Assignment 2: Web scrapping/Data Wrangling in R

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GitHub Repository

Code Execution and Output/Interpretation of Session 7

What is a "package" in R?

- In R, the fundamental unit of shareable code/function is the package.
- A package bundles together code, data, documentation, and tests, and is easy to share with others.
- The public clearing house for R packages is the Comprehensive R Archive Network or `CRAN`. The details about the packages can be found at CRAN.

How to install, use and get help about any package from CRAN?

- We can install packages of CRAN in R using: **`install.packages("packagename")`**
  For example: **`install.packages("dplyr")`**
- We can then use the installed packages in R using:
  `library(packagename)`
  `e.g. library(dplyr)`
- We can get help on the installed packages in R using:
  `?packagement` or **`help(package = "packagement")`**
  `e.g. ?dplyr` OR **`help(package = "dplyr")`**

How to develop a package in R? https://hilaryparker.com/2014/04/29/writing-an-r-package-from-scratch/

- Step 0: Packages you will need
- Step 1: Creating your package directory
- Step 2: Add functions
- Step 3: Add documentation
- Step 4: Process your documentation
- Step 5: Install
- Step 6: Make a package GitHub repo (Bonus!)
- Step 7: Infinity- Iterate

Reading (Import) data in R/R Studio:

- Text files: R base, readr etc
- Excel files: readXL, openxls etc.
- SPSS, Stata, SAS files: foreign, haven etc.

Reading data in R/R Studio

- JSON files: rjason, jsonlite, RJSONIO etc.

To install the library to work on josn files.

- `install.packages('jsonlite')`
- `install.packages('rjson')`

Code Sample 1

```
# vector
library("rjson")
data <- fromJSON(file = "jason_data.json")
data
```

```
## $ID
## [1] "1" "2" "3" "4" "5" "6" "7" "8"
##
## $Name
## [1] "Rick"     "Dan"      "Michelle" "Ryan"     "Gary"     "Nina"     "Simon"
## [8] "Guru"
##
## $Salary
## [1] "623.3"  "515.2"  "611"    "729"    "843.25" "578"    "632.8"  "722.5"
##
## $StartDate
## [1] "1/1/2012"   "9/23/2013"  "11/15/2014" "5/11/2014"  "3/27/2015"
## [6] "5/21/2013"  "7/30/2013"  "6/17/2014"
##
## $Dept
## [1] "IT"         "Operations" "IT"         "HR"         "Finance"
## [6] "IT"         "Operations" "Finance"
```

Interpretation:

- loaded the `jason_data.json` file from current working directory using rjson library.

Code Sample 2

```
# covert to data frame:
jason_data_frame <- as.data.frame(data)
jason_data_frame
```

```
##   ID     Name Salary  StartDate       Dept
## 1  1     Rick  623.3   1/1/2012         IT
## 2  2      Dan  515.2  9/23/2013 Operations
## 3  3 Michelle    611 11/15/2014         IT
## 4  4     Ryan    729  5/11/2014         HR
## 5  5     Gary 843.25  3/27/2015    Finance
## 6  6     Nina    578  5/21/2013         IT
## 7  7    Simon  632.8  7/30/2013 Operations
## 8  8     Guru  722.5  6/17/2014    Finance
```

Interpretation:

- converted the loaded json data into data.frame

Code Sample 3

```
# summary of jason_data_frame
summary(jason_data_frame)
```

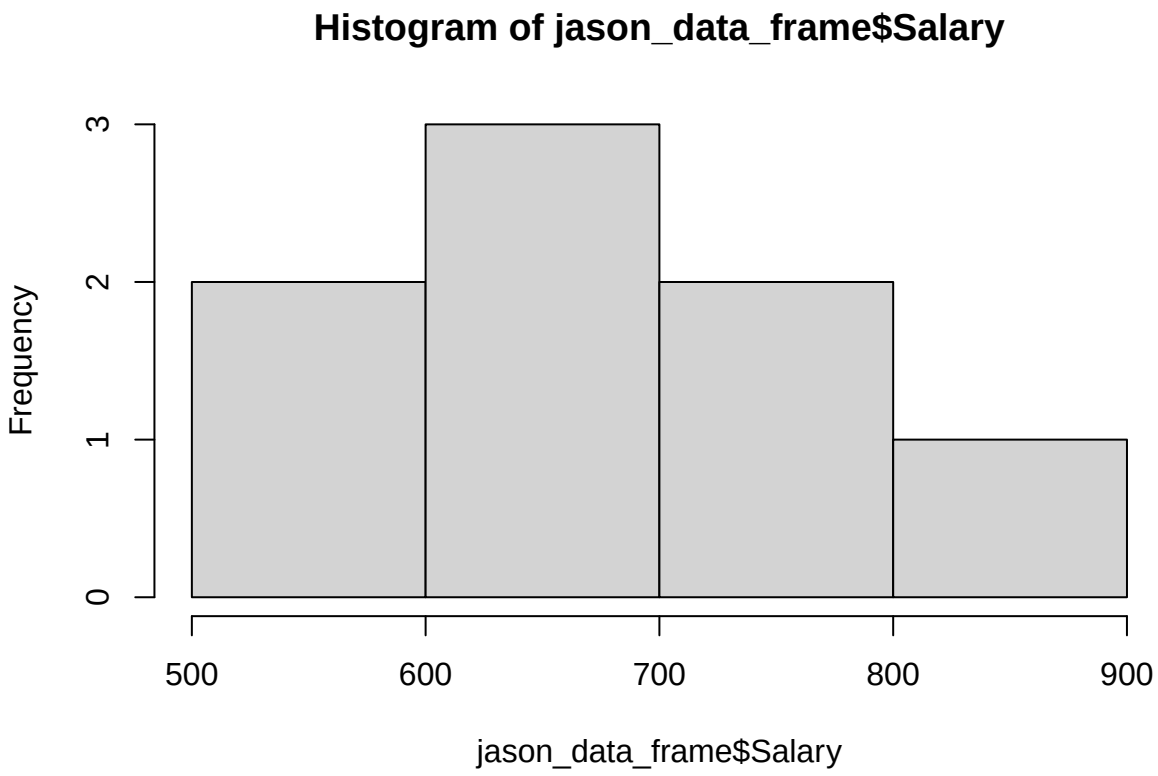
```
##       ID                Name              Salary           StartDate
##  Length:8           Length:8           Length:8           Length:8
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##      Dept
##  Length:8
##  Class :character
##  Mode  :character
```

Interpretation:

- summarizes the json data frame.

Code Sample

```
# histogram of salary of jason data frame
# since salary was of character so hist was not produced, so I converted it to integer.
jason_data_frame$Salary <- as.integer(jason_data_frame$Salary)
hist(jason_data_frame$Salary)
```

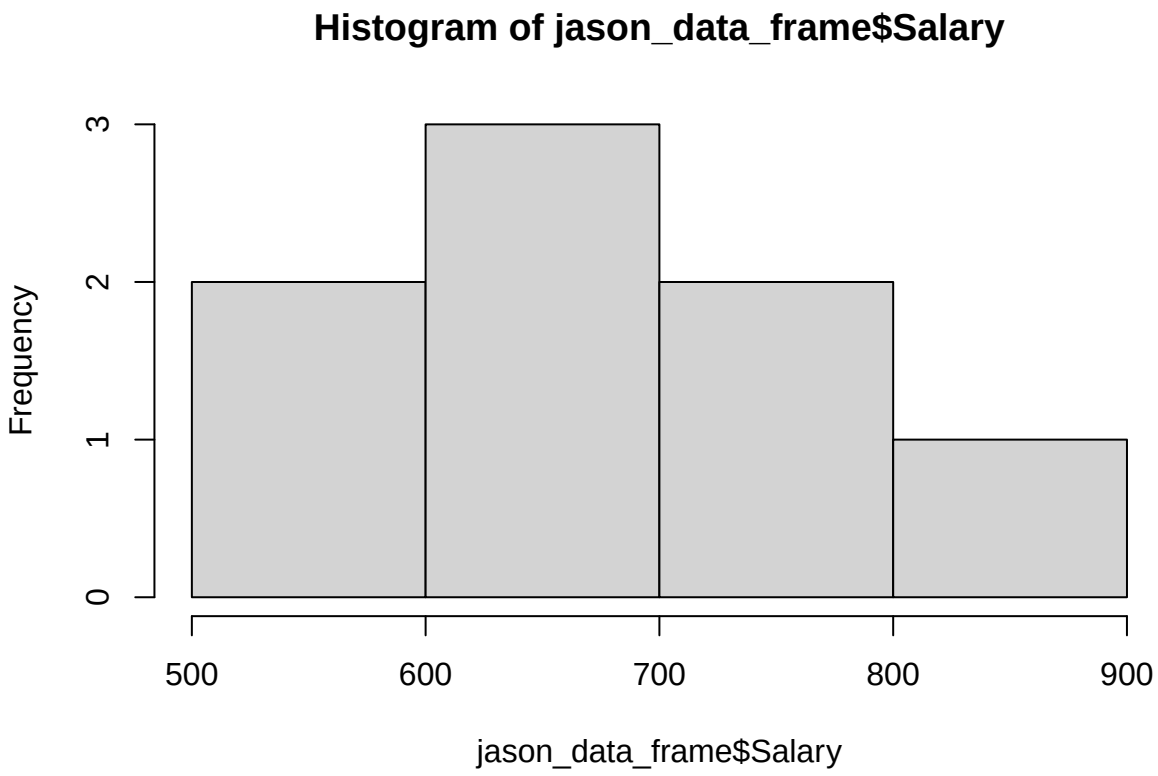


Interpretation:

- since salary was of character so hist was not produced, so I converted it to integer.
- generates histogram of salary of jason data frame

Code Sample

```
# histogram of salary of jason data frame
# since salary was of character so hist was not produced, so I converted it to integer.
jason_data_frame$Salary <- as.integer(jason_data_frame$Salary)
hist(jason_data_frame$Salary)
```



Interpretation:

- since salary was of character so hist was not produced, so I converted it to integer.
- generates histogram of salary of jason data frame

Code Sample

```
# average salary by department
aggregate(Salary ~ Dept, data = jason_data_frame, FUN = mean)
```

```
##         Dept Salary
## 1    Finance  782.5
## 2         HR  729.0
## 3         IT  604.0
## 4 Operations  573.5
```

Interpretation:

- aggregates the average salary by department.

Code Sample

```
# also using dplyr package
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(magrittr)
avg_by_dept <-
  jason_data_frame %>%
  group_by(Dept) %>%
  summarise(avg_salart = mean(Salary))
```

Interpretation:

- average salary by department can be achieved by using dplyr package and using summarise.

Code Sample

```
# frequency distribution of all variables
# since tables only shows the frequency distribution of factors, table on numerical or integer value is
table(jason_data_frame$Dept)
```

```
##
##    Finance         HR         IT Operations
##          2          1          3          2
```

Interpretation:

- since tables only shows the frequency distribution of factors, table on numerical or integer value is bad practice.

