

Tutorial 3

Data Visualization in R.

ggplot2: themes and styles.

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Course structure

Week 1-2:

Lecture 1. Principles of figure design.

Quiz 1.

Week 3-4:

Tutorial 1. ggplot2: plots and charts.

Quiz 2.

Week 5-6:

Tutorial 2. ggplot2: statistics, coordinate system, facets.

Tutorial 3. ggplot2: themes and styles.

Practice 1.

Quiz 3.

Week 7-8:

Practice 2. Project.

Practice 3. Project.

Practice 4. Project.

Assignment.

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Tutorial 1. ggplot2: plots and charts.

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Tutorial 3. ggplot2: themes and styles.

Practice 1.

Quiz 3.

Week 7-8:

Practice 2. Project.

Practice 3. Project.

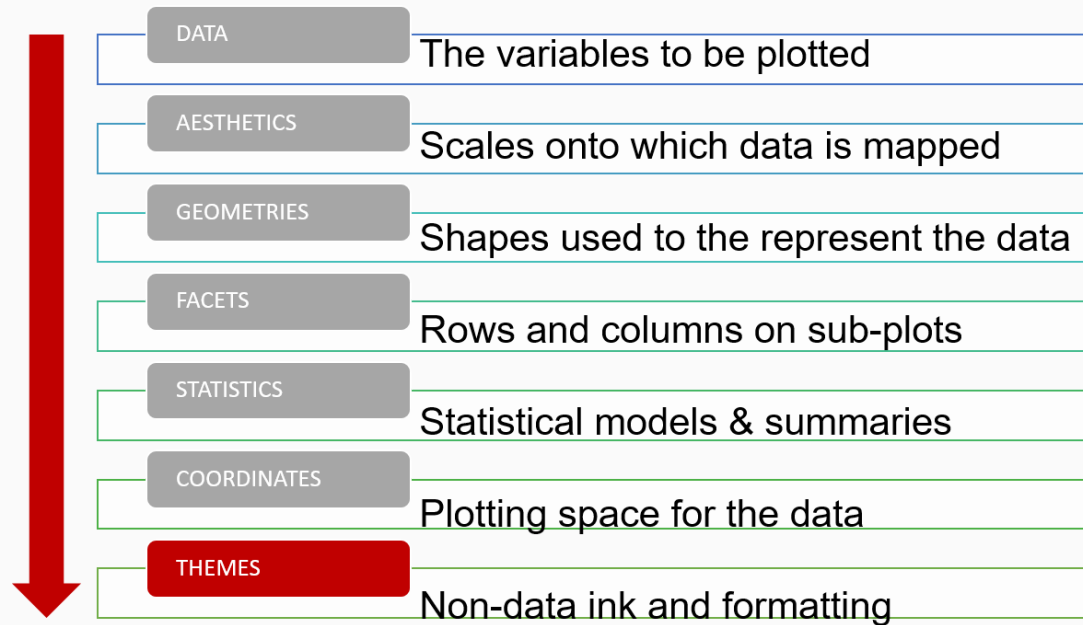
Practice 4. Project.

Assignment.

Learning goals

- Understand the basic principles behind effective data visualization
- Create data visualizations in R using ggplot2
- **Craft elegant visual presentations of data**

Grammar of graphics



Layers in grammar of graphics

The **Themes Layer** refers to all non-data ink.

- You can change the labels of x or y axis,
- add a plot title,
- modify a legend title and position,
- add text anywhere on the plot,
- change the background color, axis lines, plot lines,
- etc.

Plan of the tutorial

- Themes principles
- Build-in themes
- Data annotation
- Customized design 1
- Customized design 2

?Theme()

There are three types of elements within the themes Layer: text, line, and rectangle.

Any text element can be modified with `element_text()`

Any line element can be modified with `element_line()`

Any rect element can be modified with `element_rect()`

One can also use `element_blank()` function to drop the element.

Build-in themes

For the most part you can probably avoid the `theme()` function by using built-in themes, unless there is a specific element you want to modify.

Code	Output
------	--------

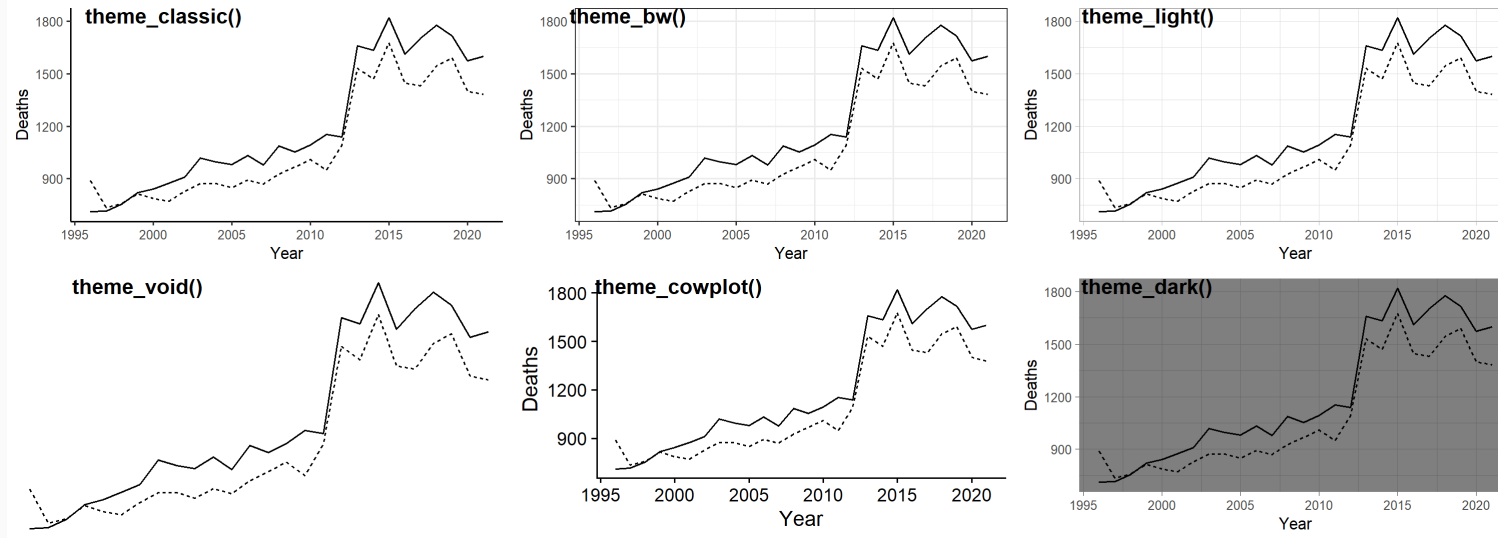
<pre>p <- Death_in_NL %>% filter(Age == "Total", CausesOfDeath == "Infections")%>% ggplot(mapping = aes(x = Year, y = Deaths, linetype = Sex))+ geom_path(show.legend = FALSE) p1 <- p + theme_classic() p2 <- p + theme_bw() p3 <- p + theme_light() p4 <- p + theme_void() p5 <- p + theme_cowplot() p6 <- p + theme_dark() plot_grid(p1, p2, p3, p4, p5, p6, ncol = 3, labels = c("theme_classic()", "theme_bw()", "theme_light()", "theme_void()", "theme_cowplot()", "theme_dark()))</pre>	
--	--

