Visualizations

Irfan Emrah Kanat, Arianna Sammarchi

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R has long been known for its extensive visualization capabilities. The number of packages that handle visualizations are many, yet ggplot shines among them all. Today I will focus on ggplot and discuss plotting histograms and scatter plots with qplot. I will focus mostly on qplot() function, and discuss ggplot structure only briefly.

Introducing the Dataset

In this document we will analyze the Motor Trends data. The dataset was compiled from 1974 issues of Motor Trends magazine and is included with R Base package.

Let us start with loading the dataset.

```
data(mtcars)
```

As we learned in the section on packages, you can querry the documentation for almost anything. Including the datasets included in packages. The document includes descriptions of the variables.

```
?mtcars
```

Let us get a sense of the data.

```
# A summary of variables
summary(mtcars)
```

```
##       mpg             cyl             disp             hp       
##  Min.   :10.40   Min.   :4.000   Min.   : 71.1   Min.   : 52.0  
##  1st Qu.:15.43   1st Qu.:4.000   1st Qu.:120.8   1st Qu.: 96.5  
##  Median :19.20   Median :6.000   Median :196.3   Median :123.0  
##  Mean   :20.09   Mean   :6.188   Mean   :230.7   Mean   :146.7  
##  3rd Qu.:22.80   3rd Qu.:8.000   3rd Qu.:326.0   3rd Qu.:180.0  
##  Max.   :33.90   Max.   :8.000   Max.   :472.0   Max.   :335.0  
##       drat             wt             qsec             vs        
##  Min.   :2.760   Min.   :1.513   Min.   :14.50   Min.   :0.0000  
##  1st Qu.:3.080   1st Qu.:2.581   1st Qu.:16.89   1st Qu.:0.0000  
##  Median :3.695   Median :3.325   Median :17.71   Median :0.0000  
##  Mean   :3.597   Mean   :3.217   Mean   :17.85   Mean   :0.4375  
##  3rd Qu.:3.920   3rd Qu.:3.610   3rd Qu.:18.90   3rd Qu.:1.0000  
##  Max.   :4.930   Max.   :5.424   Max.   :22.90   Max.   :1.0000  
##        am              gear            carb      
##  Min.   :0.0000   Min.   :3.000   Min.   :1.000  
##  1st Qu.:0.0000   1st Qu.:3.000   1st Qu.:2.000  
##  Median :0.0000   Median :4.000   Median :2.000  
##  Mean   :0.4062   Mean   :3.688   Mean   :2.812  
##  3rd Qu.:1.0000   3rd Qu.:4.000   3rd Qu.:4.000  
##  Max.   :1.0000   Max.   :5.000   Max.   :8.000  
```

```
# Correlation table for first 4 variables (due to space concerns)
cor(mtcars[,1:4])
```

```
##             mpg        cyl       disp         hp
## mpg   1.0000000 -0.8521620 -0.8475514 -0.7761684
## cyl  -0.8521620  1.0000000  0.9020329  0.8324475
## disp -0.8475514  0.9020329  1.0000000  0.7909486
## hp   -0.7761684  0.8324475  0.7909486  1.0000000
```

```
# bivariate comparisons of categorical variables
table(mtcars[,c("am","cyl")])
```

```
##    cyl
## am   4  6  8
##   0  3  4 12
##   1  8  3  2
```

```
# The histogram below should reflect these figures.
table(mtcars$gear)
```

```
##
##  3  4  5
## 15 12  5
```

Plotting with qplot()

Now we can get to the fun part. qplot simplifies the ggplot functionality by automating most common tasks. We will use qplot for most common plots.

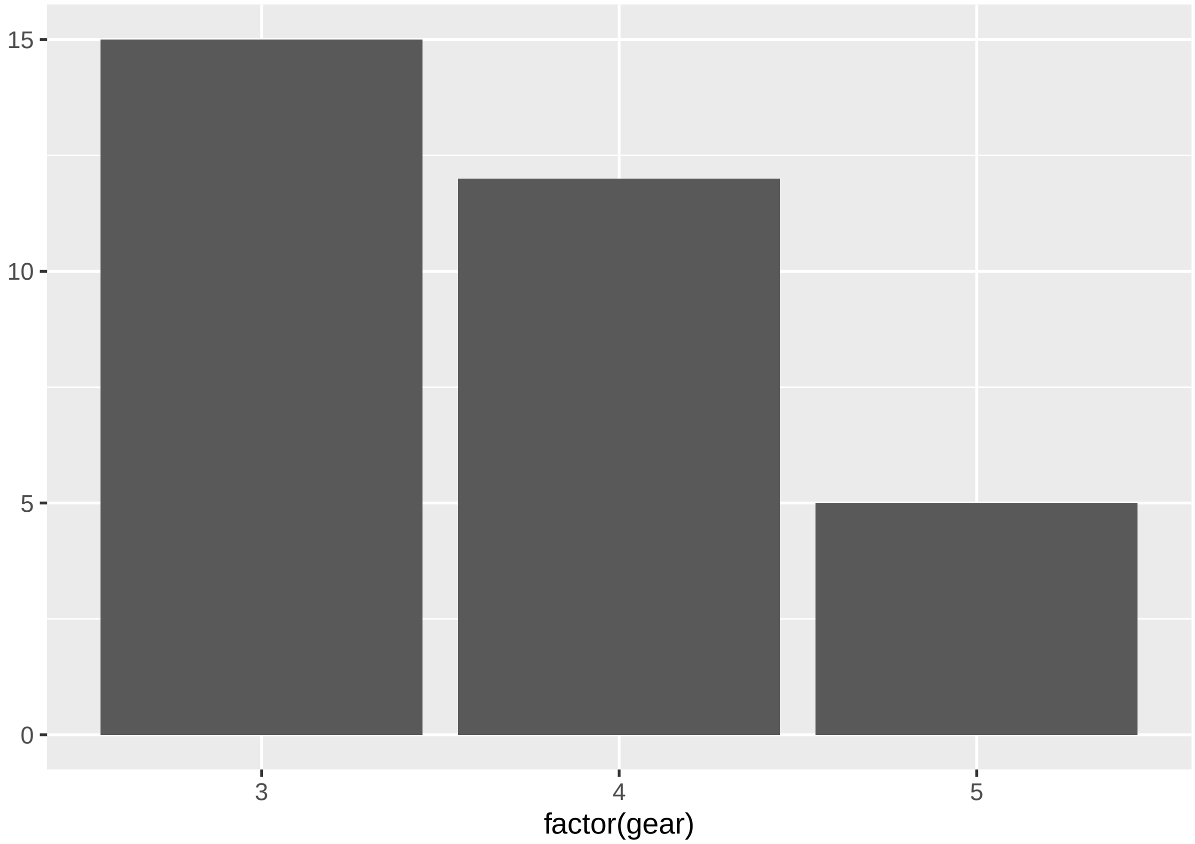
```
# Load the ggplot package
library(ggplot2)
# Review function syntax
?qplot
```

