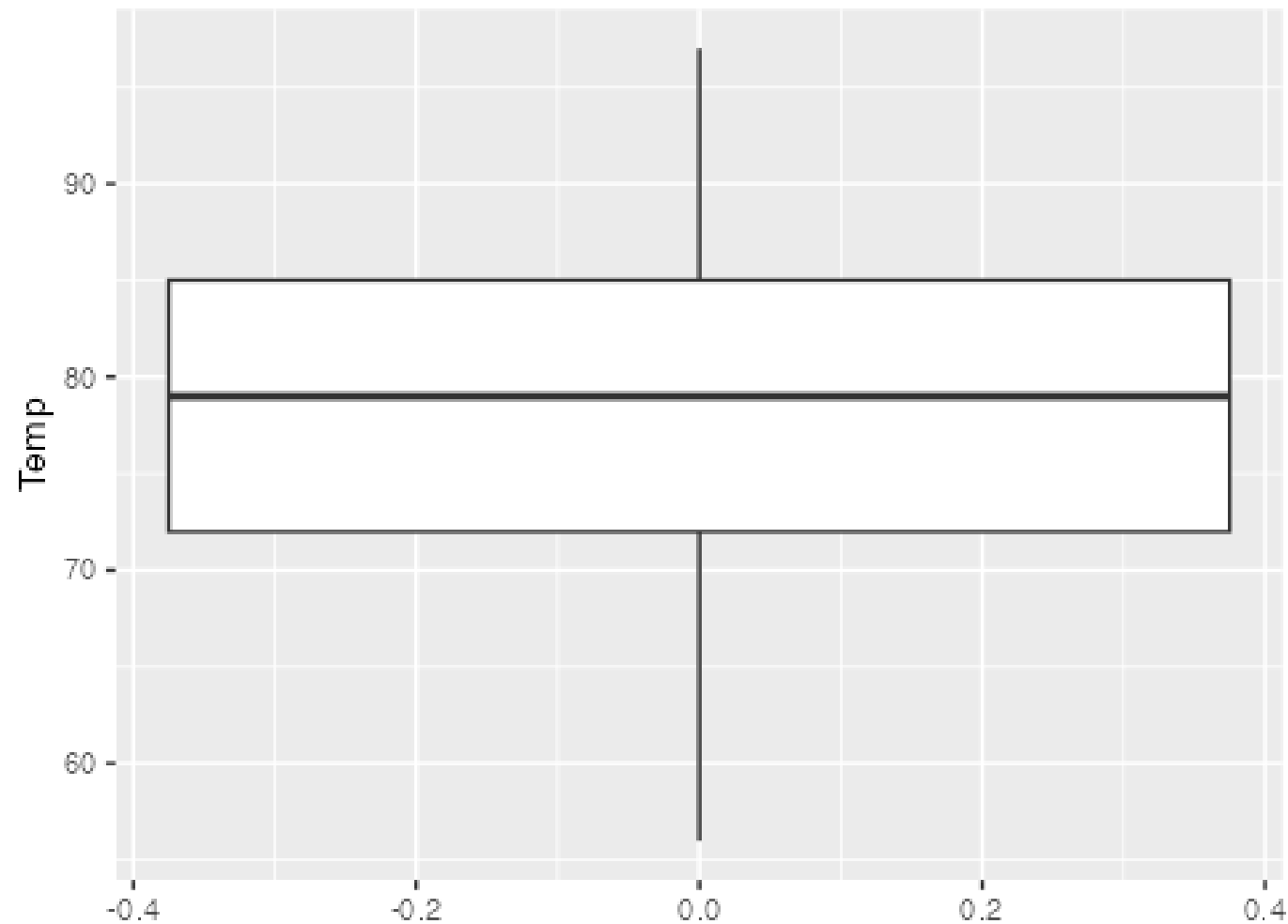
```
ggplot(aire_tbl, aes(Temp)) +  
  geom_density(color = "black", fill = "grey80", alpha = 0.5)
```



```
ggplot(aire_tbl, aes(Temp)) +  
  geom_histogram(aes(y = ..density..), color = "black", fill = "grey80") +  
  geom_density(color = "black", fill = "grey80", alpha = 0.5)
```