Build-in themes

For the most part you can probably avoid the `theme()` function by using built-in themes, unless there is a specific element you want to modify.

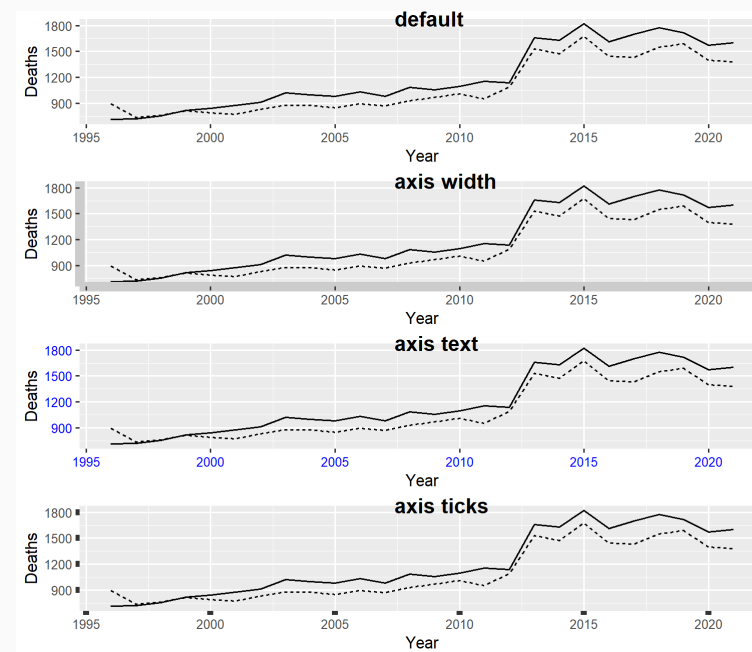
Code

Output



Customised theme: change styles of axes texts and lines

```
p ← Death_in_NL %>%  
  filter(Age == "Total", CausesOfDeath == "Infections")%>%  
  ggplot(mapping = aes(x = Year, y = Deaths, linetype = Sex))+  
  geom_path(show.legend = FALSE)  
  
p1 ← p + theme(axis.line = element_line(linewidth = 3, colour = "grey80"))  
p2 ← p + theme(axis.text = element_text(colour = "blue"))  
p3 ← p + theme(axis.ticks = element_line(linewidth = 2))  
  
plot_grid(p, p1, p2, p3, ncol = 1, labels = c("default", "axis width", "axis text", "axis ticks"),  
  label_x = 0.5, label_y = 1, hjust = 0, vjust = 1)
```

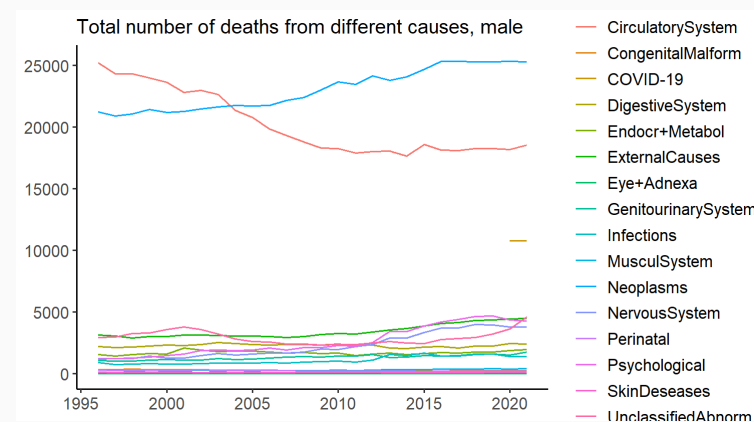
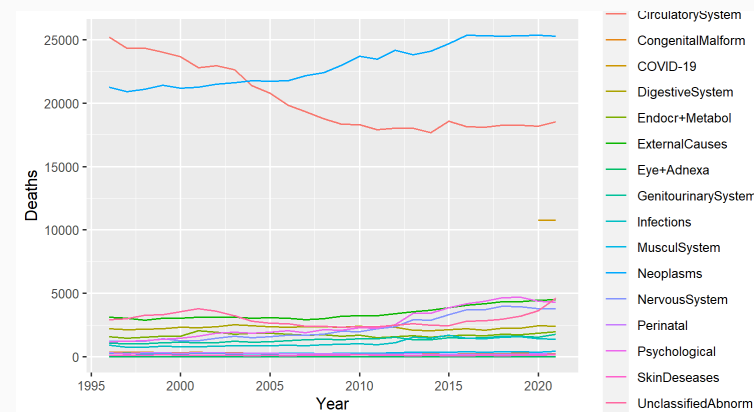