Histogram

You would use a histogram when you are interested in frequencies of certain categories, like number of people with different eye colors.

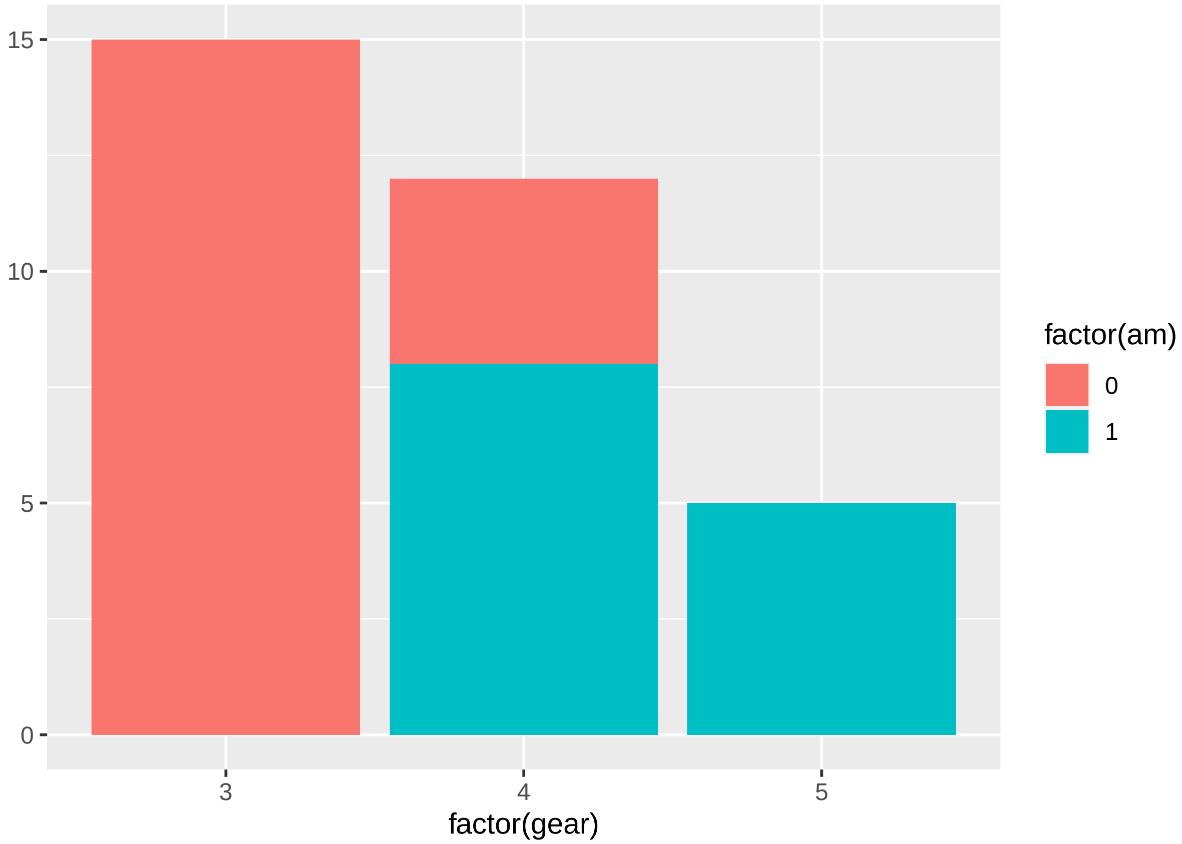
```
# Let us report the number of cars with differing number of front gears
qplot(factor(gear), data=mtcars, geom="bar") # used factor to declare categorical
```

```
## Warning: `qplot()` was deprecated in ggplot2 3.4.0.
```



If we want to get fancy and want to report across two categorical variables we can color the bars based on another variable.