Reading JSON file from URL: Web API

Code Sample

```
# fetch the data from web api
library(jsonlite)
raw <-
  fromJSON(
    "https://data.ny.gov/api/views/9a8c-vfzj/rows.json?accessType=DOWNLOAD")
food_market <- raw[['data']]
```

Interpretation:

- read the json data from API using jsonlite library
- the raw object gets the list of values from where data part is extracted and assigned to food_market object

Code Sample

```
# structure and head of food market
str(food_market)
```

```
##  chr [1:24196, 1:24] "row-4wb8.javd.fc2j" "row-cxk5.daxz~ky99" ...
```

```
head(food_market, n = 4)
```

```
##      [,1]                 [,2]                                   [,3]
## [1,] "row-4wb8.javd.fc2j" "00000000-0000-0000-5489-E0BA9784EE18" "0"
## [2,] "row-cxk5.daxz~ky99" "00000000-0000-0000-1138-77B40E28ADAD" "0"
## [3,] "row-mgqk~8t89~nkze" "00000000-0000-0000-29DB-90F34B446A8B" "0"
## [4,] "row-98en.nphr~vg8m" "00000000-0000-0000-B908-B0E6F9A8F452" "0"
##      [,4]         [,5] [,6]         [,7] [,8]  [,9]    [,10]    [,11]   [,12]
## [1,] "1707244443" NA   "1707244449" NA   "{ }" "BRONX" "750994" "Store" "JAC"
## [2,] "1707244443" NA   "1707244449" NA   "{ }" "BRONX" "608900" "Store" "JAC"
## [3,] "1707244443" NA   "1707244449" NA   "{ }" "BRONX" "607918" "Store" "JAC"
## [4,] "1707244443" NA   "1707244449" NA   "{ }" "BRONX" "746827" "Store" "JAC"
##      [,13]              [,14]          [,15]  [,16]        [,17] [,18] [,19]
## [1,] "CA FOOD MART INC" "CA FOOD MART" "3706" "3RD AVENUE" NA    NA    "BRONX"
## [2,] "1307 CORP"        "1307 CORP"    "1307" "CROSBY AVE" NA    NA    "BRONX"
## [3,] "GNP SUNIL CORP"   "GNP SUNIL"    "585"  "W 235TH ST" NA    NA    "BRONX"
## [4,] "BRONX BAZAR INC"  "BRONX BAZAR"  "2550" "BOSTON RD"  NA    NA    "BRONX"
##      [,20] [,21]   [,22]  [,23]                                  [,24]
## [1,] "NY"  "10456" "0"    "POINT (-73.903143068 40.835323772)" "307"
## [2,] "NY"  "10461" "600"  "POINT (-73.82918325 40.838483414)"  "307"
## [3,] "NY"  "10463" "1500" "POINT (-73.911162035 40.885983701)" "307"
## [4,] "NY"  "10467" "0"    "POINT (-73.863887262 40.8642032)"   "307"
```

Interpretation:

- returns the structure and head of food_market.

Code Sample

```
names <- food_market[,14]
```

Interpretation:

- returns the names stores listed in index 14 of food_market in names object

Code Sample

```
head(names)
```

```
## [1] "CA FOOD MART" "1307 CORP"    "GNP SUNIL"    "BRONX BAZAR"  "TOPS 754"
## [6] "MAY STORE"
```

```
head(table(names), n = 7)
```

```
## names
## #248-PRICE RITE OF SOUTH AVE     #249 PRICE RITE OF UTICA
##                            1                            1
##                 @JENSARTISAN                    0113 FOOD
##                            1                            1
##           056 DELI & GROCERY                1-800-FLOWERS
##                            1                            1
##              1 BASKET MARKET
##                            1
```

Interpretation:

- `head(names)` returns first few data.
- `head(table(names), n = 7)` returns the frequency table of names of stores.
- since data is so much I restricted to first 7 values for frequency table.

Code Sample

```
table(v19)
```

```
## Error in eval(expr, envir, enclos): object 'v19' not found
```

Interpretation:

- trying to get the frequency tabke v19. but v19 doesn't exist and throws error

Code Sample

```
table(food_market$V19)
```

```
## Error in food_market$V19: $ operator is invalid for atomic vectors
```

Interpretation:

- An atomic vector is a one-dimensional data object created using functions like c() or vector() in R.
- The $ operator is commonly used to access elements of a data frame by column name.
- since food_market is of atomic vectors type, while access the element using $ returned this error.
- this can be mitigated by using `table(food_market[,19])`

Code Sample

```
head(table(food_market[, 19]), n = 5)
```

```
##
##       ACCORD        ADAMS ADAMS CENTER      ADDISON   ADIRONDACK
##            5            9            2            8            1
```

Interpretation:

- returns the frequency table of data that is at 19th column of food_market
- since data is too much, I restricted the display to 5.

Web scrapping in R: A Simple (barebones) Example

Code Sample

```
# The recommended package for web scrapping in R is "rvest
# using html
library(rvest)
simple <-
  read_html('https://dataquestio.github.io/web-scraping-pages/simple.html')
simple %>% html_nodes('p') %>% html_text()
```

```
## [1] "Here is some simple content for this page."
```

Interpretation:

- reads the html using `read_html()`
- we loaded the html in simple object then using pipes parsed the html with node 'p' then converted that to normal text.

Code Sample

```
# Wikipedia Nepal Covid 19
wiki_link <- "https://en.wikipedia.org/wiki/COVID-19_pandemic_in_Nepal"
wiki_page <- read_html(wiki_link)
```

Interpretation:

- since salary was of character so hist was not produced, so I converted it to integer.
- generates histogram of salary of jason data frame

Code Sample

```
str(wiki_page)
```

```
## List of 2
##  $ node:<externalptr>
##  $ doc :<externalptr>
##  - attr(*, "class")= chr [1:2] "xml_document" "xml_node"
```

Interpretation:

- structure of wiki page, returns list of 2 xml node and xml doc

Code Sample

```
wiki_page %>% html_nodes("table")
```

```
## {xml_nodeset (68)}
##  [1] <table class="box-Update plainlinks metadata ambox ambox-content ambox-U ...
##  [2] <table class="infobox"><tbody>\n<tr><th colspan="2" class="infobox-above ...
##  [3] <table>\n<caption class="bb-default">\nCOVID-19 cases in Nepal<span clas ...
##  [4] <table class="wikitable floatright mw-collapsible {{{class}}}" style="wi ...
##  [5] <table class="box-Update plainlinks metadata ambox ambox-content ambox-U ...
##  [6] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
##  [7] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
##  [8] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
##  [9] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [10] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [11] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [12] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [13] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [14] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [15] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [16] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [17] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [18] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [19] <table class="box-Notice plainlinks metadata ambox ambox-notice" role="p ...
## [20] <table class="box-Update plainlinks metadata ambox ambox-content ambox-U ...
## ...
```

Interpretation:

- parses the html nodes containing `table` in html page of wiki_page.

Code Sample

```
covid_table <-
  wiki_page %>% html_elements('.COVID-19_pandemic_data_Nepal_medical_cases') %>% html_node('table') %>%
covid_table <- covid_table[[1]]
```

Interpretation:

- from wiki page, first parsed the html elements having `.COVID-19_pandemic_data_Nepal_medical_cases`
- then extracted the node containing `table` into html_table()
- since the data was returned in the list, the actual data was at first index which is dataframe.

Data wrangling: Part I Column names of covid_table

Code Sample

```
names(covid_table) <-
  paste(names(covid_table), covid_table[1, ], sep = "_")
covid_table <- covid_table[-1, ]
names(covid_table)
```

```
##  [1] "Date_Date"              "Confirmed cases_Total"  "Confirmed cases_New"
##  [4] "Confirmed cases_Active" "Recoveries_Total"       "Recoveries_New"
##  [7] "Deaths_Total"           "Deaths_New"             "RT-PCR tests_Total"
## [10] "RT-PCR tests_New"       "TPR_TPR"                "RR_RR"
## [13] "CFR_CFR"                "Ref._Ref."
```

Interpretation:

- even though the data was extracted to dataframe there was error in columns and we want to rename it
- concatenated the column names with first row of dataframe.
- and finally dropping the first column.

Code Sample

```
#Check the structure of data again
str(covid_table)
```

```
## tibble [495 x 14] (S3: tbl_df/tbl/data.frame)
##  $ Date_Date             : chr [1:495] "23 Jan" "24 Jan" "25 Jan" "26 Jan" ...
##  $ Confirmed cases_Total : chr [1:495] "1" "1" "1" "1" ...
##  $ Confirmed cases_New   : chr [1:495] "+1" "0" "0" "0" ...
##  $ Confirmed cases_Active: chr [1:495] "1" "1" "1" "1" ...
##  $ Recoveries_Total      : chr [1:495] "0" "0" "0" "0" ...
##  $ Recoveries_New        : chr [1:495] "0" "0" "0" "0" ...
##  $ Deaths_Total          : chr [1:495] "0" "0" "0" "0" ...
##  $ Deaths_New            : chr [1:495] "0" "0" "0" "0" ...
##  $ RT-PCR tests_Total    : chr [1:495] "" "" "" "" ...
##  $ RT-PCR tests_New      : chr [1:495] "" "" "" "" ...
##  $ TPR_TPR               : chr [1:495] "" "" "" "" ...
##  $ RR_RR                 : chr [1:495] "0%" "0%" "0%" "0%" ...
##  $ CFR_CFR               : chr [1:495] "0%" "0%" "0%" "0%" ...
##  $ Ref._Ref.             : chr [1:495] "[175]" "" "" "" ...
```

Interpretation:

- checking the structure again to ensure.

Data wrangling: Part II Renaming the column names

- Change "Date_Date" variable as **"Date"**
- Change "Confirmed cases_Total" variable as **"Confirmed_Cases_Total"**
- Change "Confirmed cases_New" variable as **"Confirmed_Cases_New"**
- Change "Confirmed cases_Active" variable as **"Confirmed_Cases_Active"**
- Change "RT-PCR tests_Total" variable as **"RT-PCR_tests_Total"**
- Change "RT-PCR tests_New" variable as **"RT-PCR_tests_New"**
- Change "TPR_TPR" variable as **"TPR"**
- Change "RR_RR" variable as **"RR"**
- Change "CFR_CFR" variable as **"CFR"**
- Change "Ref. _Ref." variable as **"Ref"**

Code Sample

```
colnames(covid_table) <- c(
  "Date",
  "Confirmed_Cases_Total",
  "Confirmed_Cases_New",
  "Confirmed_Cases_Active",
  "Recoveries_Total",
  "Recoveries_New",
  "Deaths_Total",
  "Deaths_New",
  "PCR_Total",
  "PCR_New",
  "TPR",
  "RR",
  "CFR",
  "Ref"
)
```

Interpretation:

- renaming the column names to desired column names.

Code Sample

```
colnames(covid_table) <- c(
  "Date",
  "Confirmed_Cases_Total",
  "Confirmed_Cases_New",
  "Confirmed_Cases_Active",
  "Recoveries_Total",
  "Recoveries_New",
  "Deaths_Total",
  "Deaths_New",
  "PCR_Total",
  "PCR_New",
  "TPR",
  "RR",
  "CFR",
  "Ref"
)
```

Interpretation:

- renaming the column names to desired column names.