Customised theme: axes and legend text formatting

```
p <- Death_in_NL %>%
  filter(Age == "Total", Sex == "Male")%>%
  ggplot(aes(x = Year, y = Deaths, color = CausesOfDeath), linewidth = 2)+
  geom_path()+
  scale_color_discrete()

p1 <- p + theme_classic()+
  ggtitle("Total number of deaths from different causes, male")+
  labs(x = NULL, y = NULL)+
  theme(legend.title = element_blank(),
        axis.text = element_text(size = 11),
        legend.text = element_text(size = 11))

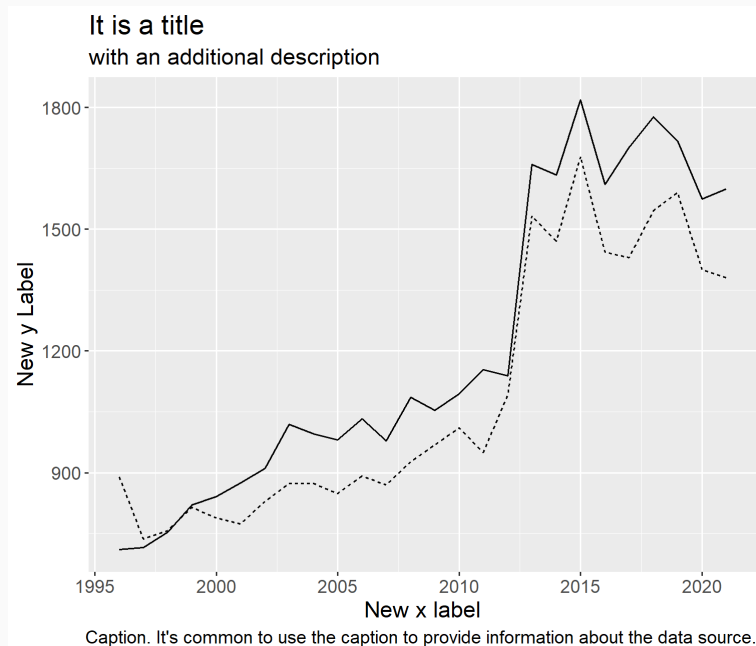
p
p1
```



labs: annotate the plot

Good labels are critical for making your plots accessible to a wider audience. Always ensure the axis and legend labels display the full variable name. Use the plot title and subtitle to explain the main findings.

```
Death_in_NL %>%
  filter(Age == "Total", CausesOfDeath == "Infections")%>%
  ggplot(mapping = aes(x = Year, y = Deaths, linetype = Sex))+
  geom_path(show.legend = FALSE)+
  labs(title = "It is a title",
       subtitle = "with an additional description",
       caption = "Caption. It's common to use the caption to provide information about the data source.",
       x = "New x label",
       y = "New y Label")+
  theme(text = element_text(size = 15))
```



Scales formatting and transformations

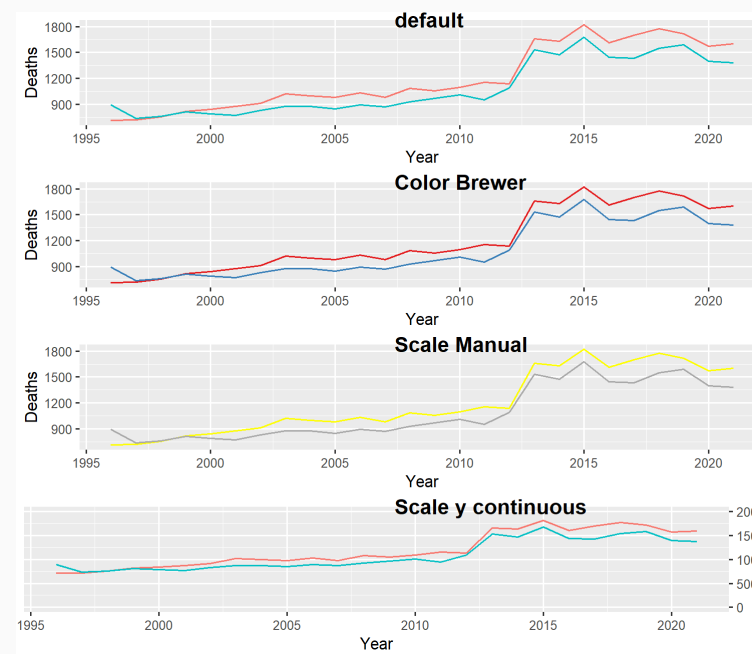
`scale_` family of functions affect how a single observation raw data is 'interpreted' before going on the graph. There are two types of scales: `continuous` and `discrete`.

`scale_` functions are used to set colors, limits, and transformations.

```
p <- Death_in_NL %>%
  filter(Age == "Total", CausesOfDeath == "Infections")%>%
  ggplot(mapping = aes(x = Year, y = Deaths, color = Sex))+
  geom_path(show.legend = FALSE)

p1 <- p + scale_color_brewer(palette = 'Set1')
p2 <- p + scale_color_manual(values = c("yellow", "dark gray"))
p3 <- p + scale_y_continuous(position = "right", limits = c(0, 2000), name

plot_grid(p, p1, p2, p3, ncol = 1, labels = c("default", "Color Brewer", "Scale Manual", "Scale y continuous"),
  label_x = 0.5, label_y = 1, hjust = 0, vjust = 1)
```