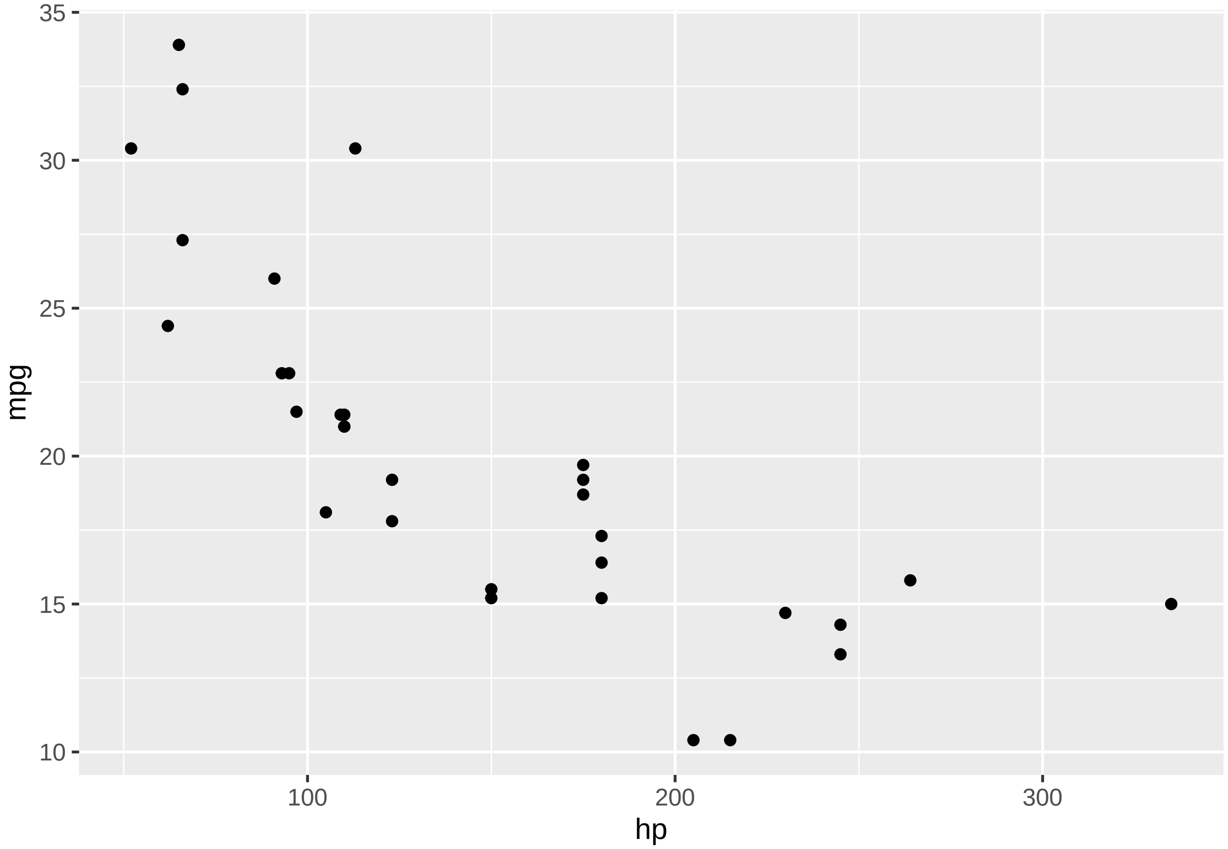
```
qplot(factor(gear), data=mtcars,  fill=factor(am), geom="bar") # used factor to declare categorical
```



Scatter Plots

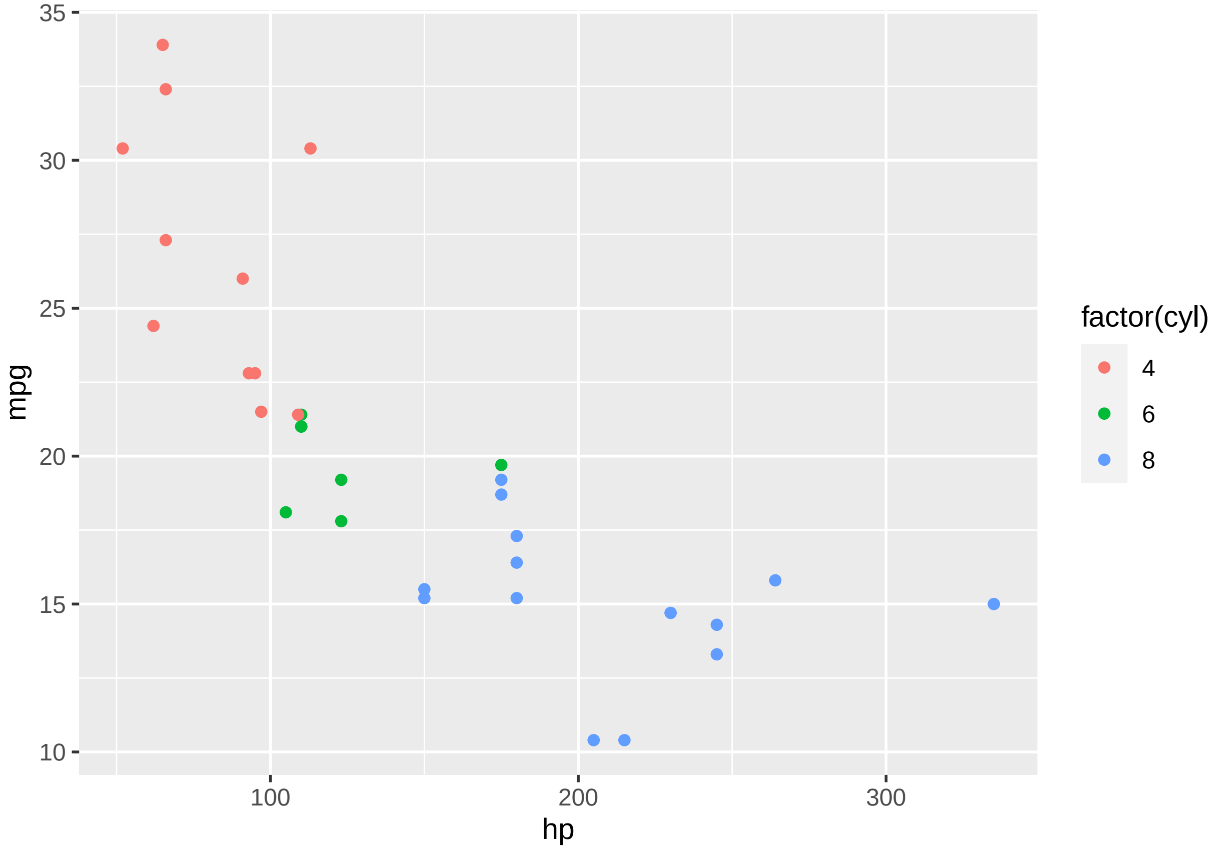
If you are interested in the relationship between two continuous variables, you can use scatter plots.

```
qplot(hp, mpg, data=mtcars)
```