Code Sample

```
# another way to do same thing

names(covid_table)[names(covid_table)=='Date_Date'] = 'Date'
names(covid_table)[names(covid_table)=='Confirmed cases_Total'] = 'Confirmed_Cases_Total'
```

```
names(covid_table)[names(covid_table)=='Confirmed cases_New'] = 'Confirmed_Cases_New'
names(covid_table)[names(covid_table)=='Confirmed cases_Active'] = 'Confirmed_Cases_Active'
names(covid_table)[names(covid_table)=='Recoveries_Total'] = 'Recoveries_Total'
names(covid_table)[names(covid_table)=='Recoveries_New'] = 'Recoveries_New'
names(covid_table)[names(covid_table)=='Deaths_Total'] = 'Deaths_Total'
names(covid_table)[names(covid_table)=='Deaths_New'] = 'Deaths_New'
names(covid_table)[names(covid_table)=='RT-PCR tests_Total'] = 'PCR_Total'
names(covid_table)[names(covid_table)=='RT-PCR tests_New'] = 'PCR_New'
names(covid_table)[names(covid_table)=='TPR_TPR'] = 'TPR'
names(covid_table)[names(covid_table)=='RR_RR'] = 'RR'
names(covid_table)[names(covid_table)=='CFR_CFR'] = 'CFR'
names(covid_table)[names(covid_table)=='Ref._Ref.'] = 'Ref'
```

Interpretation:

- Another way to rename the column names to desired column names.

Data Wrangling Part III

Code Sample

```
# removing "+" and "%" from the variables
covid_table$Confirmed_Cases_New <- gsub('[+]', '', covid_table$Confirmed_Cases_New)
covid_table$Recoveries_New <- gsub('[+]', '', covid_table$Recoveries_New)
covid_table$Deaths_New <- gsub('[+]', '', covid_table$Deaths_New)
covid_table$PCR_New <- gsub('[+]', '', covid_table$PCR_New)

covid_table$TPR <- gsub('[%]', '', covid_table$TPR)
covid_table$RR <- gsub('[%]', '', covid_table$RR)
covid_table$CFR <- gsub('[%]', '', covid_table$CFR)
```

Interpretation:

- cleaning the messy data using gsub.
- removing % and + from data.

Code Sample

```
# since in pdf while converting chr to numeric or integer type coerce warning was given for invalid typ
covid_table$Confirmed_Cases_Total <- gsub('[,]', '', covid_table$Confirmed_Cases_Total)
covid_table$Confirmed_Cases_New <- gsub('[,]', '', covid_table$Confirmed_Cases_New)
covid_table$Confirmed_Cases_Active <- gsub('[,]', '', covid_table$Confirmed_Cases_Active)
covid_table$Recoveries_Total <- gsub('[,]', '', covid_table$Recoveries_Total)
covid_table$Recoveries_New <- gsub('[,]', '', covid_table$Recoveries_New)

covid_table$Deaths_Total <- gsub('[,]', '', covid_table$Deaths_Total)
covid_table$Deaths_New <- gsub('[,]', '', covid_table$Deaths_New)
covid_table$PCR_Total <- gsub('[,]', '', covid_table$PCR_Total)
covid_table$PCR_New <- gsub('[,]', '', covid_table$PCR_New)

covid_table$TPR <- gsub('[,]', '', covid_table$TPR)
covid_table$RR <- gsub('[,]', '', covid_table$RR)
covid_table$CFR <- gsub('[,]', '', covid_table$CFR)
```

Interpretation:

- Since while converting chr to integer type it gave some warning about coerce where values were invalid type for e.g `313,333` can't be interpreted as integer because of comma. But it is right in context of html in website.
- removed the `,` using gsub.

Data wrangling: Part IV Converting "chr" variables as numbers

Code Sample

```
covid_table$Confirmed_Cases_Total <- as.integer(covid_table$Confirmed_Cases_Total)
covid_table$Confirmed_Cases_New <- as.integer(covid_table$Confirmed_Cases_New)
covid_table$Confirmed_Cases_Active <- as.integer(covid_table$Confirmed_Cases_Active)
covid_table$Recoveries_Total <- as.integer(covid_table$Recoveries_Total)
covid_table$Recoveries_New <- as.integer(covid_table$Recoveries_New)

covid_table$Deaths_Total <- as.integer(covid_table$Deaths_Total)
covid_table$Deaths_New <- as.integer(covid_table$Deaths_New)
covid_table$PCR_Total <- as.integer(covid_table$PCR_Total)
covid_table$PCR_New <- as.integer(covid_table$PCR_New)

covid_table$TPR <- as.numeric(covid_table$TPR)
covid_table$RR <- as.numeric(covid_table$RR)
covid_table$CFR <- as.numeric(covid_table$CFR)
```

Interpretation:

- converted all of the required columns of chr type of integer or numeric type using `as.numeric()` function.

Code Sample

```
str(covid_table)
```

```
## tibble [495 x 14] (S3: tbl_df/tbl/data.frame)
##  $ Date                  : chr [1:495] "23 Jan" "24 Jan" "25 Jan" "26 Jan" ...
##  $ Confirmed_Cases_Total : int [1:495] 1 1 1 1 1 1 1 1 1 1 ...
##  $ Confirmed_Cases_New   : int [1:495] 1 0 0 0 0 0 0 0 0 0 ...
##  $ Confirmed_Cases_Active: int [1:495] 1 1 1 1 1 1 0 0 0 0 ...
##  $ Recoveries_Total      : int [1:495] 0 0 0 0 0 0 1 1 1 1 ...
##  $ Recoveries_New        : int [1:495] 0 0 0 0 0 0 1 0 0 0 ...
##  $ Deaths_Total          : int [1:495] 0 0 0 0 0 0 0 0 0 0 ...
##  $ Deaths_New            : int [1:495] 0 0 0 0 0 0 0 0 0 0 ...
##  $ PCR_Total             : int [1:495] NA NA NA NA NA 3 4 5 5 NA ...
##  $ PCR_New               : int [1:495] NA NA NA NA NA NA 1 1 0 NA ...
##  $ TPR                   : num [1:495] NA NA NA NA NA ...
##  $ RR                    : num [1:495] 0 0 0 0 0 0 100 100 100 100 ...
##  $ CFR                   : num [1:495] 0 0 0 0 0 0 0 0 0 0 ...
##  $ Ref                   : chr [1:495] "[175]" "" "" "" ...
```

Interpretation:

- finally check the data type.

Converting Date (Assignment)

Code Sample

```
head(as.Date(covid_table$Date, format = "%d %b"), n = 50)
```

```
##  [1] "2024-01-23" "2024-01-24" "2024-01-25" "2024-01-26" "2024-01-27"
##  [6] "2024-01-28" "2024-01-29" "2024-01-30" "2024-01-31" "2024-02-01"
## [11] "2024-02-02" "2024-02-03" "2024-02-04" "2024-02-05" "2024-02-06"
## [16] "2024-02-07" "2024-02-08" "2024-02-09" "2024-02-10" "2024-02-11"
## [21] "2024-02-12" "2024-02-13" "2024-02-14" "2024-02-15" "2024-02-16"
## [26] "2024-02-17" "2024-02-18" "2024-02-19" "2024-02-20" "2024-02-21"
## [31] "2024-02-22" "2024-02-23" "2024-02-24" "2024-02-25" "2024-02-26"
## [36] "2024-02-27" "2024-02-28" "2024-02-29" "2024-03-01" "2024-03-02"
## [41] "2024-03-03" "2024-03-04" "2024-03-05" "2024-03-06" "2024-03-07"
## [46] "2024-03-08" "2024-03-09" "2024-03-10" "2024-03-11" "2024-03-12"
```

Interpretation:

- By default tries to check this format `"%Y-%m-%d"` or `"%Y/%m/%d"`for given date or string data.
- since out date column has day and month I have to use `%d` for day and `%b` for short name of month.
- returns the value in 2024 but that date is of 2020 and 2021
- In order to work around this I have made a logic below.

Code Sample

```
# using base R date time functions

start_date_2020 <- "2020-01-23"
end_date_2020 <- "2020-12-31"

# check days diff
days_diff <-
  as.numeric(difftime(end_date_2020, start_date_2020, units = 'days')) + 1

# check difference till first n rows and insert value if condition is true return 2020 else 2021
check_year <- ifelse(1:nrow(covid_table) <= days_diff, 2020, 2021)

# format the date according to need
formatted_date <- as.Date(covid_table$Date, format = "%d %b")
formatted_date <- format(formatted_date, '-%m-%d')

# concantante the year and formated day and date
final_converted_date <- paste0(check_year, formatted_date)

# finally since concatenation returns string again convert the type into date and load the Date column
covid_table$Date <- as.Date(final_converted_date)
head(covid_table$Date)
```

```
## [1] "2020-01-23" "2020-01-24" "2020-01-25" "2020-01-26" "2020-01-27"
## [6] "2020-01-28"
```

```
class(covid_table$Date)
```

```
## [1] "Date"
```

Interpretation:

- Since I know that data is of 23rd Jan 2020 to 31st May 2021.
- Also, after 31st Dec next year will arrive, so I set variable `start_date_2020 <- "2020-01-23"` and `end_date_2020 <- "2020-12-31"`.
- I calculated the difference in day from 23rd Jan to 31st Dec.
- Also data is serial in dataframe I filtered the data to 2020 and 2021 using difference in rows. Set `2020` to first 344 rows and rest `2021`.
- since `as.Date(covid_table$Date, format = "%d %b")` gave the date of 2024, I formatted the date and only got day and month.
- Finally concatenated the calulcated year with formatted day and month.

Code Sample

```
# using lubridate
library(lubridate)

start_date_2020 <- "2020-01-23"
end_date_2020 <- "2020-12-31"

# find difference
diff <-
  (ymd(start_date_2020) %--% ymd(end_date_2020)) %/% days(1) + 1

# check difference till first n rows and insert value if condition is true return 2020 else 2021
check_year <- ifelse(1:nrow(covid_table) <= diff, 2020, 2021)

# format the date to day and month
formatted_date <- ymd(as.Date(covid_table$Date, format = "%d %b"))

# create the date using make_date function
final_converted_date <-
  make_date(
    year = check_year,
    month = month(formatted_date),
    day = day(formatted_date)
  )
# change the Date column value with final converted date
covid_table$Date <- final_converted_date
class(covid_table$Date)
```

```
## [1] "Date"
```

Interpretation:

- Using lubridate to achieve the solution to given problem.

