Introduction to R

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- Easy integration with GitHub and Latex
- Reproducable research(?)
- Imagine with one click your code analyzes your data and generates all the required tables & graphs, and finally generates a nice pdf/word document which you can send it to a journal. This can be done in R.

Installing R

- Download and install R from https://www.r-project.org/
- User interface of just R is very bad. So we need to install R Studio. There are alternative to R-Studio like Emacs etc. You can also try them.
- Download and install R-Studio from https://www.rstudio.com/. Free version is good enough.
- R-studio runs on top of R. R-studio relies on R to execute all the commands. R-studio cannot function without R.
- Don't change the order of installation. First R and then R-Studio. Otherwise sometime it can create problems.
- Try this in console and check output to see if RStudio working

```
1+2
```

```
[1] 3
```

Optional - Git -1

Have you ever been frustated seeing files named Final_Version, New_Final_Version . . . .? Have you ever wondered what is the difference between Version_1 and Version_2?

Then what you need is a version control system. Git is a popular version control system. Luckily R-Studio has very good interface with Git and GitHub.

Once again Git is open source and free. One can download Git from https://git-scm.com/.

Git Clients : Git $\sim$ RStudio : R. There several Git clients out there. You may use any of them (Sourcetree, GitUp, GitHub etc).

Rstudio does most of the basic stuff a Git clients does. Did I forget to say RStudio has good interface with Git?

Optional - Git -2

Also create GitHub account so you can store your code online. Private repository facility is free if you register with IIM Cal id. GO through the steps after installing Git.

Step 1 - Open Git Bash app and type the following commands

git config –global user.name ‘abcd efgh’
git config –global user.email ‘abcdexy@email.iimcal.ac.in’
git config –global –list

Step 2 - Go to GitHub.com and create a new repository. Choose default options. Open your repository to find readme.md file. Press “clone or download” button on top right corner and copy the url.

Step 3 - Open Rstudio >File >New Project >Version Control >Git . Paste the above url and choose the folder you want to install the project in. A new folder with repository name will be created.

Optional - Git -3

Step 4 - Open the readme.md file. Make some changes and save it. In your Git pane in Rstudio (beside Environment pane) select Readme.md and press commit. Type a commit message in new window and then press commit. Then press push (arrow up) to send the commit to GitHub. Open GitHub.com to find the changes reflected in Readme.md file there.

Use 'diff' in Git pane to see changes you have made since last commit. To revert to previous commits use the addin below the menu section in RStudio. Git is most useful when you are colaborating with your colleagues. You can copy the code from GitHub to your desktop

RStudio Basics

'Source' pane shows the scripts. For a new script : RStudio >File >New File >R Script

Script has .R extension. It is the place where you will write all your code. Select the code and press 'Run' option on top right corner to execute it. Shortcut: CTRL + ENTER

The 'Console' pane is where you will find the result of executing the code you have written in script. Always read the output in console especially if it is in **RED**

'Environment' pane is where you will find the datasets you have loaded into the memory.

'Files' pane contains the list of files in the current working directory

Intro to R

- Display current working directory and set current working directory

```
getwd()
setwd("G:/My Drive/Thesis/BGs")
```

- Installing Packages and Loading Packages. Need to install a library only once per computer but have to load it everytime you restart.

```
install.packages("data.table")
install.packages("tidyverse")
library(data.table)
library(tidyverse)
```

Variable names

- R is case sensitive. 'Data' is not same as 'data'.
- Names can have ' . ' (dot), '_', letters and numbers.
- A good coding convention is to always start with a letter.
- Press 'ALT + SHIFT + K' for list of Keyboard shortcuts
- whenever you find '+' in the console that implies R is waiting for you to complete your command. Try typing 1+ in console.
- Always use '<-' for assigning. '=' also works but sometimes it won't.
- Missing values in R are called 'NA'. The only way to do conditional tests is "is.na".

```
x =3; y=4; x==y
x =NA; y=NA; x==y
x <- c(1,2,3,4,5,6,NA); x>3; x<4
```