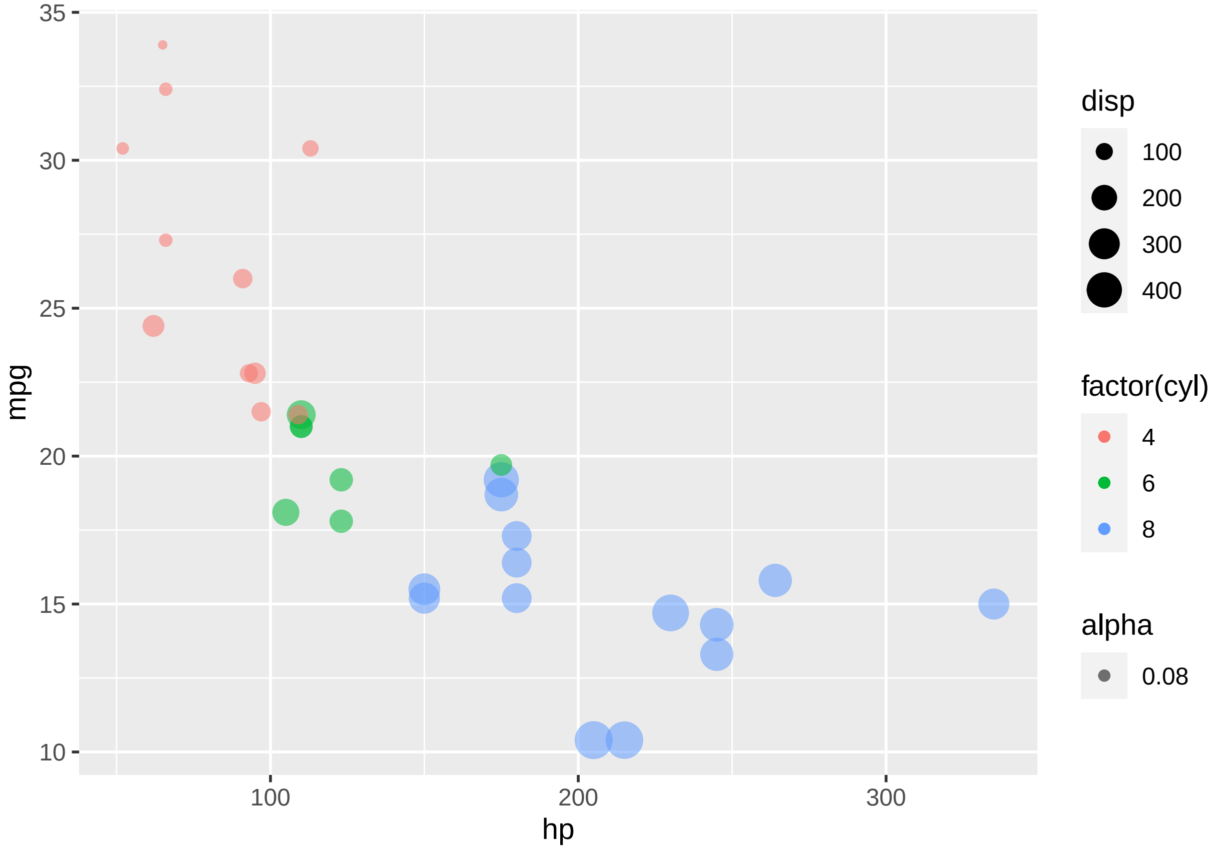
Let us impose an additional factor into the plot. Let us color the dots by the number of cylinders.

```
qplot(hp, mpg, data=mtcars, color=factor(cyl))
```



Size of dots dependent on a continuous variable (displacement).

```
qplot(hp, mpg, data=mtcars, color=factor(cyl), size=disp, alpha=.08)
```