Customised bar plot: example

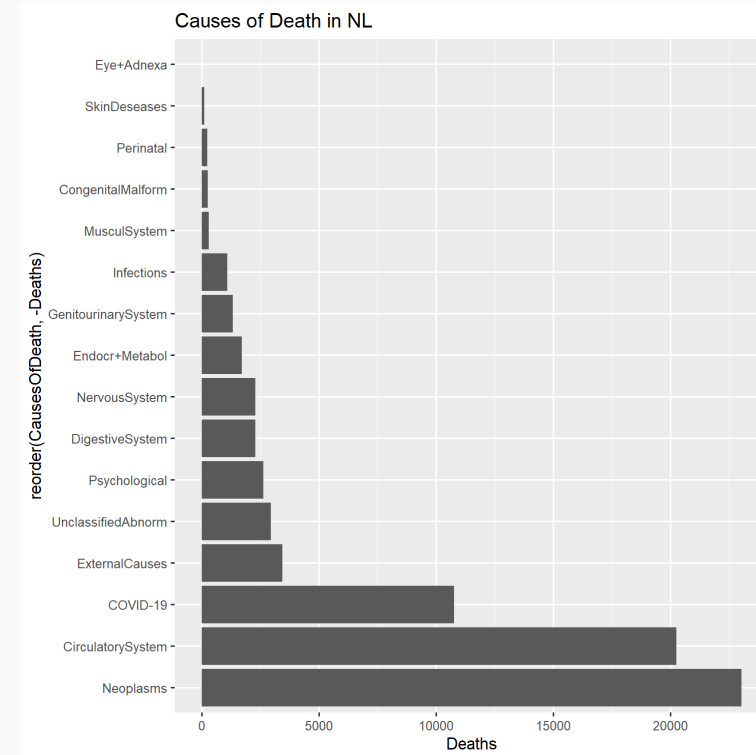
Lets customize the bar plot we built on Tutorial 2

```
Death_in_NL%>%  
  filter(Age == "Total", Sex == "Male")%>%  
  ggplot(aes(x = reorder(CausesOfDeath, -Deaths), y = Deaths))+  
  stat_summary(fun.data = "mean_se", geom = "bar")+  
  coord_flip()+  
  ggtitle("Causes of Death in NL")
```

What I don't like:

1. the y axis title is non-sense
2. the x axis title is unclear
3. the text size on the y axis is too small
4. the gray background is annoying
5. the columns color is not appealing

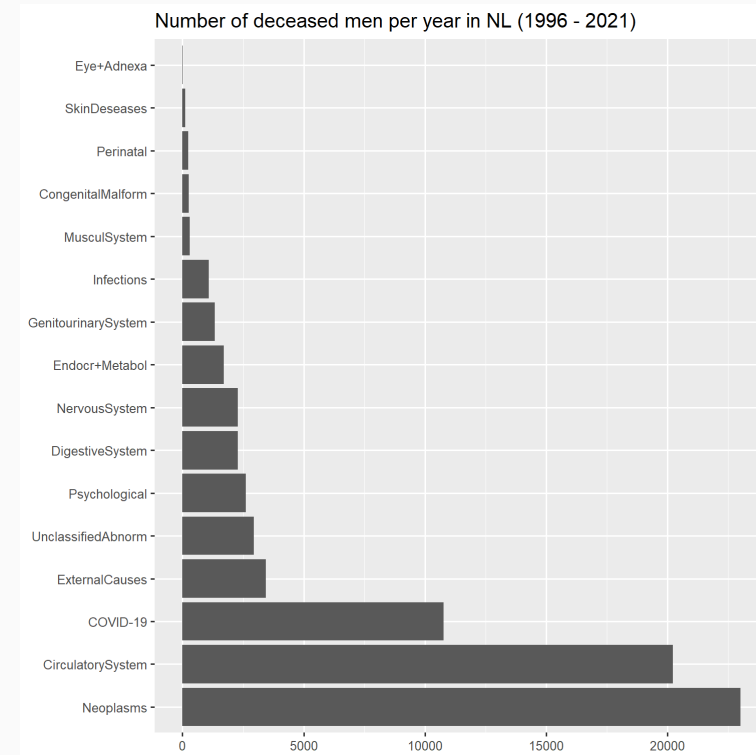
Lets address those issues!



Customised bar plot

1. the y axis title is non-sense
2. the x axis title is unclear
3. the text size on the y axis is too small
4. the gray background is annoying
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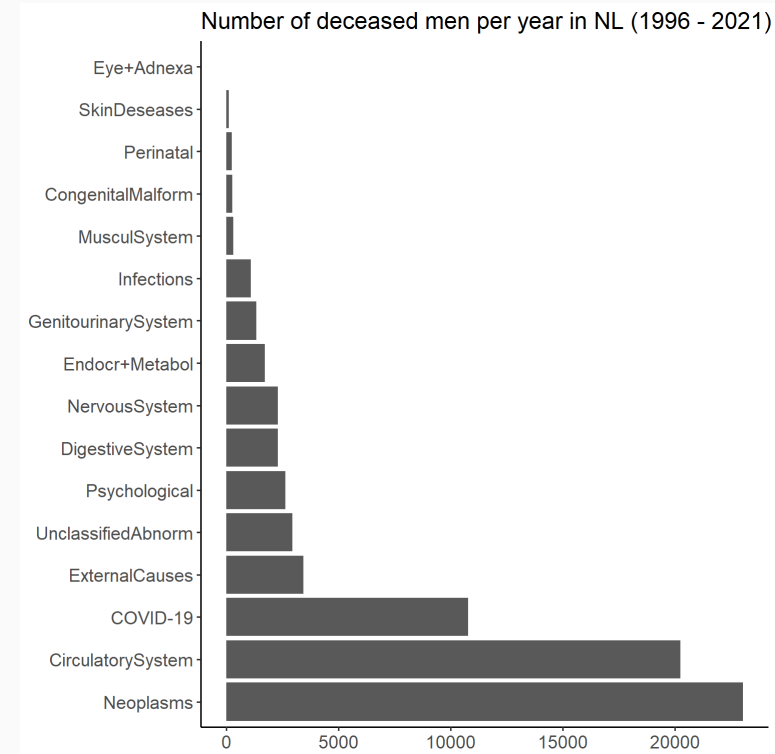
```
Death_in_NL%>%  
  filter(Age == "Total", Sex == "Male")%>%  
  ggplot(aes(x = reorder(CausesOfDeath, -Deaths), y = Deaths))+  
  stat_summary(fun.data = "mean_se", geom = "bar")+  
  coord_flip()+  
  labs(y = NULL, x = NULL)+  
  ggtitle("Number of deceased men per year in NL (1996 - 2021)")
```