Column names

Finding Column names, renaming all column names and changing just one column name

```
colnames(var1)
colnames(var1) <- c("mpg", "cyl", "disp", "hp", "drat",
                    "wt", "qsec", "vs", "am", "gear1", "carb")
setnames(var1, "gear1", "gear")
```

Cleaning Environment and Console

- Removing a specific data set

```
rm(var1, var2)
```

- Removing all data sets

```
rm(list = ls())
```

- Clear Console

```
cat("\014")
```

Reading and writing files

```
var0 <- mtcars
write.csv(var0, file = "Output/data.csv")
write.table(var0, file = "Output/data1.txt", sep = "|")
data <- read.csv(file = "Output/data.csv", row.names = 1)
data1 <- read.table("Output/data1.txt",
                    header = TRUE, sep = "|")
data2 <- read.csv(file = "Output/data.csv")
download.file("https://www.nseindia.com/content/historical/EQU
              "NSE BhavCopy/cm30JUL2018bhav.csv.zip")
```

For better import funtions refer 'readr' package. Use 'readxl' package for reading Excel data sheets. Use 'haven' & 'foreign' packages for reading SAS, STATA and SPSS files.

Basic data operations

Most operations in data cleaning process fall into these categories

filter - selecting observations/rows
arrange - ordering the observations
select - selecting columns
mutate - creating new variables from existing ones
summarize - summary

The above five are functions in 'dplyr' package. 'dplyr' and a couple of other packages together are called 'tidyverse' which we already loaded.

dplyr - filter

Use '==' when its a test/question. Use '=' for assigning/informing. We use '==' below because we want to ask "if gear = 4 then select" which is a test.

```
mtcars1 <- filter(mtcars, gear == 4, cyl == 6)
mtcars2 <- filter(mtcars, gear == 4 & cyl == 6) # =mtcars1
mtcars3 <- filter(mtcars, gear == 4 | cyl == 6) #OR operator
mtcars4 <- filter(mtcars, gear == 4 | gear == 6)
mtcars5 <- filter(mtcars, gear %in% c(4,6)) # =mtcars4
```

All 'dplyr operations dont affect the original dataset. mtcars still has 32 observations. Try 'mtcars' on the left side of the above equation. Common operators recognized in R - ">, <, >=, <=, != (not equal) and =="

dplyr - Arrange and select

Similar to filter(), first input to arrange() is dataset name followed by column names for sorting. use desc() for descing order.

```
arrange(mtcars, mpg, desc(cyl))
```

Selecting columns uses select() function which is similar to arrange() and filter() functions

```
select(mtcars, mpg, cyl)
select(mtcars, -mpg)
select(mtcars, vs, everything()) #rearranging
```

dplyr - creating variables

Similarly use 'mutate' for creating new variables

```
mutate(mtcars, mpg_per_hp = mpg/hp, mpg_per_wt = mpg/wt,
       mpg_per_wt1 = mpg_per_hp*hp/wt)
transmutate(mtcars, mpg_per_hp = mpg/hp, mpg_per_wt = mpg/wt,
       mpg_per_wt1 = mpg_per_hp*hp/wt)
```

You can use the following operators in mutate - '+, -, /, *, ^, %% (reminder e.g. - 5 %% 2 =1), %/% (e.g. - 5 %/% 2 = 2), sum(), cumsum(), prod()

dplyr - summarize() and Pipes

```
by_gear <- group_by(mtcars, gear, carb)
summarise(by_gear, mean_milage = mean(mpg))
```

Pipes are very useful to write good looking code. The most used Pipe is %>%. Pipes also reduce the need to save intermediaries.