Code Execution and Output/Interpretation of Session 8 and 9

Code Sample

```
library(tidyverse)
library(magrittr)

table1 <- tibble(
  country = c("Afghanistan", "Afghanistan", "Brazil",
              "Brazil", "China", "China"),
  year = c(1999, 2000, 1999, 2000, 1999, 2000),
  cases = c(745,2666,37737,80488,212258,213766),
  population = c(19987071,20595360,172006362,
                 174504898, 1272915272,1280428583)
)

table1
```

```
## # A tibble: 6 x 4
##   country      year  cases population
##   <chr>       <dbl>  <dbl>      <dbl>
## 1 Afghanistan  1999    745   19987071
## 2 Afghanistan  2000   2666   20595360
## 3 Brazil       1999  37737  172006362
## 4 Brazil       2000  80488  174504898
## 5 China        1999 212258 1272915272
## 6 China        2000 213766 1280428583
```

```
table2
```

```
## # A tibble: 12 x 4
##    country      year type            count
##    <chr>       <dbl> <chr>           <dbl>
##  1 Afghanistan  1999 cases             745
##  2 Afghanistan  1999 population   19987071
##  3 Afghanistan  2000 cases            2666
##  4 Afghanistan  2000 population   20595360
##  5 Brazil       1999 cases           37737
##  6 Brazil       1999 population  172006362
##  7 Brazil       2000 cases           80488
##  8 Brazil       2000 population  174504898
##  9 China        1999 cases          212258
## 10 China        1999 population 1272915272
## 11 China        2000 cases          213766
## 12 China        2000 population 1280428583
```

```
table3
```

```
## # A tibble: 6 x 3
##   country      year rate
##   <chr>       <dbl> <chr>
## 1 Afghanistan  1999 745/19987071
```

```
## 2 Afghanistan  2000 2666/20595360
## 3 Brazil       1999 37737/172006362
## 4 Brazil       2000 80488/174504898
## 5 China        1999 212258/1272915272
## 6 China        2000 213766/1280428583
```

```
table4a
```

```
## # A tibble: 3 x 3
##   country     `1999` `2000`
##   <chr>        <dbl>  <dbl>
## 1 Afghanistan    745   2666
## 2 Brazil       37737  80488
## 3 China       212258 213766
```

```
table4b
```

```
## # A tibble: 3 x 3
##   country         `1999`     `2000`
##   <chr>            <dbl>      <dbl>
## 1 Afghanistan   19987071   20595360
## 2 Brazil       172006362  174504898
## 3 China       1272915272 1280428583
```

Interpretation:

- Exploring the few built in tables from tidyverse package.
- There are two main advantages of using tidy data:
  - There's a general advantage to picking one consistent way of storing data. If you have a consistent data structure, it's easier to learn the tools that work with it because they have an underlying uniformity.
  - There's a specific advantage to placing variables in columns because it allows R's vectorized nature to shine.
  - dplyr, ggplot2, and all the other packages in the tidyverse are designed to work with tidy data.

Code Sample

```
# Pivoting - Longer to wider
# (To do standard statistical analysis)
table2 %>% pivot_wider(names_from = type, values_from = count)
```

```
## # A tibble: 6 x 4
##   country      year  cases population
##   <chr>       <dbl>  <dbl>      <dbl>
## 1 Afghanistan  1999    745   19987071
## 2 Afghanistan  2000   2666   20595360
## 3 Brazil       1999  37737  172006362
## 4 Brazil       2000  80488  174504898
## 5 China        1999 212258 1272915272
## 6 China        2000 213766 1280428583
```

Interpretation:

- Pivoting the `table2` from longer to wider.
- usually used for standard statistical analysis

Code Sample

```
# Pivoting - Wider to Longer
# (To do Variance components analysis)
table4a %>%
  pivot_longer(c(`1999`, `2000`), names_to =
                 "year", values_to = "cases")
```

```
## # A tibble: 6 x 3
##   country     year   cases
##   <chr>       <chr>  <dbl>
## 1 Afghanistan 1999     745
## 2 Afghanistan 2000    2666
## 3 Brazil      1999   37737
## 4 Brazil      2000   80488
## 5 China       1999  212258
## 6 China       2000  213766
```

Interpretation:

- Pivoting the `table2` from wider to longer.
- usually used for standard statistical analysis.

Code Sample

```
# Tidy data: Separate
table3 %>% separate(rate, into = c("cases", "population"))
```

```
## # A tibble: 6 x 4
##   country      year cases  population
##   <chr>       <dbl> <chr>  <chr>
## 1 Afghanistan  1999 745    19987071
## 2 Afghanistan  2000 2666   20595360
## 3 Brazil       1999 37737  172006362
## 4 Brazil       2000 80488  174504898
## 5 China        1999 212258 1272915272
## 6 China        2000 213766 1280428583
```

```
# OR
table3 %>% separate(rate, into = c("cases", "population"), sep = "/")
```

```
## # A tibble: 6 x 4
##   country      year cases  population
##   <chr>       <dbl> <chr>  <chr>
## 1 Afghanistan  1999 745    19987071
## 2 Afghanistan  2000 2666   20595360
## 3 Brazil       1999 37737  172006362
## 4 Brazil       2000 80488  174504898
## 5 China        1999 212258 1272915272
## 6 China        2000 213766 1280428583
```

Interpretation:

- separate the value from single column to multiple columns.
- often useful when dealing with delimited values in single column.

Code Sample

```
# Tidy data: Unite
table5 %>% unite(new, century, year)
```

```
## # A tibble: 6 x 3
##   country     new   rate
##   <chr>       <chr> <chr>
## 1 Afghanistan 19_99 745/19987071
## 2 Afghanistan 20_00 2666/20595360
## 3 Brazil      19_99 37737/172006362
## 4 Brazil      20_00 80488/174504898
## 5 China       19_99 212258/1272915272
## 6 China       20_00 213766/1280428583
```

```
# OR
table5 %>% unite(new, century, year, sep = "")
```

```
## # A tibble: 6 x 3
##   country     new   rate
##   <chr>       <chr> <chr>
## 1 Afghanistan 1999  745/19987071
## 2 Afghanistan 2000  2666/20595360
## 3 Brazil      1999  37737/172006362
## 4 Brazil      2000  80488/174504898
## 5 China       1999  212258/1272915272
## 6 China       2000  213766/1280428583
```

Interpretation:

- unites columns into one.
- opposite of separate: it combines multiple columns into a single column.

Code Sample

```
# Missing values: Example
stocks <- tibble(
  year = c(2015, 2015, 2015, 2015, 2016, 2016, 2016),
  qtr = c( 1, 2, 3, 4, 2, 3, 4),
  return = c(1.88, 0.59, 0.35, NA, 0.92, 0.17, 2.66)
)

stocks %>% pivot_wider(names_from = year, values_from = return)
```

```
## # A tibble: 4 x 3
##     qtr `2015` `2016`
##   <dbl>  <dbl>  <dbl>
## 1     1   1.88  NA
## 2     2   0.59   0.92
## 3     3   0.35   0.17
## 4     4  NA      2.66
```

Interpretation:

- pivoted the stocks to wider to check missing values on year and return
- The return for the fourth quarter of 2015 is explicitly missing, because the cell where its value should be instead contains NA.
- The return for the first quarter of 2016 is implicitly missing, because it simply does not appear in the dataset.

Code Sample

```
stocks %>%
  pivot_wider(names_from = year, values_from = return) %>%
  pivot_longer(
    cols = c(`2015`, `2016`),
    names_to = "year",
    values_to = "return",
    values_drop_na = TRUE
  )
```

```
## # A tibble: 6 x 3
##     qtr year  return
##   <dbl> <chr>  <dbl>
## 1     1 2015    1.88
## 2     2 2015    0.59
## 3     2 2016    0.92
## 4     3 2015    0.35
## 5     3 2016    0.17
## 6     4 2016    2.66
```

Interpretation:

- `pivot_wider(names_from = year, values_from = return)` pivots data from longer to wider format. the date is spread out based on different years, where year is the column providing the year information, and return is the column providing return values.
- `pivot_longer()` is used to pivot data from wider to longer format. It gathers columns specified in cols into key-value pairs. Here, it specifies to gather columns 2015 and 2016 into a new column named "year", with their corresponding values into a new column named "return". The parameter values_drop_na = TRUE indicates that rows with missing values after pivoting should be dropped.

Code Sample

```
stocks %>% complete(year, qtr)
```

```
## # A tibble: 8 x 3
##    year   qtr return
##   <dbl> <dbl>  <dbl>
## 1  2015     1   1.88
## 2  2015     2   0.59
## 3  2015     3   0.35
## 4  2015     4  NA
## 5  2016     1  NA
```

```
## 6  2016     2   0.92
## 7  2016     3   0.17
## 8  2016     4   2.66
```

Interpretation:

- `complete()` is used to complete a data frame with missing combinations of values. It takes columns specified in the arguments and ensures that all combinations of unique values are present in the resulting data frame.
- here, it ensures that all combinations of values from the columns year and qtr are present in the data frame, filling in any missing combinations with NA values.

Code Sample

```
treatment <- tribble(
~ person, ~ treatment, ~response,
"Derrick Whitmore", 1, 7,
NA, 2, 10,
NA, 3, 9,
"Katherine Burke", 1, 4
)
treatment
```

```
## # A tibble: 4 x 3
##   person           treatment response
##   <chr>                <dbl>    <dbl>
## 1 Derrick Whitmore         1        7
## 2 <NA>                     2       10
## 3 <NA>                     3        9
## 4 Katherine Burke          1        4
```

Interpretation:

- Create tibbles using an easier to read row-by-row layout. This is useful for small tables of data where readability is important.

Code Sample

```
treatment %>% fill(person)
```

```
## # A tibble: 4 x 3
##   person           treatment response
##   <chr>                <dbl>    <dbl>
## 1 Derrick Whitmore         1        7
## 2 Derrick Whitmore         2       10
## 3 Derrick Whitmore         3        9
## 4 Katherine Burke          1        4
```

Interpretation:

- `fill(person)` fills missing values in the specified column (person in this case) with the most recent non-missing value in that column.

Transform/manipulate data with "dplyr" To learn five key "dplyr" package functions that allow you to solve the vast majority of your data manipulation challenges:

- **`filter())`** function is used to subset a data frame, retaining all rows that satisfy your conditions.
- **`arrange()`**: orders the rows of a data frame by the values of selected columns.
- **`select()`**: (and optionally rename) variables in a data frame, using a concise mini-language that makes it easy to refer to variables based on their name e.g. a:f selects all columns from a on the left to f on the right) or type (e.g. where(is.numeric) selects all numeric columns).
- **`mutate()`**: creates new columns that are functions of existing variables. It can also modify (if the name is the same as an existing column) and delete columns (by setting their value to NULL). Collapse many values down to a single summary
- **`summarise()`**: It returns one row for each combination of grouping variables; if there are no grouping variables, the output will have a single row summarizing all observations in the input. It will contain one column for each grouping variable and one column for each of the summary statistics that you have specified
- **`group_by()`**: Most data operations are done on groups defined by variables. group_by() takes an existing tbl and converts it into a grouped tbl where operations are performed "by group". ungroup() removes grouping.