Customised bar plot

1. ~~the y axis title is non sense~~
2. ~~the x axis title is unclear~~
3. the text size on the y axis is too small
4. the gray background is annoying
5. the columns color is not appealing

```
Death_in_NL%>%
  filter(Age == "Total", Sex == "Male")%>%
  ggplot(aes(x = reorder(CausesOfDeath, -Deaths), y = Deaths))+
  stat_summary(fun.data = "mean_se", geom = "bar")+
  coord_flip()+
  labs(y = NULL, x = NULL)+
  theme_classic()+
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 13))+
  ggtitle("Number of deceased men per year in NL (1996 - 2021)")
```

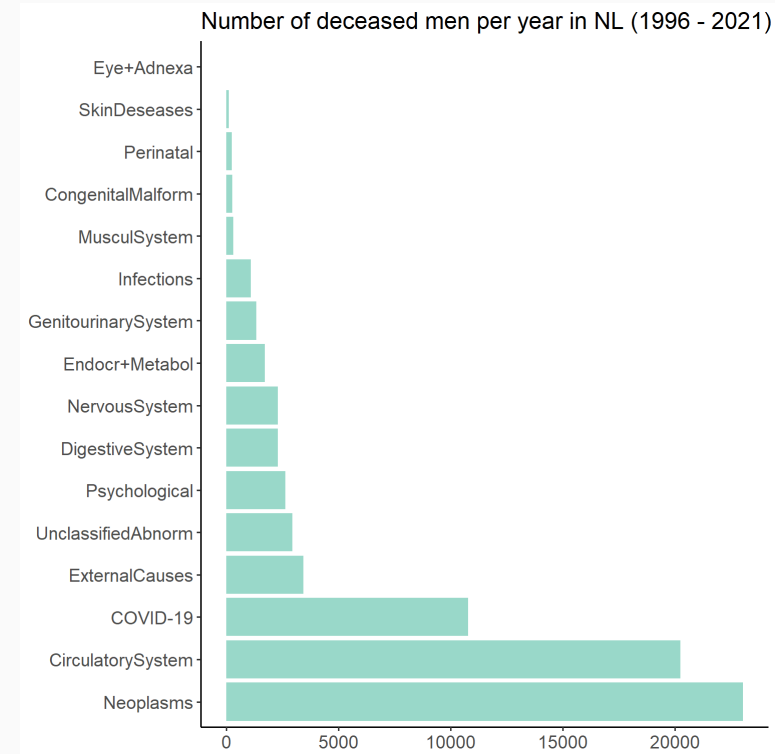


Customised bar plot

1. ~~the y axis title is non sense~~
2. ~~the x axis title is unclear~~
3. ~~the text size on the y axis is too small~~
4. ~~the gray background is annoying~~
5. the columns color is not appealing

```
Death_in_NL%>%
  filter(Age == "Total", Sex == "Male")%>%
  ggplot(aes(x = reorder(CausesOfDeath, -Deaths), y = Deaths))+
  stat_summary(fun.data = "mean_se", geom = "bar",
    fill = "#99d8c9")+
  coord_flip()+
  labs(y = NULL, x = NULL)+
  theme_classic()+
  theme(axis.text = element_text(size = 12),
    title = element_text(size = 13))+
  ggtitle("Number of deceased men per year in NL (1996 - 2021)")
```

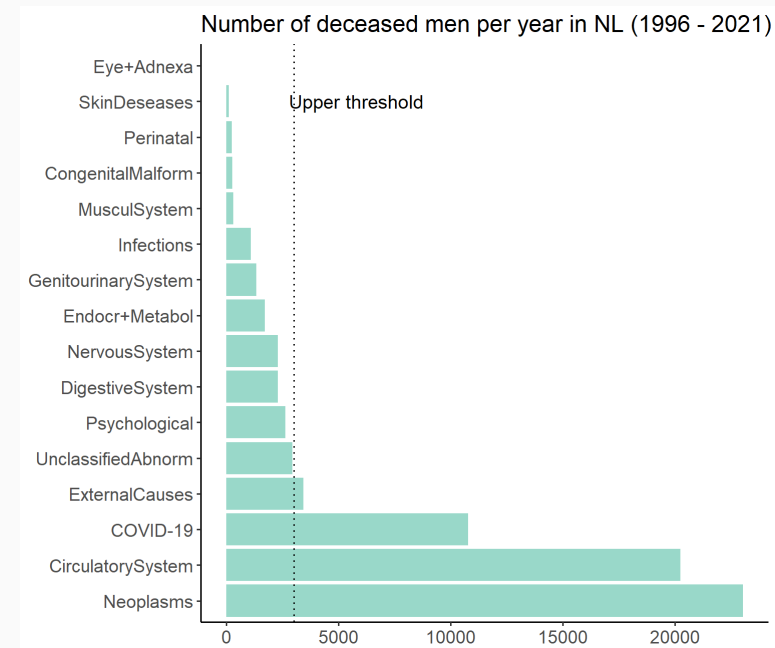
You can pick the color [here](#), or [here](#)