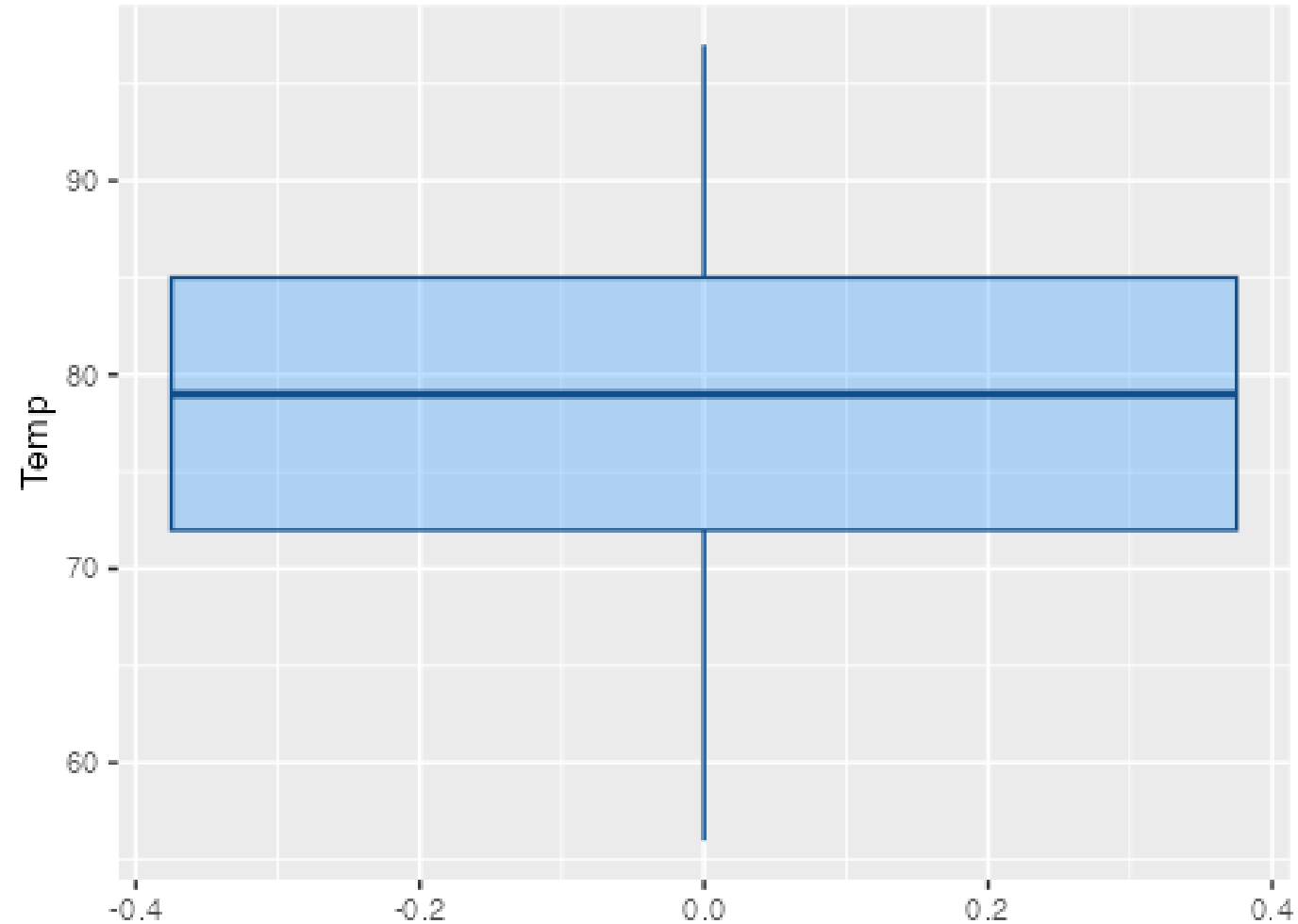


```
ggplot(aire_tbl, aes(Temp)) +  
  geom_boxplot()
```





```
ggplot(aire_tbl, aes(Temp)) +  
  geom_boxplot(color = "dodgerblue4", fill = "dodgerblue1", alpha = 0.3)
```