Code Sample

```
library(dplyr)
library(nycflights13)
flights
```

```
## # A tibble: 336,776 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 336,766 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- load the flights dataset.

Filter

Code Sample

```
filter(flights, month == 1, day == 1)
```

```
## # A tibble: 842 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 832 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- filters flights datasets for all months and day equals to 1

Code Sample

```
# filter jan1
jan1 <- filter(flights, month == 1, day == 1)
(jan1 <- filter(flights, month == 1, day == 1))
```

```
## # A tibble: 842 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 832 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```
# filter dec25
dec25 <- filter(flights, day ==12 , day == 25)
(dec25 <- filter(flights, day ==12 , day == 25))
```

```
## # A tibble: 0 x 19
## # i 19 variables: year <int>, month <int>, day <int>, dep_time <int>,
## #   sched_dep_time <int>, dep_delay <dbl>, arr_time <int>,
## #   sched_arr_time <int>, arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Code Sample ***Interpretation***:

- filters January 1 for all flights data.
- filters December 25 for all flights data.

Code Sample

```
filter(flights, month = 1) #throws error
```

```
## Error in `filter()`:
## ! We detected a named input.
## i This usually means that you've used `=` instead of `==`.
## i Did you mean `month == 1`?
```

```
filter(flights, month == 1) #works fine
```

```
## # A tibble: 27,004 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 26,994 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- `filter(flights, month = 1)` will throw an error because month=1 doesn't filter but assigns the value 1 to month.
- filter(flights, month == 1) will filter the month 1.

Code Sample

```r
# valid filter to fetch only rows where the month is either November December.
filter(flights, month == 11 | month == 12)
```

```
## # A tibble: 55,403 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013    11     1        5           2359         6      352            345
##  2  2013    11     1       35           2250       105      123           2356
##  3  2013    11     1      455            500        -5      641            651
##  4  2013    11     1      539            545        -6      856            827
##  5  2013    11     1      542            545        -3      831            855
##  6  2013    11     1      549            600       -11      912            923
##  7  2013    11     1      550            600       -10      705            659
##  8  2013    11     1      554            600        -6      659            701
##  9  2013    11     1      554            600        -6      826            827
## 10  2013    11     1      554            600        -6      749            751
## # i 55,393 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```r
# returns all row since 11 | 12 computes to TRUE
filter(flights, month == 11 | 12)
```

```
## # A tibble: 336,776 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 336,766 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```r
# valid filter to fetch only rows where the month is either November December.
nov_dec <- filter(flights, month %in% c(11, 12))
```

Interpretation:

- `filter(flights, month == 11 | month == 12)` fetch only rows where the month is either November December.
- `filter(flights, month == 11 | 12)` returns all row since 11 | 12 computes to TRUE, even though syntactically it returns values but it won't gives us desired output.
- `nov_dec <- filter(flights, month %in% c(11, 12))` fetch only rows where the month is either November December.

Code Sample

```
# De Morgan's Law:
filter(flights, !(arr_delay > 120 | dep_delay > 120))
```

```
## # A tibble: 316,050 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 316,040 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```
filter(flights, arr_delay <= 120, dep_delay <= 120)
```

```
## # A tibble: 316,050 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 316,040 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- Both returns the same value: `filter(flights, !(arr_delay > 120 | dep_delay > 120))` filters all arrival and departure delayed which are not greater 120.
- `filter(flights, arr_delay <= 120, dep_delay <= 120)` filters all arrival and departure delayed which are less than or equal to 120.

Arrange Example

Code Sample

```
# by default sorts in ascending order
arrange(flights, year, month, day)
```

```
## # A tibble: 336,776 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 336,766 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```
# descending order
arrange(flights, desc(dep_delay))
```

```
## # A tibble: 336,776 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     9      641            900      1301     1242           1530
##  2  2013     6    15     1432           1935      1137     1607           2120
##  3  2013     1    10     1121           1635      1126     1239           1810
##  4  2013     9    20     1139           1845      1014     1457           2210
##  5  2013     7    22      845           1600      1005     1044           1815
##  6  2013     4    10     1100           1900       960     1342           2211
##  7  2013     3    17     2321            810       911      135           1020
##  8  2013     6    27      959           1900       899     1236           2226
##  9  2013     7    22     2257            759       898      121           1026
## 10  2013    12     5      756           1700       896     1058           2020
## # i 336,766 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- `arrange(flights, year, month, day)` sorts year, month and day in ascending order.

- `arrange(flights, year, month, day)` sorts year, month and day in descending order.
- Missing values are always sorted at the end.

Select Example

Code Sample

```r
# Select columns by name
select(flights, year, month, day)
```

```
## # A tibble: 336,776 x 3
##     year month   day
##    <int> <int> <int>
##  1  2013     1     1
##  2  2013     1     1
##  3  2013     1     1
##  4  2013     1     1
##  5  2013     1     1
##  6  2013     1     1
##  7  2013     1     1
##  8  2013     1     1
##  9  2013     1     1
## 10  2013     1     1
## # i 336,766 more rows
```

```r
# Select all columns between year and day (inclusive)
select(flights, year:day)
```

```
## # A tibble: 336,776 x 3
##     year month   day
##    <int> <int> <int>
##  1  2013     1     1
##  2  2013     1     1
##  3  2013     1     1
##  4  2013     1     1
##  5  2013     1     1
##  6  2013     1     1
##  7  2013     1     1
##  8  2013     1     1
##  9  2013     1     1
## 10  2013     1     1
## # i 336,766 more rows
```

```r
# Select all columns except those from year to day (inclusive)
select(flights, -(year:day))
```

```
## # A tibble: 336,776 x 16
##    dep_time sched_dep_time dep_delay arr_time sched_arr_time arr_delay carrier
##       <int>          <int>     <dbl>    <int>          <int>     <dbl> <chr>
##  1      517            515         2      830            819        11 UA
##  2      533            529         4      850            830        20 UA
##  3      542            540         2      923            850        33 AA
##  4      544            545        -1     1004           1022       -18 B6
##  5      554            600        -6      812            837       -25 DL
##  6      554            558        -4      740            728        12 UA
##  7      555            600        -5      913            854        19 B6
##  8      557            600        -3      709            723       -14 EV
##  9      557            600        -3      838            846        -8 B6
```

```
## 10      558            600        -2      753            745         8 AA
## # i 336,766 more rows
## # i 9 more variables: flight <int>, tailnum <chr>, origin <chr>, dest <chr>,
## #   air_time <dbl>, distance <dbl>, hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- `select(flights, year, month, day)` selects year, month and day from flights.
- `select(flights, year:day)` selects all columns between year and day (inclusive) from flights.
- `select(flights, year, month, day)` selects all columns except those from year to day (inclusive).

Other useful select functions

- `flights %>% select(starts_with('d'))` #matches names beginning with d
- `flights %>% select(ends_with('e'))` #matches names ending with e
- `flights %>% select(contains('d'))` #matches names containing with d
- `flights %>% select(matches("(.)\\1"))` #matches any variables that contain repeated characters
- `flights %>% select(num_range("dest",1:15))` #matches if dest contains any -range between 1 to 15

Code Sample

```
flights %>% select(starts_with('d')) #matches names beginning with d
```

```
## # A tibble: 336,776 x 5
##      day dep_time dep_delay dest  distance
##    <int>    <int>     <dbl> <chr>    <dbl>
##  1     1      517         2 IAH       1400
##  2     1      533         4 IAH       1416
##  3     1      542         2 MIA       1089
##  4     1      544        -1 BQN       1576
##  5     1      554        -6 ATL        762
##  6     1      554        -4 ORD        719
##  7     1      555        -5 FLL       1065
##  8     1      557        -3 IAD        229
##  9     1      557        -3 MCO        944
## 10     1      558        -2 ORD        733
## # i 336,766 more rows
```

```
flights %>% select(ends_with('e')) #matches names ending with e
```

```
## # A tibble: 336,776 x 7
##    dep_time sched_dep_time arr_time sched_arr_time air_time distance minute
##       <int>          <int>    <int>          <int>    <dbl>    <dbl>  <dbl>
##  1      517            515      830            819      227     1400     15
##  2      533            529      850            830      227     1416     29
##  3      542            540      923            850      160     1089     40
##  4      544            545     1004           1022      183     1576     45
##  5      554            600      812            837      116      762      0
##  6      554            558      740            728      150      719     58
##  7      555            600      913            854      158     1065      0
```

```
##  8      557            600      709            723       53      229      0
##  9      557            600      838            846      140      944      0
## 10      558            600      753            745      138      733      0
## # i 336,766 more rows
```

```
flights %>% select(contains('d')) #matches names containing with d
```

```
## # A tibble: 336,776 x 8
##      day dep_time sched_dep_time dep_delay sched_arr_time arr_delay dest
##    <int>    <int>          <int>     <dbl>          <int>     <dbl> <chr>
##  1     1      517            515         2            819        11 IAH
##  2     1      533            529         4            830        20 IAH
##  3     1      542            540         2            850        33 MIA
##  4     1      544            545        -1           1022       -18 BQN
##  5     1      554            600        -6            837       -25 ATL
##  6     1      554            558        -4            728        12 ORD
##  7     1      555            600        -5            854        19 FLL
##  8     1      557            600        -3            723       -14 IAD
##  9     1      557            600        -3            846        -8 MCO
## 10     1      558            600        -2            745         8 ORD
## # i 336,766 more rows
## # i 1 more variable: distance <dbl>
```

```
flights %>% select(matches("(.)\\1")) #matches any variables that contain repeated characters
```

```
## # A tibble: 336,776 x 4
##    arr_time sched_arr_time arr_delay carrier
##       <int>          <int>     <dbl> <chr>
##  1      830            819        11 UA
##  2      850            830        20 UA
##  3      923            850        33 AA
##  4     1004           1022       -18 B6
##  5      812            837       -25 DL
##  6      740            728        12 UA
##  7      913            854        19 B6
##  8      709            723       -14 EV
##  9      838            846        -8 B6
## 10      753            745         8 AA
## # i 336,766 more rows
```

```
flights %>% select(num_range("dest",1:15)) #matches if dest contains any range between 1 to 15
```

```
## # A tibble: 336,776 x 0
```

Code Sample

```
# rename
rename(flights, tail_num = tailnum)
```

```
## # A tibble: 336,776 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
```

```
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 336,766 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tail_num <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```
# move to the start of the data frame
select(flights, time_hour, air_time, everything())
```

```
## # A tibble: 336,776 x 19
##    time_hour           air_time  year month   day dep_time sched_dep_time
##    <dttm>                 <dbl> <int> <int> <int>    <int>          <int>
##  1 2013-01-01 05:00:00      227  2013     1     1      517            515
##  2 2013-01-01 05:00:00      227  2013     1     1      533            529
##  3 2013-01-01 05:00:00      160  2013     1     1      542            540
##  4 2013-01-01 05:00:00      183  2013     1     1      544            545
##  5 2013-01-01 06:00:00      116  2013     1     1      554            600
##  6 2013-01-01 05:00:00      150  2013     1     1      554            558
##  7 2013-01-01 06:00:00      158  2013     1     1      555            600
##  8 2013-01-01 06:00:00       53  2013     1     1      557            600
##  9 2013-01-01 06:00:00      140  2013     1     1      557            600
## 10 2013-01-01 06:00:00      138  2013     1     1      558            600
## # i 336,766 more rows
## # i 12 more variables: dep_delay <dbl>, arr_time <int>, sched_arr_time <int>,
## #   arr_delay <dbl>, carrier <chr>, flight <int>, tailnum <chr>, origin <chr>,
## #   dest <chr>, distance <dbl>, hour <dbl>, minute <dbl>
```

Interpretation:

- select() can be used to rename variables, but it's rarely useful because it drops all of the variables not explicitly.
- so using rename(), which is a variant of select() that keeps all the variables that aren't explicitly mentioned.
- Another option is to use select() in conjunction with the everything() helper.

Mutate: Example

Code Sample