Customised bar plot: add annotation

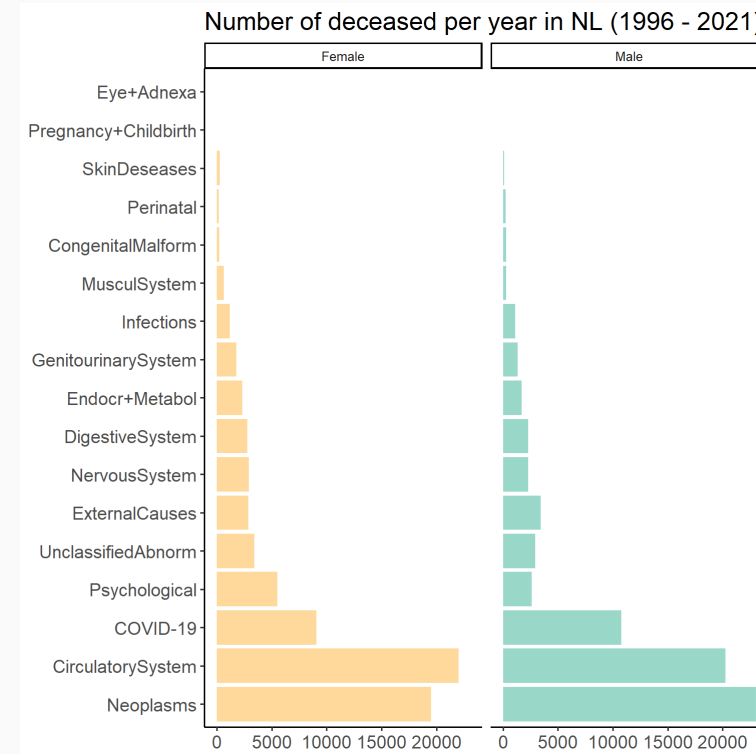
One can add additional elements and annotations

```
Death_in_NL%>%
  filter(Age == "Total", Sex == "Male")%>%
  ggplot(aes(x = reorder(CausesOfDeath, -Deaths), y = Deaths, fill = Sex))
  stat_summary(fun.data = "mean_se", geom = "bar", fill = "#99d8c9")+
  geom_hline(yintercept=3000, linetype="dotted")+
  annotate(geom="text", x=15, y=5800, label="Upper threshold", size = 4.5)+
  coord_flip()+
  labs(y = NULL, x = NULL)+
  theme_classic()+
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 13))+
  ggtitle("Number of deceased men per year in NL (1996 - 2021)")
```



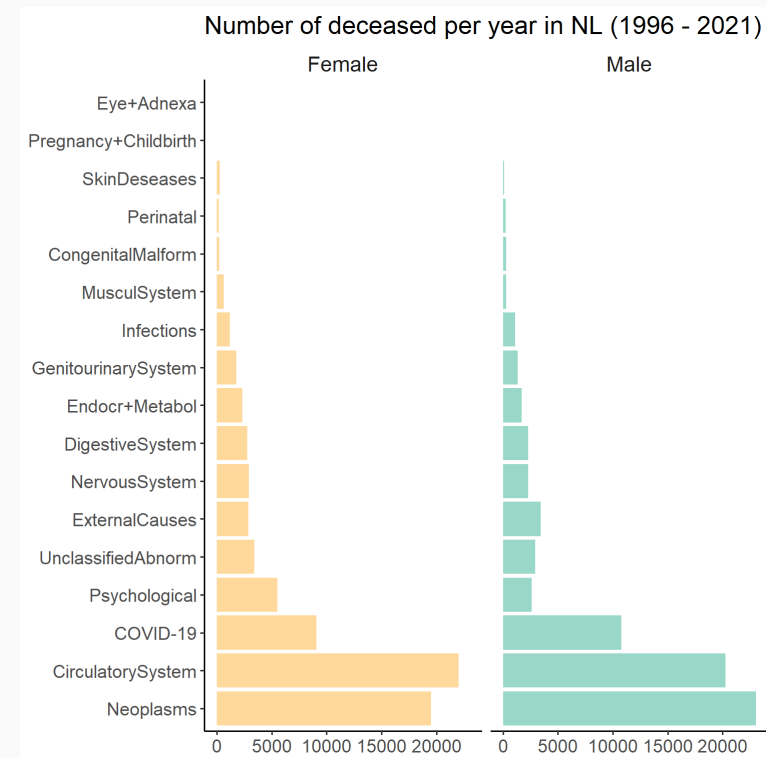
Customised bar plot: facets

```
Death_in_NL%>%
  filter(Age == "Total")%>%
  ggplot(aes(x = reorder(CausesOfDeath, -Deaths), y = Deaths, fill = Sex))
  stat_summary(fun.data = "mean_se", geom = "bar", show.legend = FALSE)+
  coord_flip()+
  labs(y = NULL, x = NULL)+
  scale_fill_manual(values = c("#fed99b", "#99d8c9"))+
  theme_classic()+
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 14))+
  ggtitle("Number of deceased per year in NL (1996 - 2021)")
  facet_wrap(~Sex)
```



Customised bar plot: facets

```
Death_in_NL%>%
  filter(Age == "Total")%>%
  ggplot(aes(x = reorder(CausesOfDeath, -Deaths), y = Deaths, fill = Sex))
  stat_summary(fun.data = "mean_se", geom = "bar", show.legend = FALSE)+
  coord_flip()+
  labs(y = NULL, x = NULL)+
  scale_fill_manual(values = c("#fed99b", "#99d8c9"))+
  theme_classic()+
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 14),
        strip.background = element_blank(),
        strip.text = element_text(size = 14))+
  ggtitle("Number of deceased per year in NL (1996 - 2021)")+
  facet_wrap(~Sex)
```

