SIMPLE MULTICRITERIA BAR BLOT IN R FOR MAPPING THE CONCENTRATION OF CONTAMINANTS IN INFLUENT AND EFFLUENT STREAMS OF WATEWATER TREATMENT PLANT WITH REGULATORY GUIDELINES

- Get libraries and packages

```
#libraries required for basic bar graph
library(ggplot2)
library(devtools)
library(dplyr)

```

- Data setup

```
#read csv function for reading the file from internet, usb or local drive
guidelines <- read.csv("/Volumes/Lexar/Lexar/EarthWorks/Wastewater Guidelines_coloured.csv", header=TRUE)

```

- View and summarise your data in console

```
#this the variable for the data file I am using. Typing the name will display the contents of the file
guidelines
```

```
> guidelines
  Parameter       X  Range Influent Effluent Guideline    Legend
1       BOD gBOD/m3 medium    312.0     12.0        30  Influent
2       COD gCOD/m3 medium    752.0     57.0        25  Effluent
3        SS  gSS/m3 medium    285.0     14.0        30 Guideline
4         P   gP/m3 medium     11.5      2.2         1
5       TKN   gN/m3 medium     62.5      9.0        11
> 
```

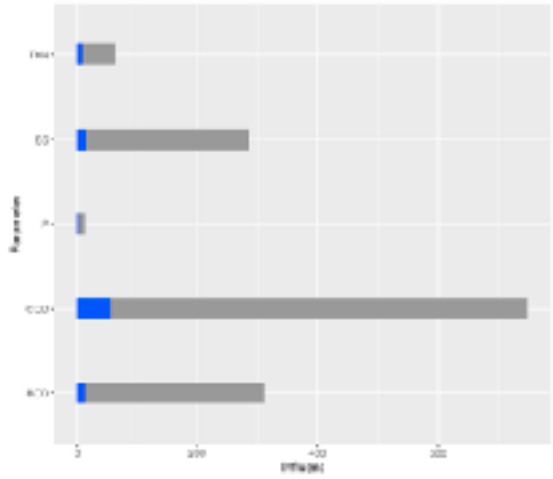
```
#a good practice to summarize your data. I learned this from video tutorials of data science gurus
summary(guidelines)

```

```
> summary(guidelines)
  Parameter             X                Range              Influent       Effluent       Guideline      Legend
 Length:5           Length:5           Length:5           Min.   : 11.5   Min.   : 2.20   Min.   : 1.8   Length:5
 Class :character   Class :character   Class :character   1st Qu.: 62.5   1st Qu.: 9.00   1st Qu.:11.0   Class :character
 Mode  :character   Mode  :character   Mode  :character   Median :265.0   Median :12.00   Median :25.0   Mode  :character
                                                          Mean   :283.5   Mean   :18.54   Mean   :19.4
                                                          3rd Qu.:410.0   3rd Qu.:14.00   3rd Qu.:30.0
                                                          Max.   :750.0   Max.   :57.00   Max.   :38.0
>
```

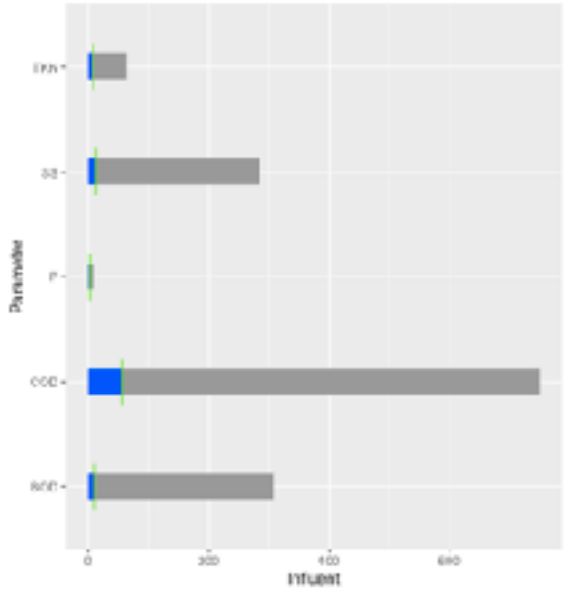
- geom_bars (the fun part)
    - The grey bar is the concentration of contaminants in influent wastewater
    - Blue bar is the concentration of contaminant in effluent wastewater

```
15  #ggplot function (your_data, aes(x parameter, y parameter))
16  ggplot(guidelines, aes(Influent, Parameter))+
17
18    #geom_bar(stat, fill and width of the bar) --- [this is the bar plot based on the x and y defined above]
19    geom_bar(stat="identity", fill="Grey60", width = 0.25)+
20
21    #geom_bar(your parameter of choice, stat, fill and width of the bar)
22    geom_bar(aes(Effluent),stat="identity", fill="blue", width = 0.25)+
23
```