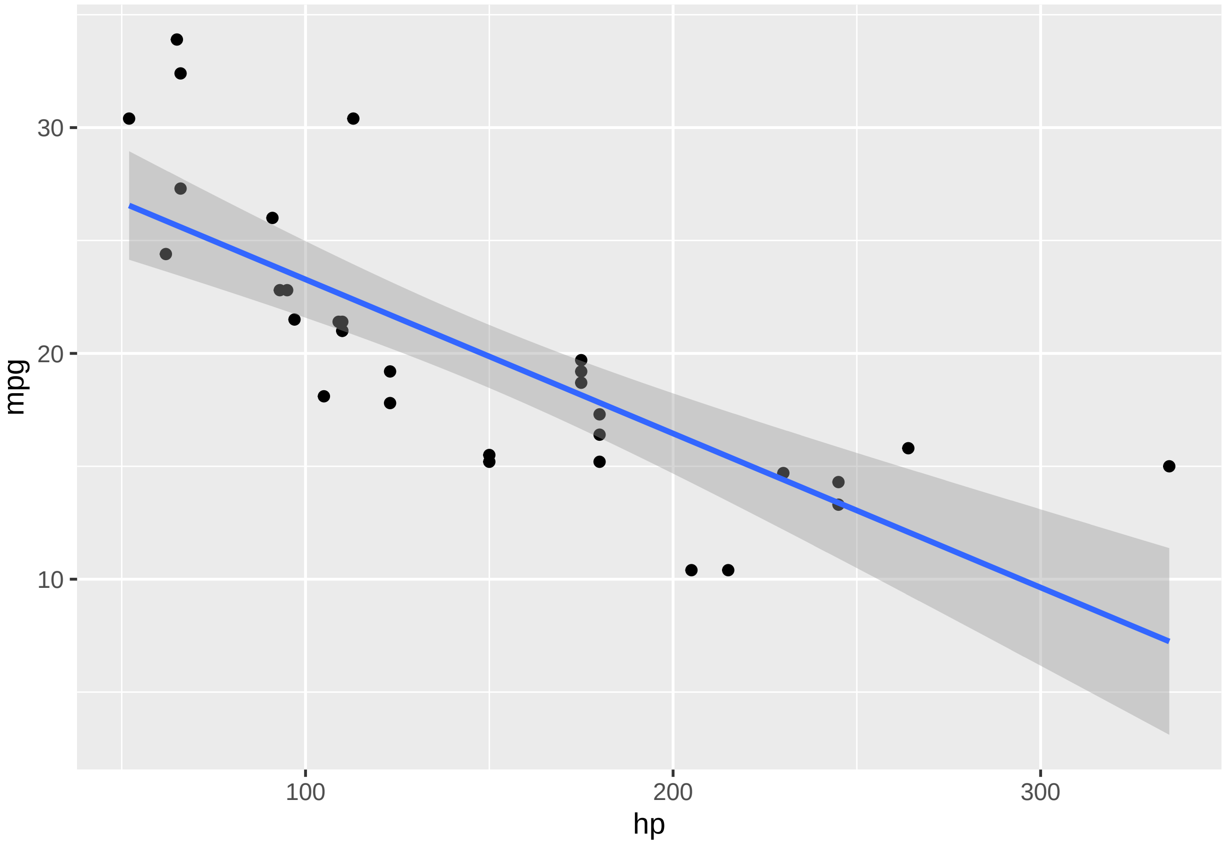


Let us fit a regression line. This is where things start to get a bit ggplotty.

```
qplot(hp, mpg, data=mtcars) +
  geom_smooth(method=lm, sd=F)
```

```
## Warning in geom_smooth(method = lm, sd = F): Ignoring unknown parameters: `sd`
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

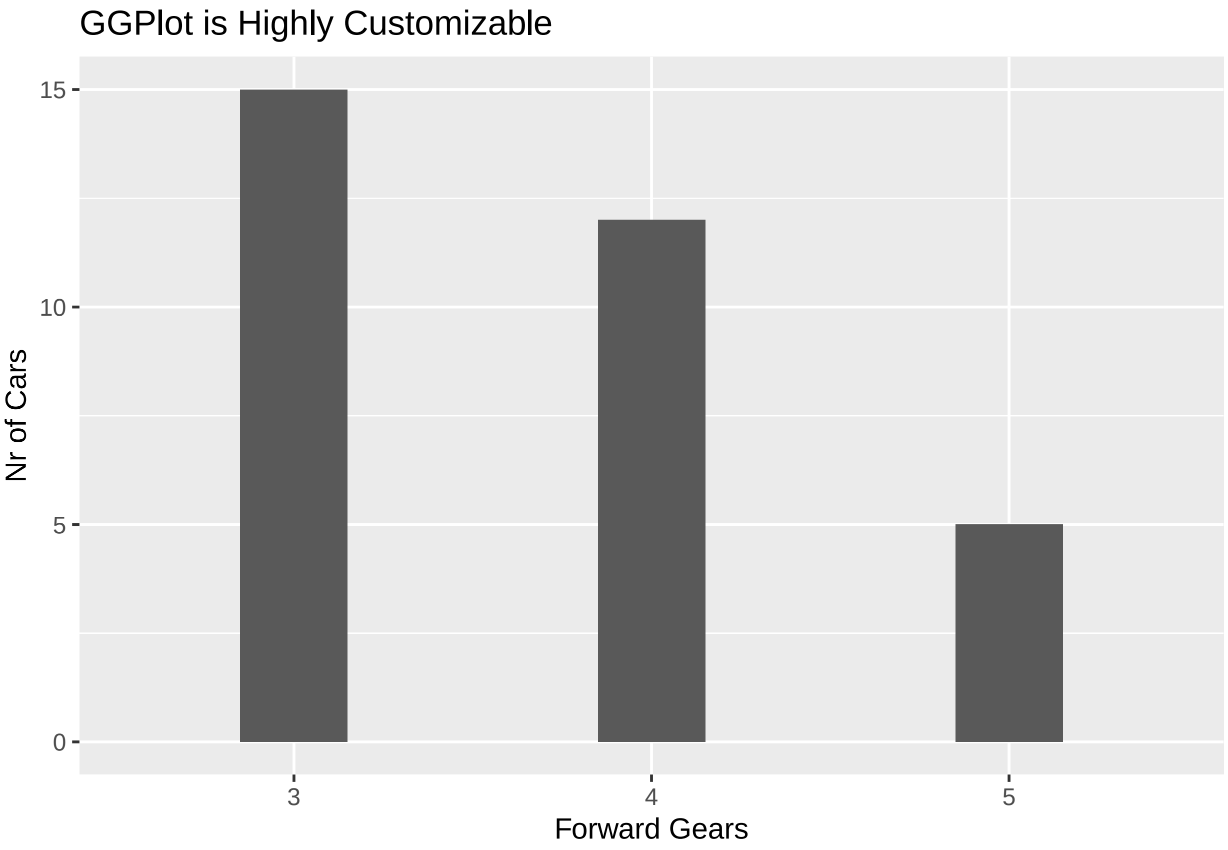


ggplot

qplot provides a convenient command for plotting. While qplot would address 90% of your plotting needs. ggplot is way more than qplot, it is almost a different language just for