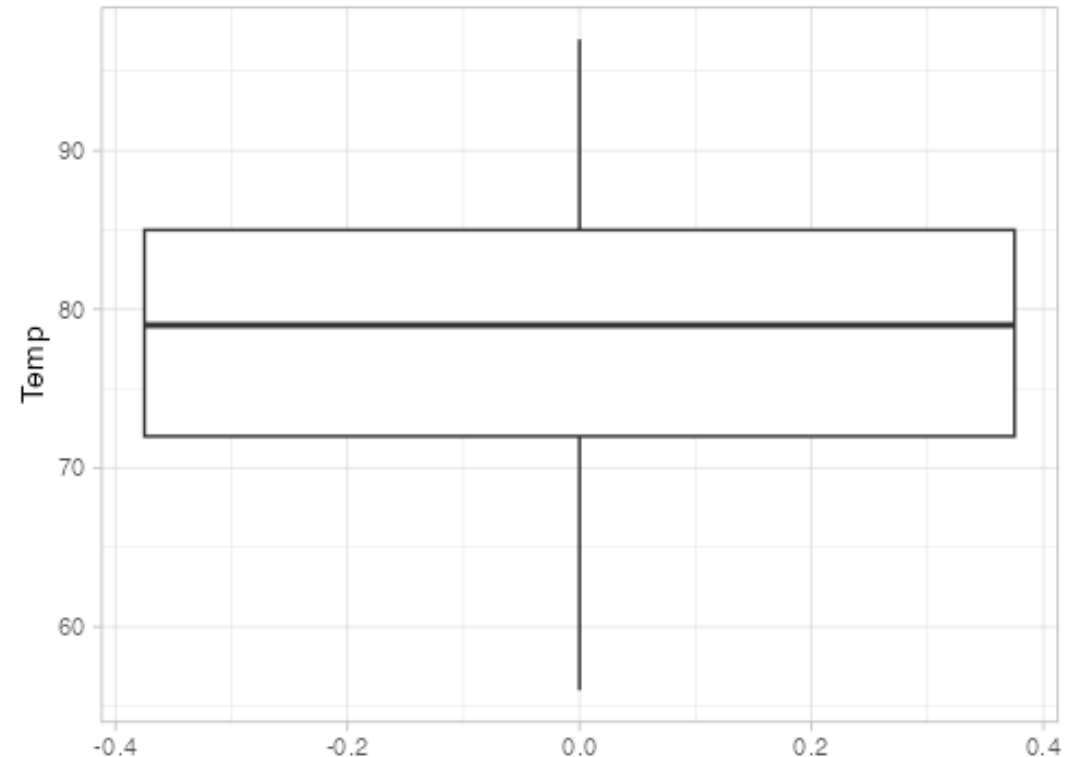




Temas en gráficos

- `theme_grey()`
- `theme_gray()`
- `theme_bw()`
- `theme_linedraw()`
- `theme_dark()`
- `theme_light()`
- `theme_minimal()`

```
ggplot(aire_tbl, aes(Temp)) +  
  geom_boxplot() +  
  theme_light()
```





Su turno...