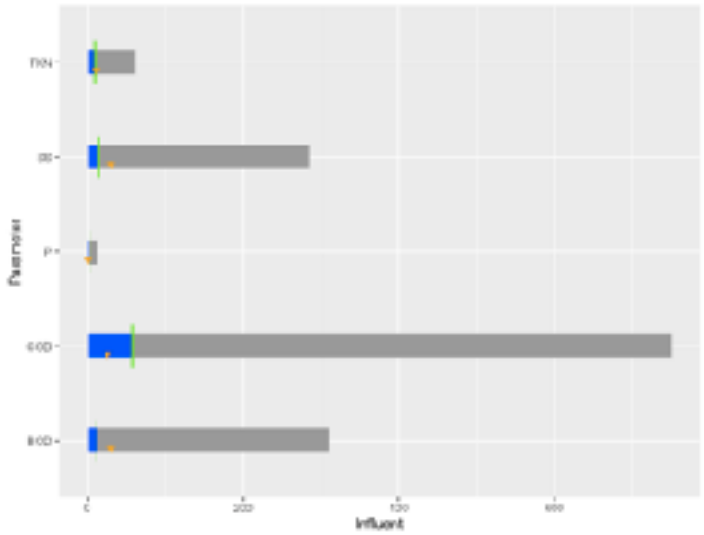
- geom_errorbar (more fun)

```
#geom_errorbar(your parameter of choice(x, ymin, ymax), width, color and size) --- [very cool! adds a line at the end of your bar]
geom_errorbar(aes(x=Effluent, ymin=Parameter, ymax=Parameter),width=1.5, color='green',size=13)+
```



- geom_point
  - The value of guideline standards set by the wastewater effluent regulations

```
#geom_point(aesthetics, color, fill, size, shape(number 25 for the upside down triangle), nudge to find the spot)
geom_point(aes(Guideline),color="orange", fill="orange", size=1.5, shape=25, position = position_nudge(y=-0.083))+
```

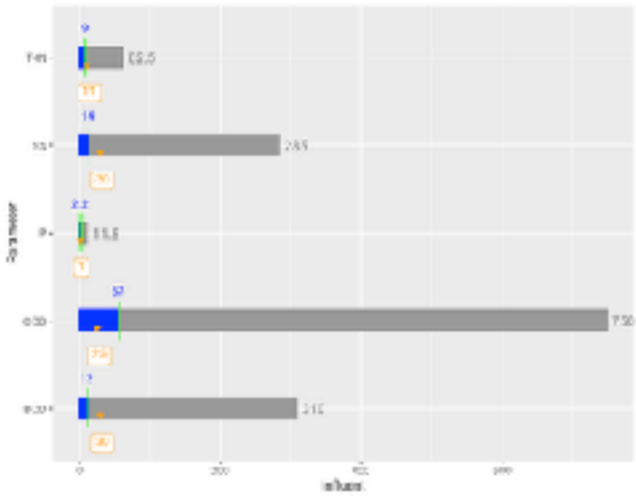


- geom_text
  - Label for the numerical values for influent, effluent and guidelines

```
#geom_text to get the values for the parameters on the panel
geom_text(data=guidelines, aes(label=Influent, x=Influent), stat="identity", position=position_dodge(width=0.9),size=4,hjust=-0.2,color="Grey60",fontface='bold')+
geom_text(data=guidelines, aes(label=Effluent, x=Effluent), stat="identity", position=position_dodge(width=0.9), size=3.5, hjust=0.6,vjust=-2., color="blue")+

#I used geom_label here to make the numbers stand out from the grid background (parse for bold fonts did not return bold fonts???)
geom_label(data=guidelines, aes(label=Guideline, x=Guideline), stat="identity", position=position_dodge(width=0.9), parse = TRUE, size=3.6, hjust=0.4,vjust=2.2, color="orange")+