```
flights_sml <- select(flights,
                      year:day,
                      ends_with("delay"),
```

```
                      distance,
                      air_time)
```

Interpretation:

- adding some variables in flights_sml from flights.

Code Sample

```
mutate(flights_sml,
       gain = dep_delay - arr_delay,
       speed = distance / air_time * 60)
```

```
## # A tibble: 336,776 x 9
##     year month   day dep_delay arr_delay distance air_time  gain speed
##    <int> <int> <int>     <dbl>     <dbl>    <dbl>    <dbl> <dbl> <dbl>
##  1  2013     1     1         2        11     1400      227    -9  370.
##  2  2013     1     1         4        20     1416      227   -16  374.
##  3  2013     1     1         2        33     1089      160   -31  408.
##  4  2013     1     1        -1       -18     1576      183    17  517.
##  5  2013     1     1        -6       -25      762      116    19  394.
##  6  2013     1     1        -4        12      719      150   -16  288.
##  7  2013     1     1        -5        19     1065      158   -24  404.
##  8  2013     1     1        -3       -14      229       53    11  259.
##  9  2013     1     1        -3        -8      944      140     5  405.
## 10  2013     1     1        -2         8      733      138   -10  319.
## # i 336,766 more rows
```

Interpretation:

- two new columns, gain and speed, is added based on existing variables in the flights_sml dataset.

Code Sample

```
mutate(flights_sml,
       gain = dep_delay - arr_delay,
       hours = air_time / 60,
       gain_per_hour = gain / hours
)
```

```
## # A tibble: 336,776 x 10
##     year month   day dep_delay arr_delay distance air_time  gain hours
##    <int> <int> <int>     <dbl>     <dbl>    <dbl>    <dbl> <dbl> <dbl>
##  1  2013     1     1         2        11     1400      227    -9 3.78
##  2  2013     1     1         4        20     1416      227   -16 3.78
##  3  2013     1     1         2        33     1089      160   -31 2.67
##  4  2013     1     1        -1       -18     1576      183    17 3.05
##  5  2013     1     1        -6       -25      762      116    19 1.93
##  6  2013     1     1        -4        12      719      150   -16 2.5
##  7  2013     1     1        -5        19     1065      158   -24 2.63
##  8  2013     1     1        -3       -14      229       53    11 0.883
```

```
##  9  2013     1     1        -3        -8      944      140     5 2.33
## 10  2013     1     1        -2         8      733      138   -10 2.3
## # i 336,766 more rows
## # i 1 more variable: gain_per_hour <dbl>
```

Interpretation:

- three new columns (gain, hours, and gain_per_hour) were added based on existing variables which are computed in the flights_sml dataset.

Code Sample

```
# transmute
# If you only want to keep the new variables, use transmute()
transmute(
  flights,
  gain = dep_delay - arr_delay,
  hours = air_time / 60,
  gain_per_hour = gain / hours
)
```

```
## # A tibble: 336,776 x 3
##     gain hours gain_per_hour
##    <dbl> <dbl>         <dbl>
##  1    -9 3.78          -2.38
##  2   -16 3.78          -4.23
##  3   -31 2.67         -11.6
##  4    17 3.05           5.57
##  5    19 1.93           9.83
##  6   -16 2.5           -6.4
##  7   -24 2.63          -9.11
##  8    11 0.883         12.5
##  9     5 2.33           2.14
## 10   -10 2.3           -4.35
## # i 336,766 more rows
```

Interpretation:

- three new variables (gain, hours, and gain_per_hour) based on existing variables in the flights dataset while discarding all other variables.

Code Sample

```
transmute(flights,
          dep_time,
          hour = dep_time %/% 100,
          minute = dep_time %% 100)
```

```
## # A tibble: 336,776 x 3
##    dep_time  hour minute
##       <int> <dbl>  <dbl>
```

```
##  1      517     5     17
##  2      533     5     33
##  3      542     5     42
##  4      544     5     44
##  5      554     5     54
##  6      554     5     54
##  7      555     5     55
##  8      557     5     57
##  9      557     5     57
## 10      558     5     58
## # i 336,766 more rows
```

Interpretation:

- this code creates two new variables (hour and minute) from the dep_time variable in the flights dataset, while still retaining the original dep_time variable in the output and discard all other columns.

Code Sample

```
# Select columns by name
select(flights, year, month, day)
```

```
## # A tibble: 336,776 x 3
##     year month   day
##    <int> <int> <int>
##  1  2013     1     1
##  2  2013     1     1
##  3  2013     1     1
##  4  2013     1     1
##  5  2013     1     1
##  6  2013     1     1
##  7  2013     1     1
##  8  2013     1     1
##  9  2013     1     1
## 10  2013     1     1
## # i 336,766 more rows
```

```
# Select all columns between year and day (inclusive)
select(flights, year:day)
```

```
## # A tibble: 336,776 x 3
##     year month   day
##    <int> <int> <int>
##  1  2013     1     1
##  2  2013     1     1
##  3  2013     1     1
##  4  2013     1     1
##  5  2013     1     1
##  6  2013     1     1
##  7  2013     1     1
##  8  2013     1     1
##  9  2013     1     1
## 10  2013     1     1
## # i 336,766 more rows
```

```r
# Select all columns except those from year to day (inclusive)
select(flights, -(year:day))
```

```
## # A tibble: 336,776 x 16
##    dep_time sched_dep_time dep_delay arr_time sched_arr_time arr_delay carrier
##       <int>          <int>     <dbl>    <int>          <int>     <dbl> <chr>
##  1      517            515         2      830            819        11 UA
##  2      533            529         4      850            830        20 UA
##  3      542            540         2      923            850        33 AA
##  4      544            545        -1     1004           1022       -18 B6
##  5      554            600        -6      812            837       -25 DL
##  6      554            558        -4      740            728        12 UA
##  7      555            600        -5      913            854        19 B6
##  8      557            600        -3      709            723       -14 EV
##  9      557            600        -3      838            846        -8 B6
## 10      558            600        -2      753            745         8 AA
## # i 336,766 more rows
## # i 9 more variables: flight <int>, tailnum <chr>, origin <chr>, dest <chr>,
## #   air_time <dbl>, distance <dbl>, hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- `select(flights, year, month, day)` selects year, month and day from flights.
- `select(flights, year:day)` selects all columns between year and day (inclusive) from flights.
- `select(flights, year, month, day)` selects all columns except those from year to day (inclusive).

Summarise Example

Code Sample

```r
summarise(flights, delay = mean(dep_delay, na.rm = TRUE))
```

```
## # A tibble: 1 x 1
##   delay
##   <dbl>
## 1  12.6
```

Interpretation:

- computes the mean departure delay for the flights dataset, removing any missing values in the dep_delay column.

Code Sample

```r
summarise(flights, delay = mean(dep_delay, na.rm = TRUE))
```

```
## # A tibble: 1 x 1
##   delay
##   <dbl>
## 1  12.6
```

Interpretation:

- computes the mean departure delay for the flights dataset, removing any missing values in the dep_delay column.

Code Sample

```
summarise(flights, delay = mean(dep_delay, na.rm = TRUE))
```

```
## # A tibble: 1 x 1
##   delay
##   <dbl>
## 1  12.6
```

Interpretation:

- computes the mean departure delay for the flights dataset, removing any missing values in the dep_delay column.

Code Sample

```
summarise(flights, delay = mean(dep_delay, na.rm = TRUE))
```

```
## # A tibble: 1 x 1
##   delay
##   <dbl>
## 1  12.6
```

Interpretation:

- computes the mean departure delay for the flights dataset, removing any missing values in the dep_delay column.

Code Sample

```
summarise(flights, delay = mean(dep_delay, na.rm = TRUE))
```

```
## # A tibble: 1 x 1
##   delay
##   <dbl>
## 1  12.6
```

Interpretation:

- computes the mean departure delay for the flights dataset, removing any missing values in the dep_delay column.

Code Sample

```
by_day <- group_by(flights, year, month, day)
summarise(by_day, delay = mean(dep_delay, na.rm = TRUE))
```

```
## `summarise()` has grouped output by 'year', 'month'. You can override using the
## `.groups` argument.
```

```
## # A tibble: 365 x 4
## # Groups:   year, month [12]
##     year month   day delay
##    <int> <int> <int> <dbl>
##  1  2013     1     1 11.5
##  2  2013     1     2 13.9
##  3  2013     1     3 11.0
##  4  2013     1     4  8.95
##  5  2013     1     5  5.73
##  6  2013     1     6  7.15
##  7  2013     1     7  5.42
##  8  2013     1     8  2.55
##  9  2013     1     9  2.28
## 10  2013     1    10  2.84
## # i 355 more rows
```

Interpretation:

- computes the mean departure delay for each day in the dataset by grouping the data by year, month, and day, and then summarizing the grouped data by average delayed time.

Code Sample

```
delays <- flights %>%
  group_by(dest) %>%
  summarise(
    count = n(),
    dist = mean(distance, na.rm = TRUE),
    delay = mean(arr_delay, na.rm =
                   TRUE)
  ) %>%
  filter(count > 20, dest != "HNL")
delays
```

```
## # A tibble: 96 x 4
##    dest  count  dist delay
##    <chr> <int> <dbl> <dbl>
##  1 ABQ     254 1826   4.38
##  2 ACK     265  199   4.85
##  3 ALB     439  143  14.4
##  4 ATL   17215  757. 11.3
##  5 AUS    2439 1514.  6.02
##  6 AVL     275  584.  8.00
##  7 BDL     443  116   7.05
```

```
##  8 BGR     375  378   8.03
##  9 BHM     297  866. 16.9
## 10 BNA    6333  758. 11.8
## # i 86 more rows
```

Interpretation:

- computes summary statistics on flight delays, including the count of flights, the average distance, and the average arrival delay, grouped by destination. It then filters the results to exclude destinations with greater than 20 flights and the destination of Honolulu.

Code Sample

```
flights %>%
  group_by(year, month, day) %>%
  summarise(mean = mean(dep_delay))
```

```
## `summarise()` has grouped output by 'year', 'month'. You can override using the
## `.groups` argument.
```

```
## # A tibble: 365 x 4
## # Groups:   year, month [12]
##     year month   day  mean
##    <int> <int> <int> <dbl>
##  1  2013     1     1    NA
##  2  2013     1     2    NA
##  3  2013     1     3    NA
##  4  2013     1     4    NA
##  5  2013     1     5    NA
##  6  2013     1     6    NA
##  7  2013     1     7    NA
##  8  2013     1     8    NA
##  9  2013     1     9    NA
## 10  2013     1    10    NA
## # i 355 more rows
```

Interpretation:

- calculates the mean departure delay for each day by grouping the data by year, month, and day, and then summarising the grouped data.