Descargue los archivos que se le indican

- Archivo **iris.dta**: <https://www.stata-press.com/data/r10/mvmain.html>
- Descargue los promedios de 24 horas de PST, PM₁₀ y PM_{2.5} en formato CSV de la página del Sistema de Monitoreo Atmosférico de la Ciudad de México: <https://www.aire.cdmx.gob.mx/>
- Descargue de Classroom los archivos: **09mun.dbf** y **datos_pob_2020.xlsx**
- Mueva los archivos a la carpeta **data** de su proyecto
- Genere un nuevo script
- Active los paquetes **tidyverse**, **haven**, **readxl** y **foreign** en su sesión





Importando mallas de datos en R

```
cdmx_dbf <- read.dbf("./data/09mun.dbf")
```

```
library(foreign)
```

```
iris_dta <- read_dta("./data/iris.dta")
```

```
library(haven)
```

```
redma_csv <- read_csv("./data/red_manual_particulas_susp.csv")
```

```
library(tidyverse) {readr}
```

```
pob_xlsx <- read_xlsx("./data/datos_pob_2020.xlsx")
```

```
library(readxl)
```




Formato de nombre de columnas

	A	B	C	D
	ID estación monitoreo	Concentración de contaminante	ID del municipio	Nombre de municipio
1				
2	site1	37.70312459	011	Tláhuac
3	site2	13.86911435	003	Coyoacán
4	site3	25.65814387	014	Benito Juárez
5	site4	18.71379389	004	Cuajimalpa
6	site5	31.59713493	016	Miguel Hidalgo
7	site6	18.81195947	013	
8	site7	35.22971464	007	Iztapalapa

```
read_xlsx("./data/datos_pob_2020.xlsx", sheet = "contam")
```

```
# A tibble: 7 x 4
  `ID estación monitoreo` `Concentración de contaminante` `ID del municipio` `Nombre de municipio`
  <chr>                  <dbl> <chr>                  <chr>
1 site1                  37.7 011                Tláhuac
2 site2                  13.9 003                Coyoacán
3 site3                  25.7 014                Benito Juárez
4 site4                  18.7 004                Cuajimalpa
5 site5                  31.6 016                Miguel Hidalgo
6 site6                  18.8 013                NA
7 site7                  35.2 007                Iztapalapa
```



```
read_xlsx("./data/datos_pob_2020.xlsx",  
          sheet = "contam",  
          .name_repair = "universal")
```

New names:

- `ID estación monitoreo` -> `ID.estación.monitoreo`
- `Concentración de contaminante` -> `Concentración.de.contaminante`
- `ID del municipio` -> `ID.del.municipio`
- `Nombre de municipio` -> `Nombre.de.municipio`

A tibble: 7 × 4

	ID.estación.monitoreo	Concentración.de.contaminante	ID.del.municipio	Nombre.de.municipio
	<chr>	<dbl>	<chr>	<chr>
1	site1	37.7	011	Tláhuac
2	site2	13.9	003	Coyoacán
3	site3	25.7	014	Benito Juárez
4	site4	18.7	004	Cuajimalpa
5	site5	31.6	016	Miguel Hidalgo
6	site6	18.8	013	NA
7	site7	35.2	007	Iztapalapa



```
read_xlsx("./data/datos_pob_2020.xlsx",  
  sheet = "contam") %>%  
  clean_names()
```

{janitor}
clean_names()

```
# A tibble: 7 x 4
```

	id_estacion_monitoreo	concentracion_de_contaminante	id_del_municipio	nombre_de_municipio
	<chr>		<dbl> <chr>	<chr>
1	site1	37.7	011	Tláhuac
2	site2	13.9	003	Coyoacán
3	site3	25.7	014	Benito Juárez
4	site4	18.7	004	Cuajimalpa
5	site5	31.6	016	Miguel Hidalgo
6	site6	18.8	013	NA
7	site7	35.2	007	Iztapalapa

Snake case: nombre_de_variable, nom_var, n_var, name_var, ~~Nombre_Var, NOM_VAR, NAME~~

https://geeks.ms/jorge/2019/03/24/la-importancia-de-las-convenciones-de-codificacion-pascalcase-camelcase-snake_case-y-kebab-case/

<http://programacion.jias.es/2017/09/estandares-de-nomenclatura-snake-case-kebab-case-camel-case/>

<https://github.com/Tazinho/snakecase>



Convención codificación

Tipo codificación	Resultado
camelCase	firstName
PascalCase	FirstName
SnakeCase	first_name
KebabCase	first-name
UpperCase + SnakeCase	FIRST_NAME
lowercase	firstname