```



- Labels on x and y axis

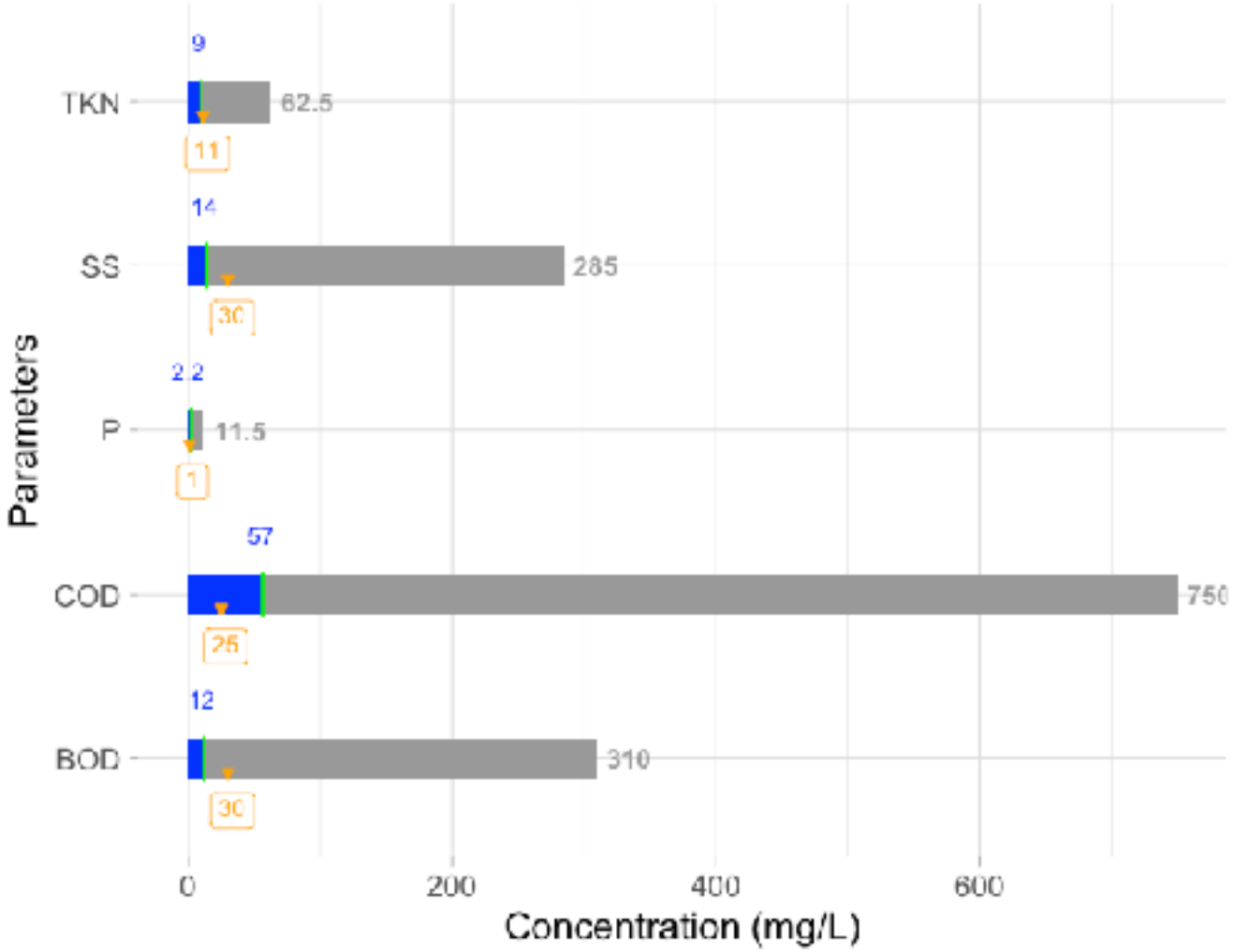
```
#I use this function to modify headers for the x and y axis (saves the hassle of adding extra lines)
scale_x_continuous("Concentration (mg/L)")+
#use continuous if your y axis is also numerical
scale_y_discrete("Parameters")+

```

- themes that you want

```
#here you can change the theme
theme(
  axis.text= element_text(color = 'black',family='serif'),
  panel.background = element_line(color = "grey95")
)+

theme_light(base_rect_size = 0, base_size = 16)
```



References

Godin, D., C. Bouchard, and P.A. Vanrolleghem. "LCA of wastewater treatment systems: Introducing a net environmental benefit approach." *Watermatex 2011: Conference Proceedings.* Watermatex, 2011.

SOR/2012-139. *Wastewater Systems Effluent Regulations.* Minister of Justice, 2020.