Code Sample

```
flights %>%
  group_by(year, month, day) %>%
  summarise(mean = mean(dep_delay, na.rm = TRUE))
```

```
## `summarise()` has grouped output by 'year', 'month'. You can override using the
## `.groups` argument.
```

```
## # A tibble: 365 x 4
## # Groups:   year, month [12]
##     year month   day  mean
##    <int> <int> <int> <dbl>
##  1  2013     1     1 11.5
##  2  2013     1     2 13.9
##  3  2013     1     3 11.0
##  4  2013     1     4  8.95
##  5  2013     1     5  5.73
##  6  2013     1     6  7.15
##  7  2013     1     7  5.42
##  8  2013     1     8  2.55
##  9  2013     1     9  2.28
## 10  2013     1    10  2.84
## # i 355 more rows
```

Interpretation:

- calculates the mean departure delay for each day by grouping the data by year, month, and day, and then summarizing the grouped data after removing null from the data in the dep_delay column while computing the mean.

Code Sample

```
not_cancelled <- flights %>%
  filter(!is.na(dep_delay),!is.na(arr_delay))
```

Interpretation:

- not_cancelled contains only flights that were not cancelled, based on the absence of missing values in the departure delay and arrival delay columns.
- ! negates the TRUE value to FALSE and vice versa.

Code Sample

```
not_cancelled %>%
  group_by(year, month, day) %>%
  summarise(mean =
              mean(dep_delay))
```

```
## `summarise()` has grouped output by 'year', 'month'. You can override using the
## `.groups` argument.
```

```
## # A tibble: 365 x 4
## # Groups:   year, month [12]
##     year month   day  mean
##    <int> <int> <int> <dbl>
##  1  2013     1     1 11.4
##  2  2013     1     2 13.7
##  3  2013     1     3 10.9
##  4  2013     1     4  8.97
```

```
##  5  2013     1     5  5.73
##  6  2013     1     6  7.15
##  7  2013     1     7  5.42
##  8  2013     1     8  2.56
##  9  2013     1     9  2.30
## 10  2013     1    10  2.84
## # i 355 more rows
```

Interpretation:

- calculates the mean departure delay for each day in the not_cancelled dataset by grouping the data by year, month, and day, and then summarizing the grouped data.

Code Sample

```
delays <- not_cancelled %>%
  group_by(tailnum) %>%
  summarise(
    delay = mean(arr_delay)
  )
delays
```

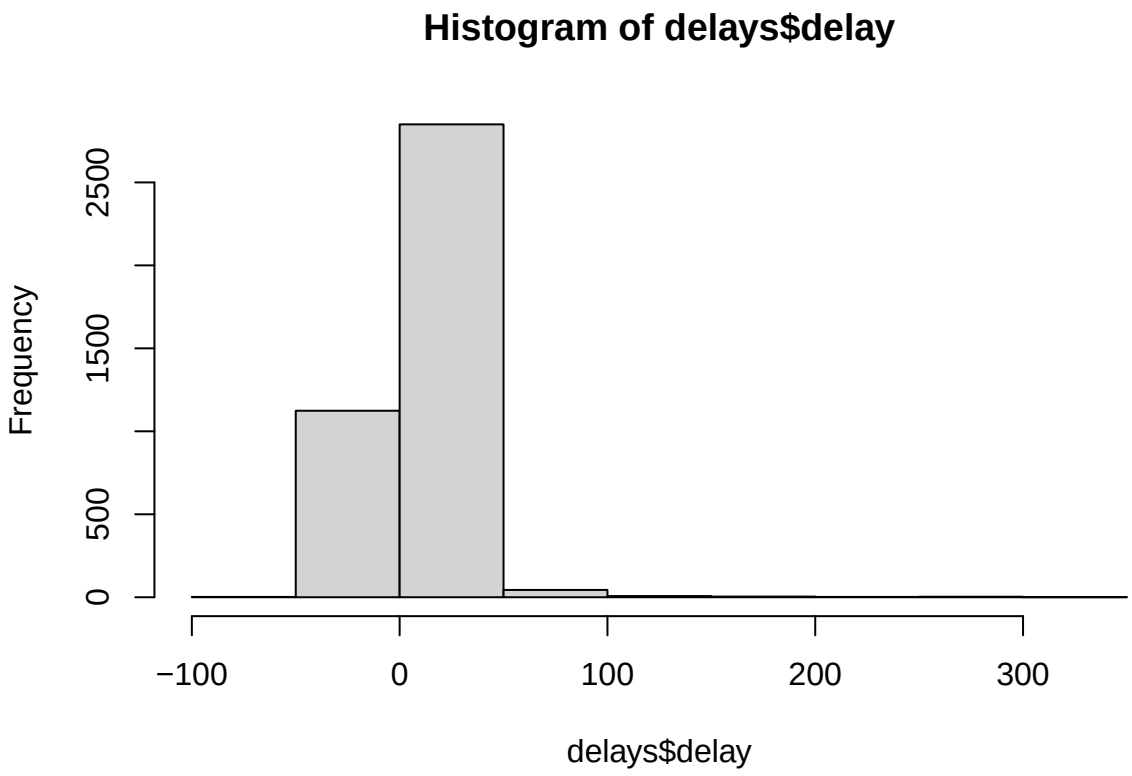
```
## # A tibble: 4,037 x 2
##    tailnum  delay
##    <chr>    <dbl>
##  1 D942DN  31.5
##  2 N0EGMQ   9.98
##  3 N10156  12.7
##  4 N102UW   2.94
##  5 N103US  -6.93
##  6 N104UW   1.80
##  7 N10575  20.7
##  8 N105UW  -0.267
##  9 N107US  -5.73
## 10 N108UW  -1.25
## # i 4,027 more rows
```

Interpretation:

- calculates the average arrival delay for each planes in the not_cancelled dataset by grouping the data by tailnum and then summarizing the grouped data.

Code Sample

```
hist(delays$delay)
```

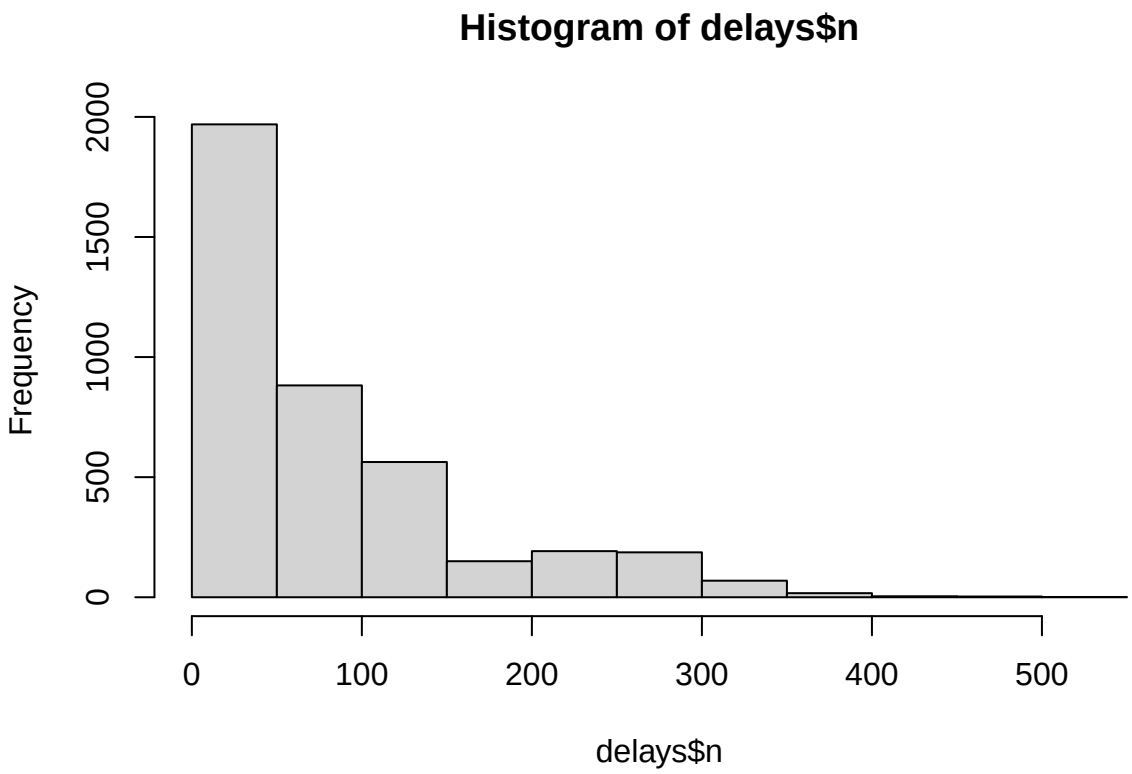


Interpretation:

- creates a histogram of the average arrival delays (delay) column.

Code Sample

```
delays <- not_cancelled %>%
  group_by(tailnum) %>%
  summarise(
    delay = mean(arr_delay,
                 na.rm = TRUE),
    n = n()
  )
hist(delays$n)
```

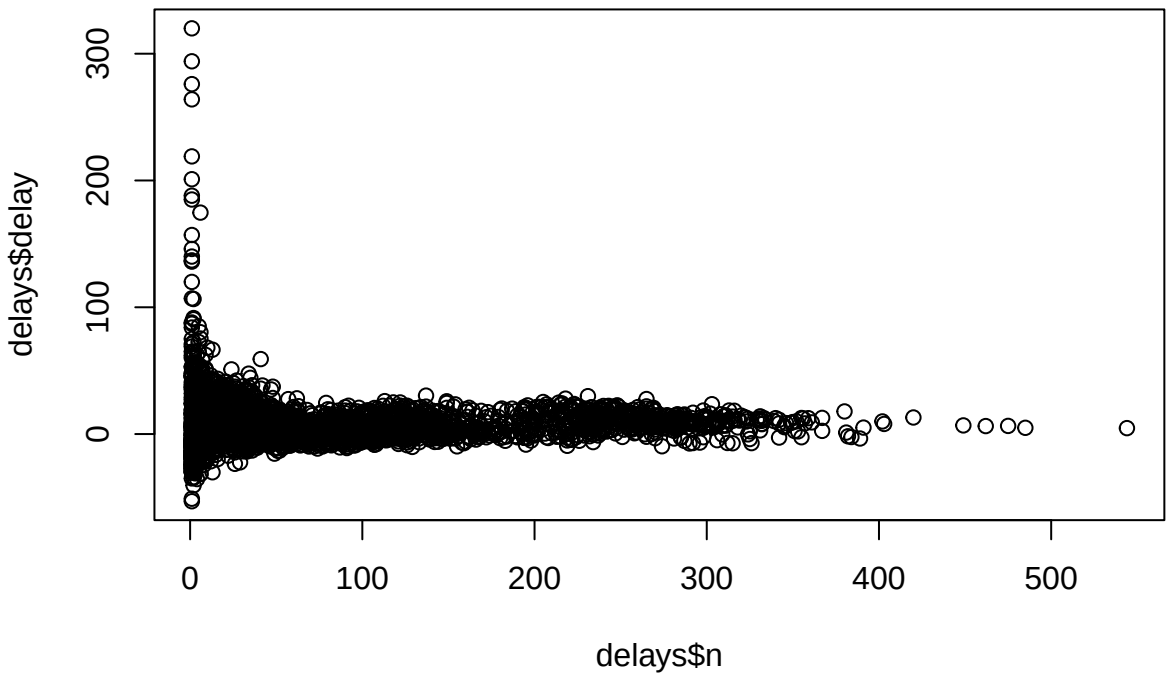


Interpretation:

- creates a histogram of the counts (n) of flights for each tailnum.