plotting. The intricacies may be hard to learn and is clearly beyond the scope of this workshop. I am providing ggplot code below to achieve the same results as the qplot, so the attendees can get a sense of what ggplot is really about.

Histogram

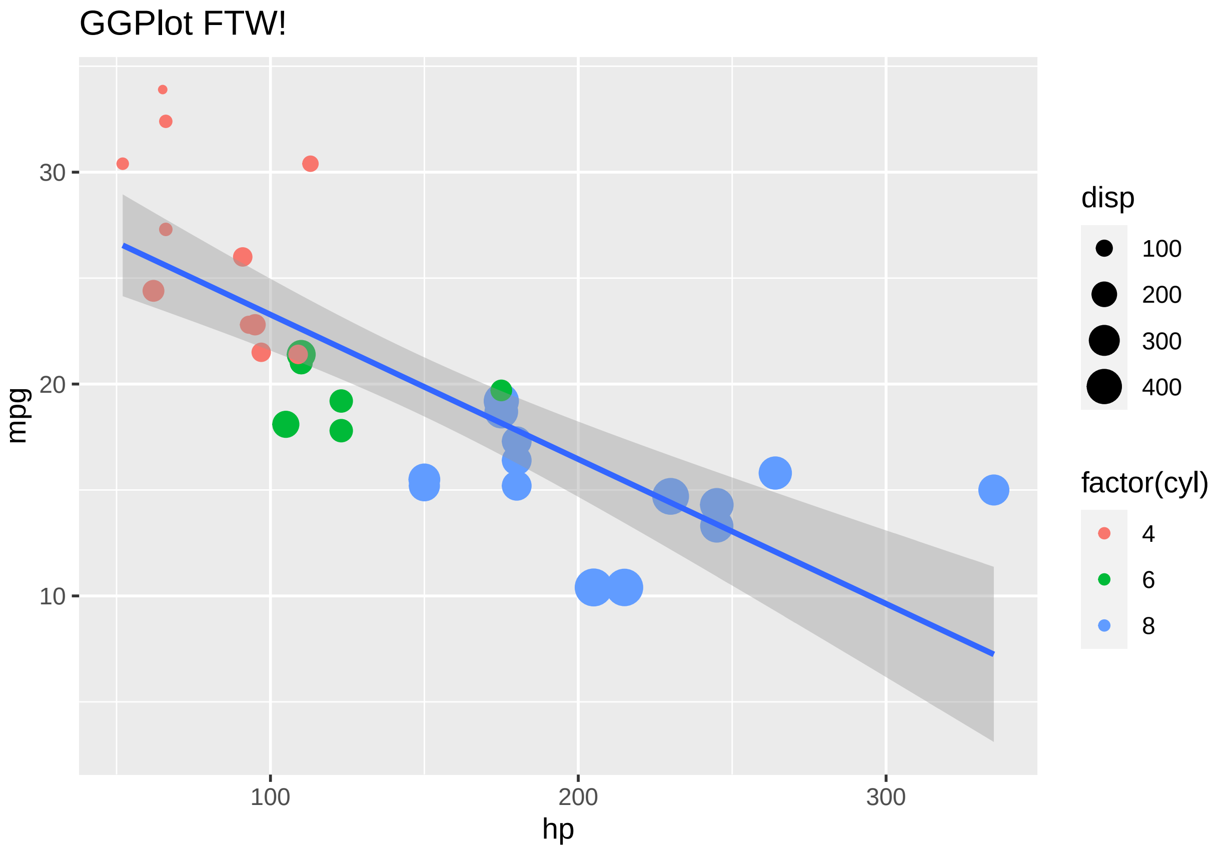
```
# Initialize the plot with variables of interest
ggplot(mtcars, aes(factor(gear))) +
# Instruct ggplot to plot bars of width .3
  geom_bar(stat = "count", width=0.3) +
  ggtitle('GGPlot is Highly Customizable') +
  xlab('Forward Gears') +
  ylab('Nr of Cars')
```



Scatter Plot