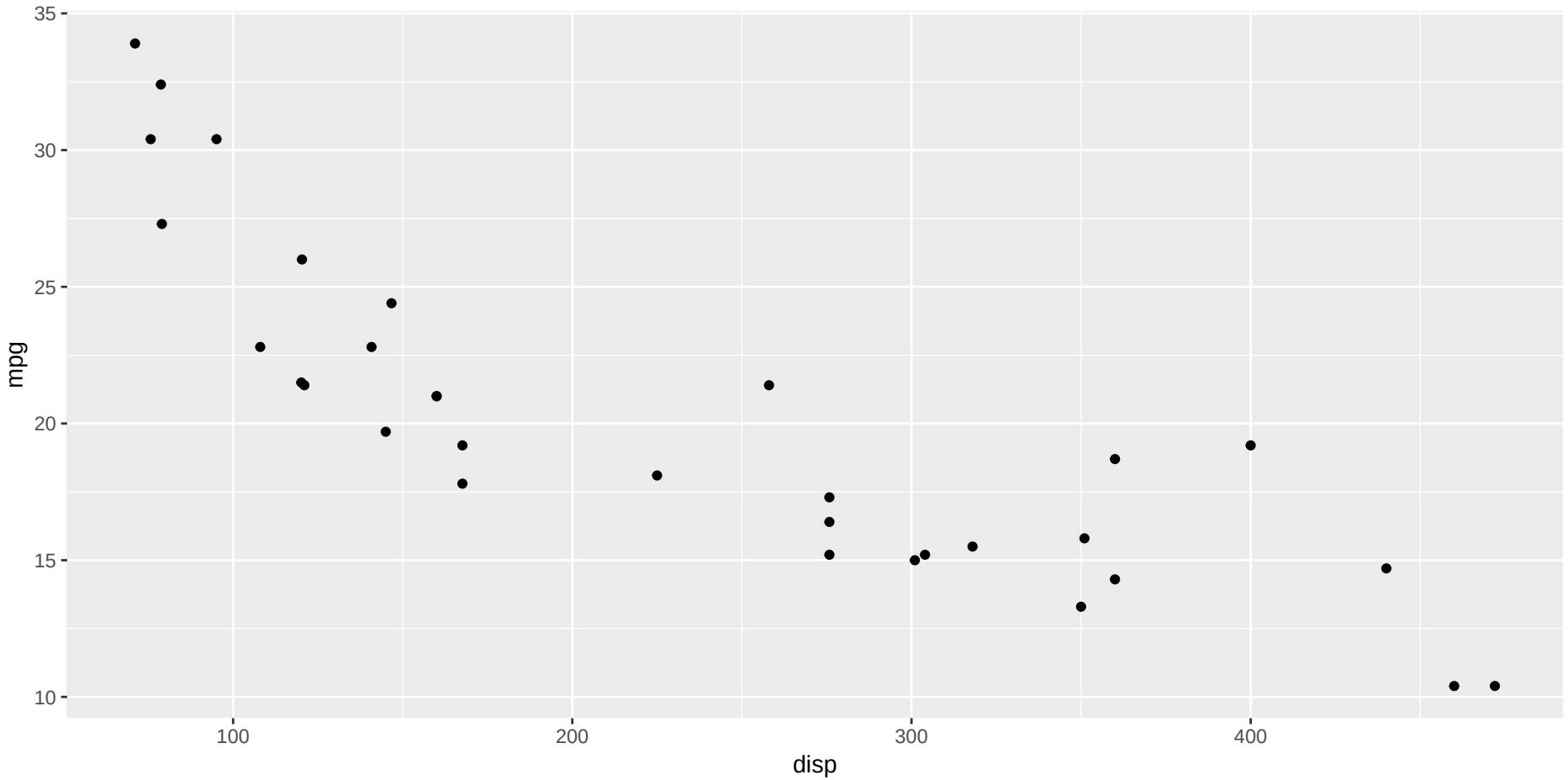
x %>% f(y) is equvalent to f(x,y). Above example can be rewritten as. . .

```
mtcars %>% group_by(gear, carb) %>%
  summarise(mean_milage = mean(mpg))
```