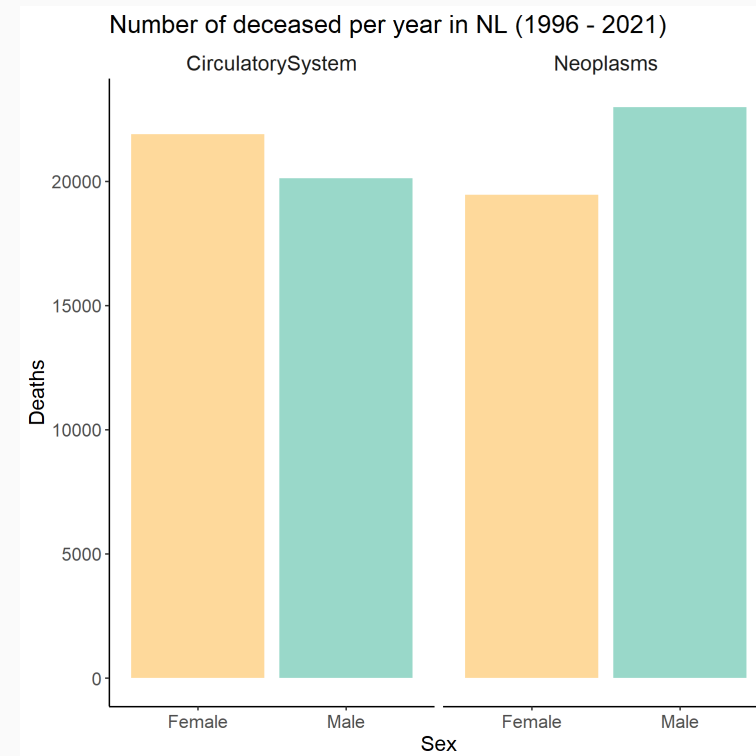


Customised strip chart

Vizualizations to explore the data

Lets zoom in to the top2 causes of death in NL and explore if the gender-related differences are significant or not

```
Death_in_NL%>%
  filter(Age == "Total", CausesOfDeath == c("Neoplasms", "CirculatorySystem"))
  ggplot(aes(x = Sex, y = Deaths, fill = Sex))+
  stat_summary(fun.data = "mean_se", geom = "bar", show.legend = FALSE)+
  scale_fill_manual(values = c("#fed99b", "#99d8c9"))+
  theme_classic()+
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 14),
        strip.background = element_blank(),
        strip.text = element_text(size = 14))+
  ggtitle("Number of deceased per year in NL (1996 - 2021)")+
  facet_wrap(~CausesOfDeath)
```

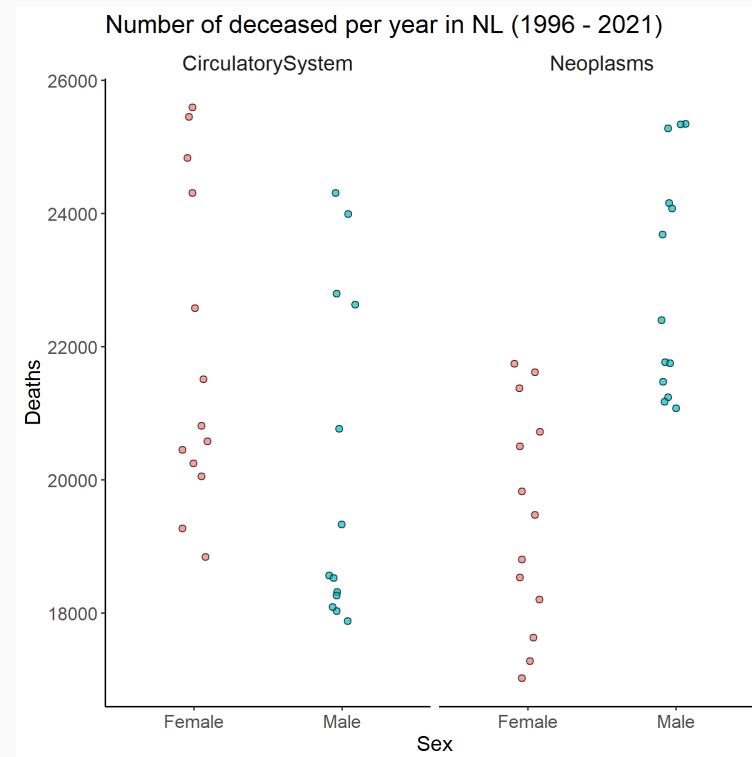


Showing individual observations on the plot

Lets plot individual observations instead of the bar plot using `geom_jitter`. This will requires some adjustments of the code.

```
Death_in_NL%>%
  filter(Age == "Total", CausesOfDeath == c("Neoplasms", "CirculatorySystem"))
  ggplot(aes(x = Sex, y = Deaths, fill = Sex))+
  geom_jitter(show.legend = FALSE, alpha = 0.7, shape = 21, size = 2, width = 0.5,
  scale_color_manual(values = c("#ef8a62", "#67a9cf")))+
  theme_classic()+
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 14),
        strip.background = element_blank(),
        strip.text = element_text(size = 14))+
  ggtitle("Number of deceased per year in NL (1996 - 2021)")
  facet_wrap(~CausesOfDeath)
```

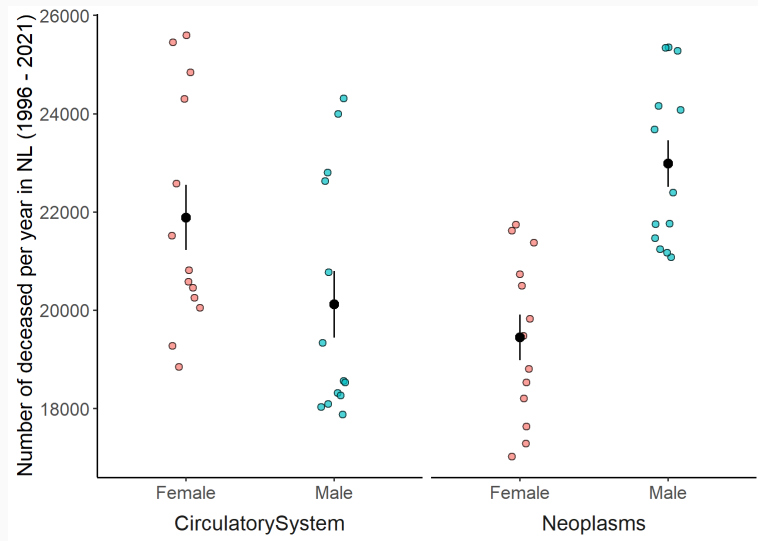
Are the differences significant?