```
ggplot(mtcars, aes(x=hp, y=mpg)) +
  geom_point(aes(color=factor(cyl), size=disp)) + # For scatter plot
    geom_smooth(method=lm) + # Add a regression line
  ggtitle('GGPlot FTW!') # Add a title
```

```
## `geom_smooth()` using formula = 'y ~ x'
```

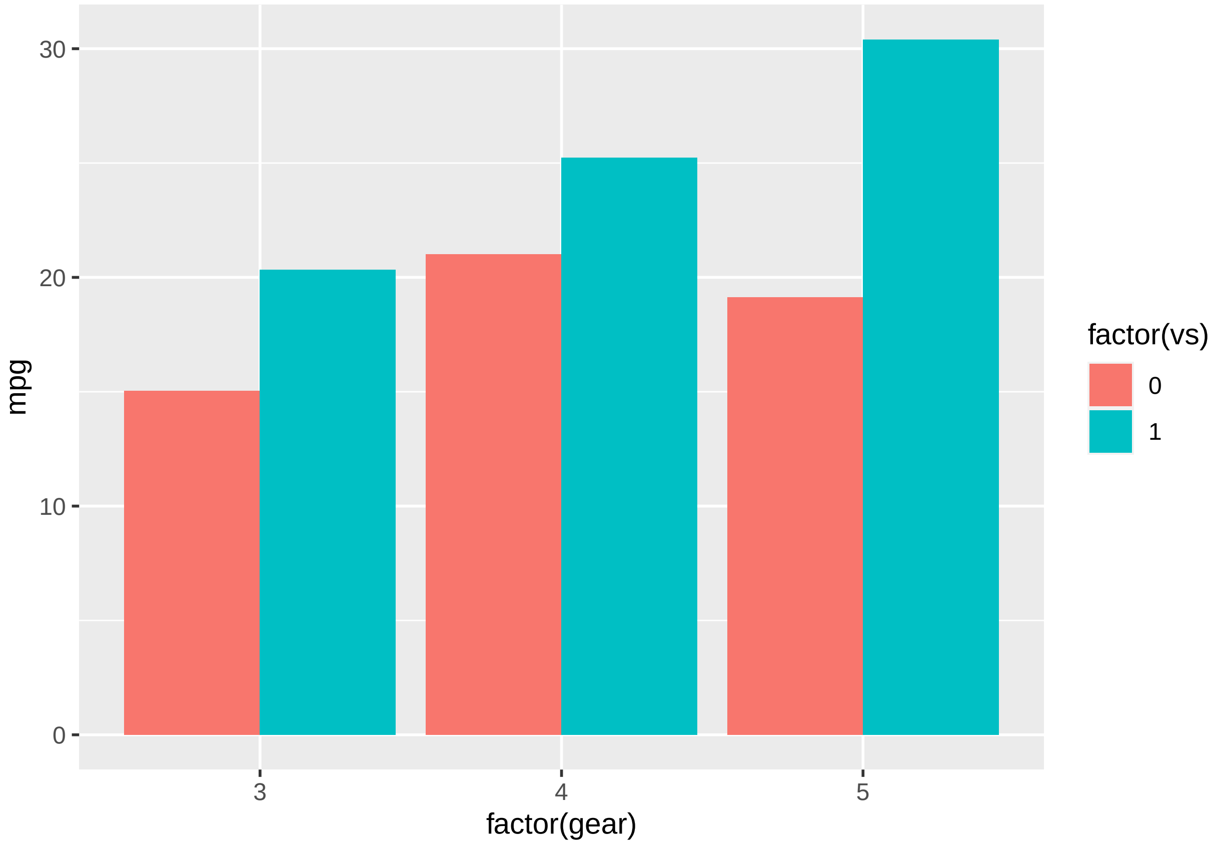


Bar Charts

You use bar charts when you want to visualize the relationship of a continuous variable over a categorical variable (eg. gender-height). Here I plot mean mpg over two categorical variables.

```
ggplot(mtcars,aes(x=factor(gear),y=mpg,fill=factor(vs)), color=factor(vs)) +
  stat_summary(fun.y=mean, position=position_dodge(), geom="bar")
```

```
## Warning: The `fun.y` argument of `stat_summary()` is deprecated as of ggplot2 3.3.0.
## i Please use the `fun` argument instead.
```



Bonus! World Map Visualizations

After having mingled that GDP data so much, I could not help but plot the results on a map. Here is how:

Process data into a map.