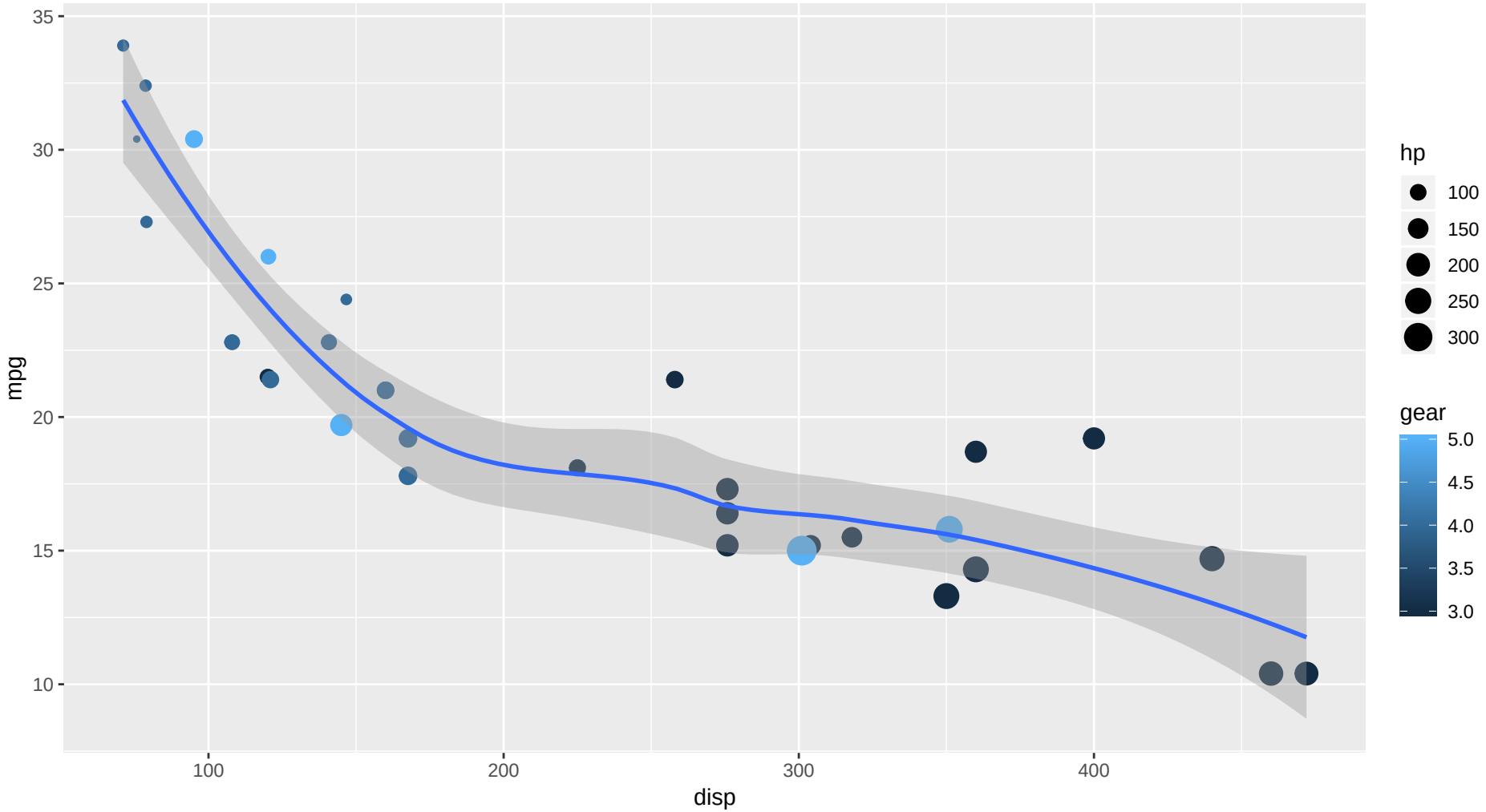
```
ungroup(mtcars)
```

ggplot