Showing individual observations on the plot

Would be better having some statistical estimates on the top of the individual observations.

```
Death_in_NL%>%
  filter(Age = "Total", CausesOfDeath = c("Neoplasms", "CirculatorySystem"))+
  ggplot(aes(x = Sex, y = Deaths, fill = Sex))+
  geom_jitter(show.legend = FALSE, alpha = 0.7, shape = 21, size = 2, width = 0.5)+
  stat_summary(fun.data = "mean_se", show.legend = FALSE)+
  scale_color_manual(values = c("#ef8a62", "#67a9cf"))+
  theme_classic()+
  labs(x = NULL, y = "Number of deceased per year in NL (1996 - 2021)")+
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 14),
        strip.background = element_blank(),
        strip.text = element_text(size = 14),
        strip.placement = "outside")+
  facet_wrap(~CausesOfDeath, strip.position = "bottom")
```

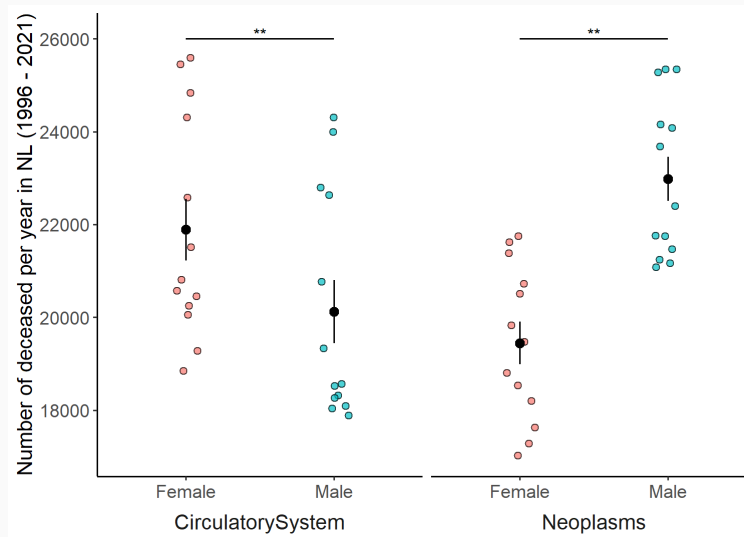


Are the differences significant?

```
##           Female
## Male 2.130499e-09
```


Showing significance levels

```
Death_in_NL%>%
  filter(Age == "Total", CausesOfDeath == c("Neoplasms", "CirculatorySystem"))
ggplot(aes(x = Sex, y = Deaths, fill = Sex))+
  geom_jitter(show.legend = FALSE, alpha = 0.7, shape = 21, size = 2, width = 0.5) +
  stat_summary(fun.data = "mean_se", show.legend = FALSE)+
  scale_color_manual(values = c("#ef8a62", "#67a9cf"))+
  theme_classic()+
  labs(x = NULL, y = "Number of deceased per year in NL (1996 - 2021)") +
  theme(axis.text = element_text(size = 12),
        title = element_text(size = 14),
        strip.background = element_blank(),
        strip.text = element_text(size = 14),
        strip.placement = "outside")+
  facet_wrap(~CausesOfDeath, strip.position = "bottom")+
  geom_line(data = tibble(x = c(1,2), y = c(26000, 26000)),
            aes(x=x, y = y), inherit.aes = FALSE)+
  geom_text(data = tibble(x = c(1.5), y = c(26100)),
            aes(x=x, y = y, label = "**"), inherit.aes = FALSE)
```

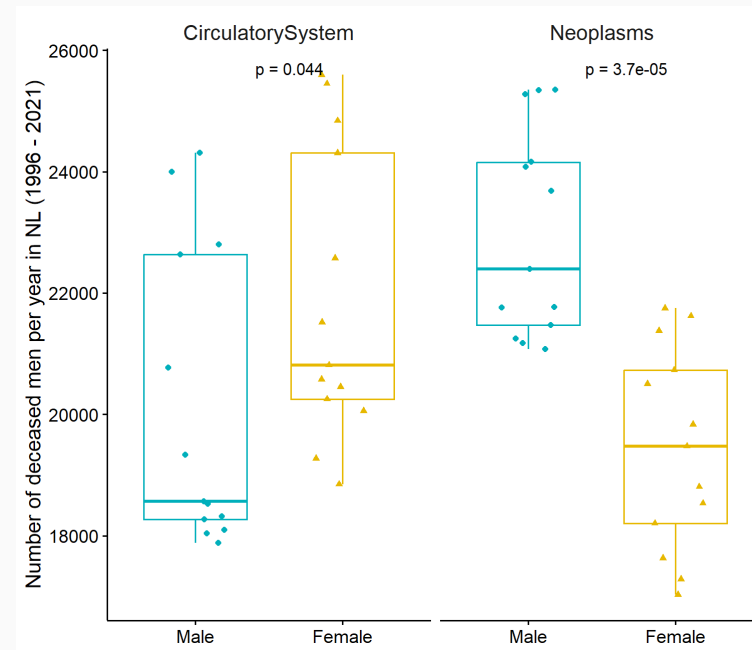


Vizualizing statistical data using ggpubr package

The `ggpubr` package provides some easy-to-use functions for creating and customizing 'ggplot2'- based publication ready plots.

```
library(ggpubr)
```

```
Death_in_NL%%  
  filter(Age = "Total", CausesOfDeath = c("Neoplasms", "CirculatorySystem"))  
  ggboxplot(x = "Sex", y = "Deaths",  
            color = "Sex", palette = c("#00AFBB", "#E7B800"),  
            add = "jitter", shape = "Sex")+  
  facet_wrap(~CausesOfDeath)+  
  stat_compare_means(label = "p.format", label.x = 1.5)+  
  labs(x = NULL, y = "Number of deceased men per year in NL (1996 - 2021)")  
  theme(axis.text = element_text(size = 12),  
        title = element_text(size = 14),  
        strip.background = element_blank(),  
        strip.text = element_text(size = 14))+  
  remove("legend")
```



Your turn

Part 1.

Using the `Death_in_NL` dataset, build the following two visualizations:

- 1) What is the age profile of the number of deaths from external causes (not a disease) in NL? Is there any difference between men and women?
 - 2) How has the number of perinatal deaths in the Netherlands changed over time?
- You will need this information to complete the quiz in the brightspace.

Part 2.

- Adjust the style and design of the plot making it visually appealing.

You will need these skills to finalize your project next week.