```
# Load the Library
library(rworldmap) # Install if necessary
```

```
## Loading required package: sp

## ### Welcome to rworldmap ###

## For a short introduction type :   vignette('rworldmap')
```

```
# Get the dataset
cData_Long<-read.csv("cDataLong.csv")
# Subset
cDataL2011 <- subset(cData_Long, time==2011)
# Get a taste
head(cDataL2011)
```

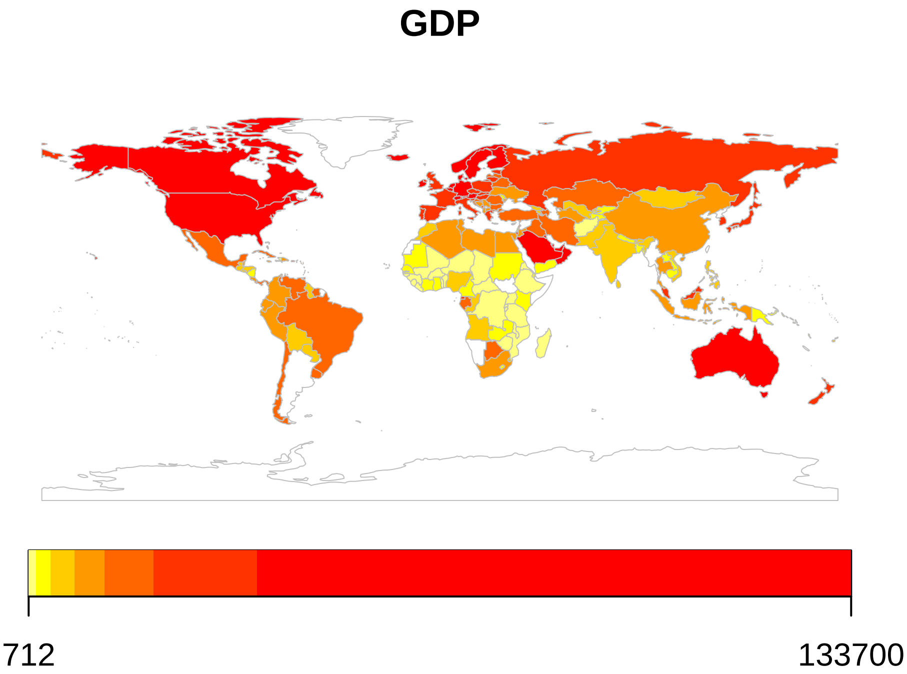
```
##    ISO2 Continent time       GDP    logGDP    cumGDP    lagGDP
## 9    AE        AS 2011 56376.770 10.939812 754381.32 57379.972
## 19   AF        AS 2011  1695.153  7.435529  11970.69  1637.297
## 29   AG        AN 2011 19987.924  9.902884 200080.43 20567.359
## 39   AL        EU 2011  9897.180  9.200005  73030.75  9559.157
## 49   AM        AS 2011  6812.352  8.826493  54071.70  6507.914
## 59   AO        AF 2011  7094.084  8.867017  52753.28  7047.052
```

```
# Turn into map
cDataL2011<- joinCountryData2Map(cDataL2011, joinCode = "ISO2",
                                 nameJoinColumn = 'ISO2')
```

```
## 187 codes from your data successfully matched countries in the map
## 0 codes from your data failed to match with a country code in the map
## 54 codes from the map weren't represented in your data
```

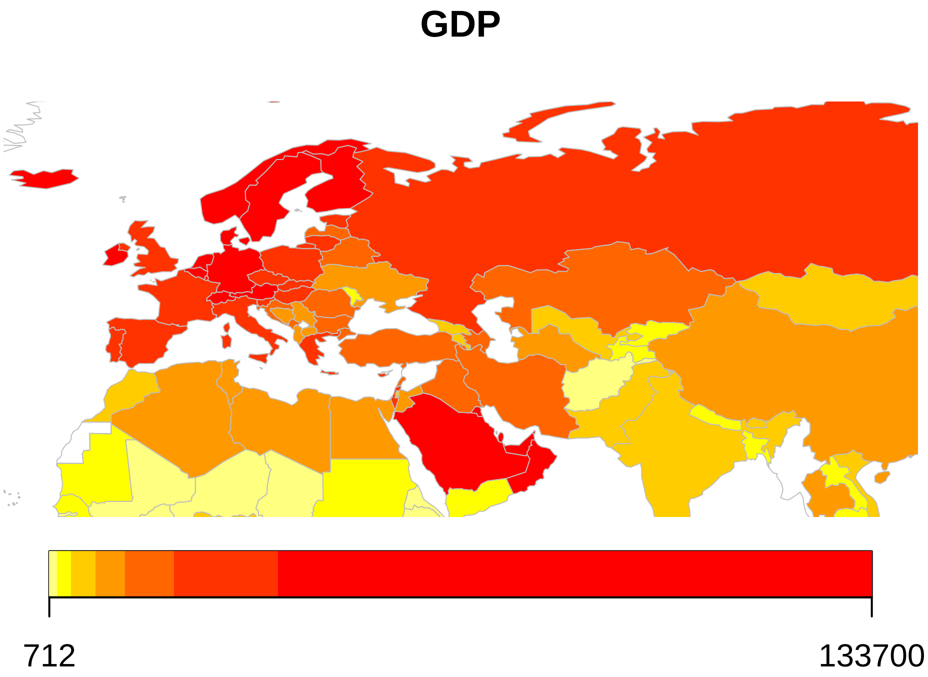
Plot the world map.

```
mapCountryData(cDataL2011, nameColumnToPlot = "GDP")
```



Focus on Eurasia.

```
mapCountryData(cDataL2011, nameColumnToPlot = "GDP", mapRegion = "eurasia")
```



Plot a categorical variable as color and continuous as size.

```
mapDevice() # Initialize the map
mapBubbles(dF=cDataL2011, nameZSize="GDP", nameZColour="Continent", colourPalette="rainbow", oceanCol="
```

caret and Visualizations

We will cover caret a little in machine learning samples. This package provides convenient shortcuts to ggplot functionality. Simplifying most common plotting tasks in machine learning. Please refer to the project page for further reference.