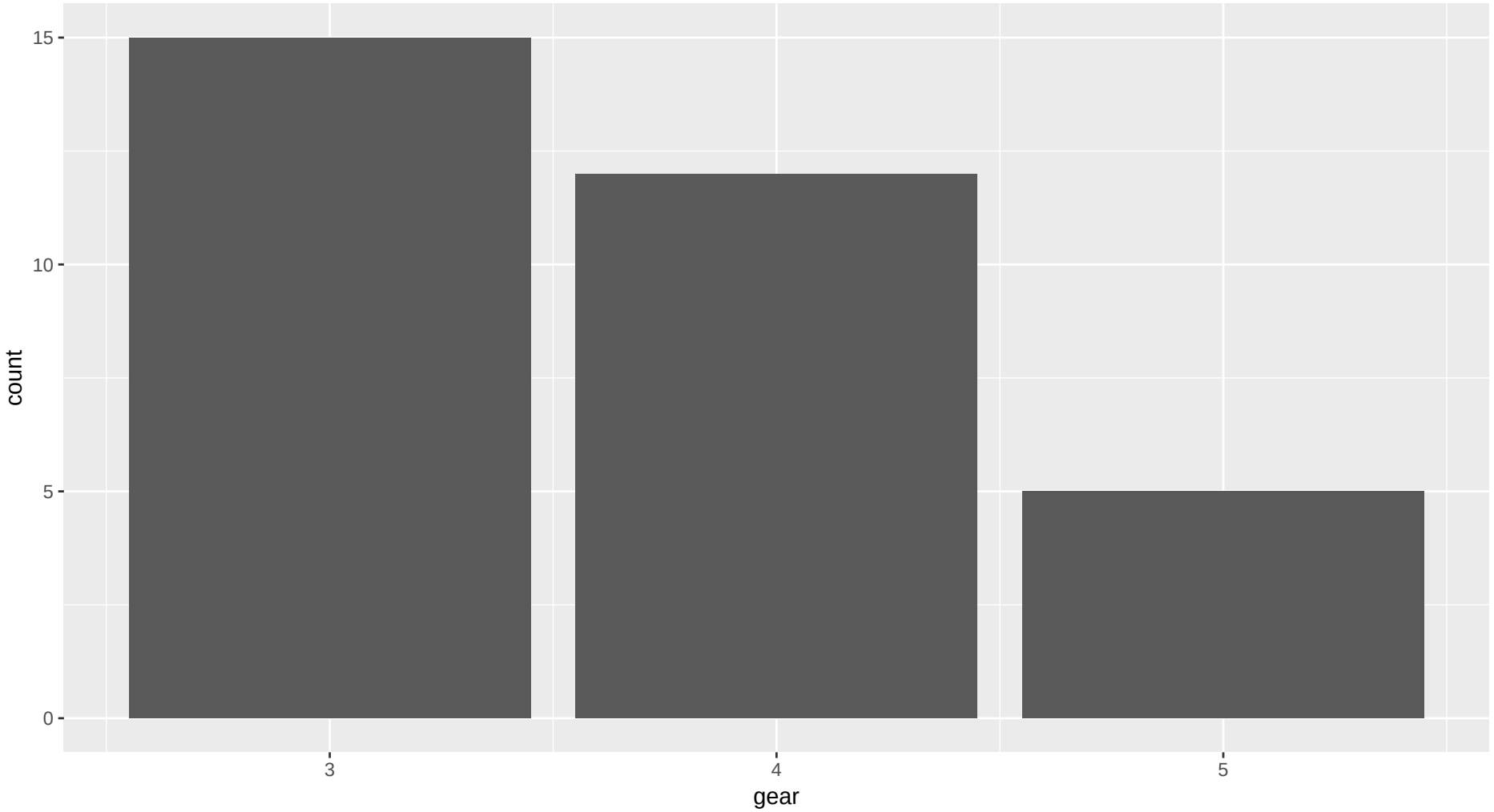
```
ggplot(mtcars ) + geom_point(aes(x= disp, y = mpg))
```



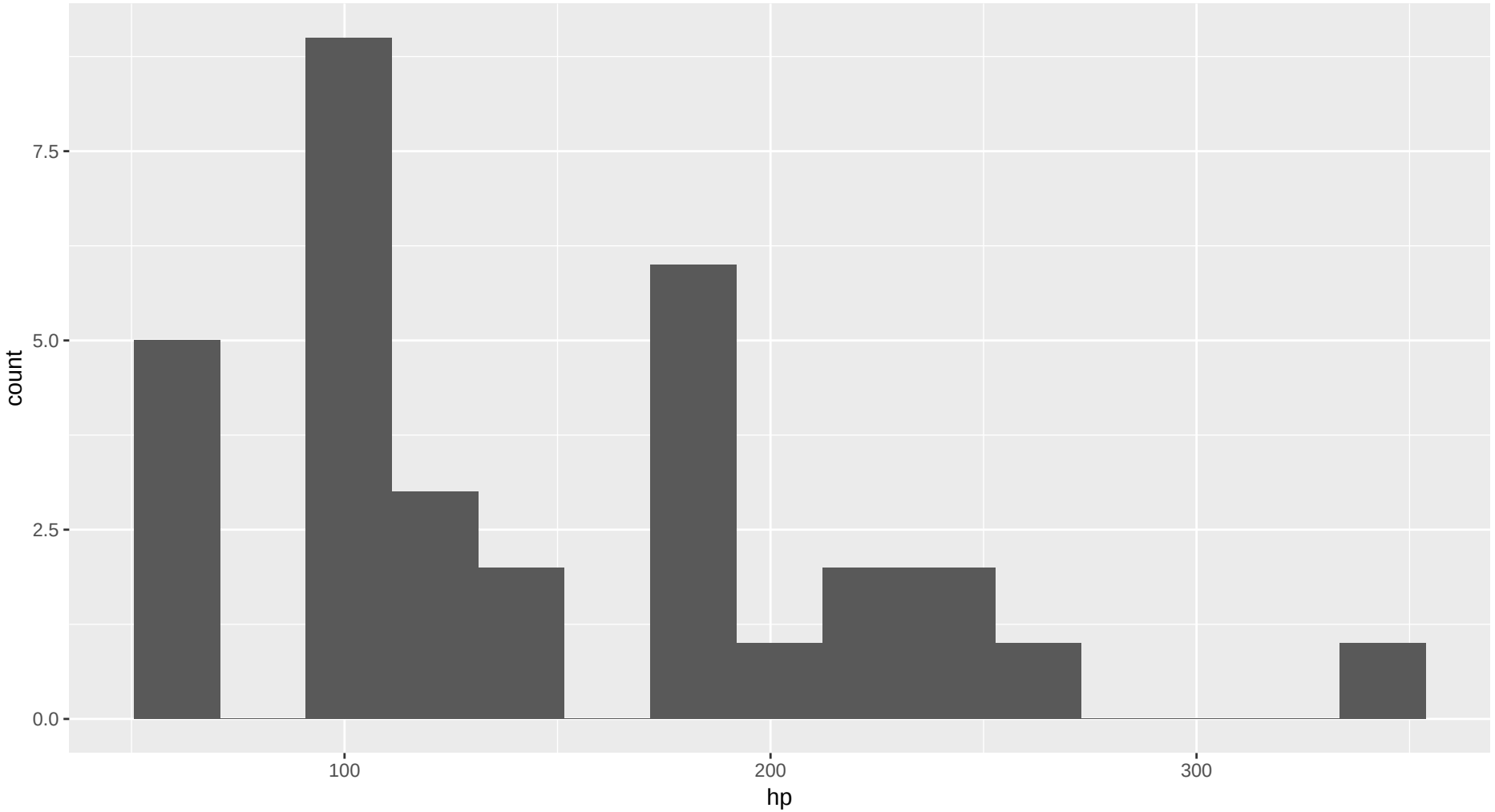
```
ggplot(mtcars, aes(x= disp, y = mpg))+geom_point(aes(
  size = hp,color = gear)) + geom_smooth()
```



```
ggplot(mtcars)+ geom_bar(mapping = aes(x = gear))
```



```
ggplot(mtcars)+ geom_histogram(mapping=aes(x=hp),bins=15)
```



Transforming data (tidyr package) - creating dataset

```
data <- data.frame(alpha = rep(LETTERS[1:3], 2),
name = sort(rep(c("bobbur","abhi"),3)), year=2011:2016)
```

```
  alpha   name year
1     A   abhi 2011
2     B   abhi 2012
3     C   abhi 2013
4     A bobbur 2014
5     B bobbur 2015
6     C bobbur 2016
```

Transforming data - spread()

```
spread(data, key = name, value = year)
```

```
  alpha abhi bobbur
1     A 2011   2014
2     B 2012   2015
3     C 2013   2016
```

Transforming data - gather()

```
gather(data, abhi, bobbur, key = name, value = year)
```

```
  alpha    name year
1     A    abhi 2011
2     B    abhi 2012
3     C    abhi 2013
4     A bobbur 2014
5     B bobbur 2015
6     C bobbur 2016
```

Others - Joining datasets - rbind

```
data1 <- data
data1$year <- data1$year + 1000
data2 <- rbind(data, data1)
head(data2,8)
```

```
  alpha   name year
1     A   abhi 2011
2     B   abhi 2012
3     C   abhi 2013
4     A bobbur 2014
5     B bobbur 2015
6     C bobbur 2016
7     A   abhi 3011
8     B   abhi 3012
```

Joining datasets - merge

```
merge(data,data1, by = c("alpha","name"))
```

```
  alpha    name year.x year.y
1     A    abhi   2011   3011
2     A  bobbur   2014   3014
3     B    abhi   2012   3012
4     B  bobbur   2015   3015
5     C    abhi   2013   3013
6     C  bobbur   2016   3016
```

IF ELSE, IFELSE and for loops

```
x=2
if(x==1){print("hello World") } else if(x==2)
  {print("hello!")} else {print("!")}
data1$dummy <- ifelse(data1$year>3012, 1, 0)
for (i in 1:nrow(data1)){data1$dummy1[i] <-
                          data1$dummy[i]+1 }
data1$name <- NULL
```

```
[1] "hello!"
```

```
  alpha year dummy dummy1
1     A 3011     0      1
2     B 3012     0      1
3     C 3013     1      2
```

Row Selection

```
data4 <- data.frame(alpha = rep(LETTERS[1:3], 2), num = 1:6)
elim <- c(TRUE, FALSE, TRUE, TRUE, FALSE, FALSE)
data4[elim,]
data4[num > 3,]
data4[data4$num >3,]
```

```
  alpha num beta
1     A   1    b
3     C   3    b
4     A   4    a
```

Row selection

```
data4[data4$num >3,]
data4[c(1,2,2,2),]
```

```
  alpha num beta
4     A   4    a
5     B   5    a
6     C   6    a
    alpha num beta
1       A   1    b
2       B   2    b
2.1     B   2    b
2.2     B   2    b
```

Selection of columns

```
data4[,c(2,3)] %>% head(n=3)
data4[,c('num', 'alpha')] %>% head(n=3)
```

```
  num beta
1   1    b
2   2    b
3   3    b
  num alpha
1   1     A
2   2     B
3   3     C
```

duplicates

```
data4[duplicated(data4$alpha),]
data4[!duplicated(data4$beta),]
```

```
  alpha num beta
4     A   4    a
5     B   5    a
6     C   6    a
  alpha num beta
1     A   1    b
4     A   4    a
```

order

```
data4[order(data4$alpha),]  %>% head(n=3)
data4[order(data4$alpha, data4$beta),] %>% head(n=3)
```

```
  alpha num beta
1     A   1    b
4     A   4    a
2     B   2    b
  alpha num beta
4     A   4    a
1     A   1    b
5     B   5    a
```

Thank you!