Code Sample

```
plot(delays$n, delays$delay)
```



Interpretation:

- creates a scatter plot showing the relationship between the count of flights and the average arrival delay for each aircraft.
- even though creating histogram and scatter plot is good idead but if we can't make sense or interpret it, it will be useless in analysis.

Code Sample

```
# When do the first and last flights leave each day
not_cancelled %>%
  group_by(year, month, day) %>%
  summarise(
    first = min(dep_time),
    last = max(dep_time)
  )
```

```
## `summarise()` has grouped output by 'year', 'month'. You can override using the
## `.groups` argument.
```

```
## # A tibble: 365 x 5
## # Groups:   year, month [12]
##     year month   day first  last
##    <int> <int> <int> <int> <int>
##  1  2013     1     1   517  2356
```

```
##  2  2013     1     2    42  2354
##  3  2013     1     3    32  2349
##  4  2013     1     4    25  2358
##  5  2013     1     5    14  2357
##  6  2013     1     6    16  2355
##  7  2013     1     7    49  2359
##  8  2013     1     8   454  2351
##  9  2013     1     9     2  2252
## 10  2013     1    10     3  2320
## # i 355 more rows
```

Interpretation:

- calculates the first and last departure times for each day in the not_cancelled dataset by grouping the data by year, month, and day, and then summarizing the grouped data.

Code Sample

```
# Why is distance to some destinations more variable than to others?
not_cancelled %>%
  group_by(dest) %>%
  summarise(distance_sd =
              sd(distance)) %>%
  arrange(desc(distance_sd))
```

```
## # A tibble: 104 x 2
##    dest  distance_sd
##    <chr>       <dbl>
##  1 EGE         10.5
##  2 SAN         10.4
##  3 SFO         10.2
##  4 HNL         10.0
##  5 SEA          9.98
##  6 LAS          9.91
##  7 PDX          9.87
##  8 PHX          9.86
##  9 LAX          9.66
## 10 IND          9.46
## # i 94 more rows
```

Interpretation:

- provides information about the variability of distances for each destination in the not_cancelled dataset, with destinations having higher standard deviations of distances appearing first in the resulting dataset.

Code Sample

```
# Which destinations have the most carriers?
not_cancelled %>%
  group_by(dest) %>%
  summarise(carriers =
              n_distinct(carrier)) %>%
  arrange(desc(carriers))
```

```
## # A tibble: 104 x 2
##    dest  carriers
##    <chr>    <int>
##  1 ATL          7
##  2 BOS          7
##  3 CLT          7
##  4 ORD          7
##  5 TPA          7
##  6 AUS          6
##  7 DCA          6
##  8 DTW          6
##  9 IAD          6
## 10 MSP          6
## # i 94 more rows
```

Interpretation:

- summarizes the destination by most number of carriers.

Code Sample

```
# How many flights left before 5am? (these usually indicate delayed flights from the previous day)
not_cancelled %>%
  group_by(year, month, day) %>%
  summarise(n_early =
              sum(dep_time < 500))
```

```
## `summarise()` has grouped output by 'year', 'month'. You can override using the
## `.groups` argument.
```

```
## # A tibble: 365 x 4
## # Groups:   year, month [12]
##     year month   day n_early
##    <int> <int> <int>   <int>
##  1  2013     1     1       0
##  2  2013     1     2       3
##  3  2013     1     3       4
##  4  2013     1     4       3
##  5  2013     1     5       3
##  6  2013     1     6       2
##  7  2013     1     7       2
##  8  2013     1     8       1
##  9  2013     1     9       3
## 10  2013     1    10       3
## # i 355 more rows
```

Interpretation:

- summarizes the number of flights departing before 5:00 AM for each day in the not_cancelled dataset, grouped by year, month, and day.

Code Sample

```
# What proportion of flights are delayed by more than an hour?
not_cancelled %>%
  group_by(year, month, day) %>%
  summarise(hour_prop =
              mean(arr_delay > 60))
```

```
## `summarise()` has grouped output by 'year', 'month'. You can override using the
## `.groups` argument.
```

```
## # A tibble: 365 x 4
## # Groups:   year, month [12]
##     year month   day hour_prop
##    <int> <int> <int>     <dbl>
##  1  2013     1     1    0.0722
##  2  2013     1     2    0.0851
##  3  2013     1     3    0.0567
##  4  2013     1     4    0.0396
##  5  2013     1     5    0.0349
##  6  2013     1     6    0.0470
##  7  2013     1     7    0.0333
##  8  2013     1     8    0.0213
##  9  2013     1     9    0.0202
## 10  2013     1    10    0.0183
## # i 355 more rows
```

Interpretation:

- summarizes the proportion of flights with arrival delays exceeding 60 minutes for each day in the not_cancelled dataset, grouped by year, month, and day.

Code Sample

```
#Find all groups bigger than a threshold:
popular_dests <- flights %>%
  group_by(dest) %>%
  filter(n() > 365)
popular_dests
```

```
## # A tibble: 332,577 x 19
## # Groups:   dest [77]
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      517            515         2      830            819
##  2  2013     1     1      533            529         4      850            830
##  3  2013     1     1      542            540         2      923            850
##  4  2013     1     1      544            545        -1     1004           1022
##  5  2013     1     1      554            600        -6      812            837
##  6  2013     1     1      554            558        -4      740            728
##  7  2013     1     1      555            600        -5      913            854
##  8  2013     1     1      557            600        -3      709            723
```

```
##  9  2013     1     1      557            600        -3      838            846
## 10  2013     1     1      558            600        -2      753            745
## # i 332,567 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

```
head(popular_dests$dest)
```

```
## [1] "IAH" "IAH" "MIA" "BQN" "ATL" "ORD"
```

```
tail(popular_dests$dest)
```

```
## [1] "BNA" "DCA" "SYR" "BNA" "CLE" "RDU"
```

Interpretation:

- summarizes the destinations that are popular based on having more than 365 flights in the flights dataset.
- head() and tail() functions are then used to display the first and last few destinations in the popular_dests dataset, respectively.

Slice function

Code Sample

```
#What will happen?
flights %>% slice(1L)
```

```
## # A tibble: 1 x 19
##    year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##   <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
## 1  2013     1     1      517            515         2      830            819
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- slice the first row of the flights dataset.

Code Sample

```
#What will happen?
flights %>% slice(n())
```

```
## # A tibble: 1 x 19
##    year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##   <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
## 1  2013     9    30       NA            840        NA       NA           1020
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation: - slice the last row of the flights dataset.

Code Sample

```
#What will happen?
flights %>% slice(5:n())
```

```
## # A tibble: 336,772 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      554            600        -6      812            837
##  2  2013     1     1      554            558        -4      740            728
##  3  2013     1     1      555            600        -5      913            854
##  4  2013     1     1      557            600        -3      709            723
##  5  2013     1     1      557            600        -3      838            846
##  6  2013     1     1      558            600        -2      753            745
##  7  2013     1     1      558            600        -2      849            851
##  8  2013     1     1      558            600        -2      853            856
##  9  2013     1     1      558            600        -2      924            917
## 10  2013     1     1      558            600        -2      923            937
## # i 336,762 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- will slice rows from the 5th row to the last row of the flights dataset.

Code Sample

```
#What will happen?
slice(flights,-(1:4))
```

```
## # A tibble: 336,772 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     1     1      554            600        -6      812            837
##  2  2013     1     1      554            558        -4      740            728
##  3  2013     1     1      555            600        -5      913            854
##  4  2013     1     1      557            600        -3      709            723
##  5  2013     1     1      557            600        -3      838            846
##  6  2013     1     1      558            600        -2      753            745
##  7  2013     1     1      558            600        -2      849            851
##  8  2013     1     1      558            600        -2      853            856
##  9  2013     1     1      558            600        -2      924            917
## 10  2013     1     1      558            600        -2      923            937
## # i 336,762 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- will remove the first four rows from the flights dataset.

Code Sample

```
#What will happen?
flights %>% slice_sample(n=5)
```

```
## # A tibble: 5 x 19
##    year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##   <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
## 1  2013     4    11     1610           1529        41     1729           1648
## 2  2013    10    25      626            600        26      733            715
## 3  2013     2    28     1125           1115        10     1229           1255
## 4  2013     9    28      822            822         0     1248           1215
## 5  2013     5    27     1221           1230        -9     1314           1338
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- will randomly sample 5 rows from the flights dataset without replacement.

Code Sample

```
#What will happen?
flights %>% slice_sample(n=5, replace = TRUE)
```

```
## # A tibble: 5 x 19
##    year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##   <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
## 1  2013     4    24     1859           1815        44     2115           1948
## 2  2013    11    15     1947           1955        -8     2147           2207
## 3  2013     5    18      843            820        23      951            930
## 4  2013     3    22      815            820        -5      928            944
## 5  2013    12     1     1603           1600         3     1807           1824
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- will randomly sample 5 rows from the flights dataset with replacement, meaning the same row may be selected more than once.

Code Sample

```
#What will happen?
set.seed(123)
train_data <- flights %>% slice_sample(prop=0.8)
train_data
```

```
## # A tibble: 269,420 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     4    26      730            655        35      901            820
##  2  2013     2    26     1714           1720        -6     2031           2040
##  3  2013     2    15     1442           1445        -3     1634           1647
##  4  2013     3    27     1444           1445        -1     1556           1604
##  5  2013     6     5     1428           1430        -2     1537           1555
##  6  2013     2    16      613            600        13      731            735
##  7  2013     5     1      848            850        -2      947           1014
##  8  2013    10    20     1918           1855        23     2132           2130
##  9  2013    11    11      825            835       -10      942           1000
## 10  2013     8    31      656            700        -4      904            929
## # i 269,410 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- sets the random seed to ensure reproducibility of random sampling.
- `train_data <- flights %>% slice_sample(prop = 0.8)` creates a training dataset (train_data) by randomly sampling 80% of the rows from the flights dataset without replacement.

Code Sample

```
test_data <- flights %>% slice_sample(prop=0.2)
test_data
```

```
## # A tibble: 67,355 x 19
##     year month   day dep_time sched_dep_time dep_delay arr_time sched_arr_time
##    <int> <int> <int>    <int>          <int>     <dbl>    <int>          <int>
##  1  2013     8    23     1605           1559         6     1700           1721
##  2  2013     5     2     1222           1205        17     1444           1425
##  3  2013     4     7     1957           2000        -3     2204           2208
##  4  2013     4    16      639            640        -1      837            851
##  5  2013     4     2     1132           1135        -3     1311           1255
##  6  2013     8     7     1006            959         7     1116           1114
##  7  2013     9    26     1826           1829        -3     2014           2033
##  8  2013     5    19     1945           1925        20     2252           2250
##  9  2013     7    15     1654           1659        -5     1843           1905
## 10  2013     4    13      741            745        -4      959           1012
## # i 67,345 more rows
## # i 11 more variables: arr_delay <dbl>, carrier <chr>, flight <int>,
## #   tailnum <chr>, origin <chr>, dest <chr>, air_time <dbl>, distance <dbl>,
## #   hour <dbl>, minute <dbl>, time_hour <dttm>
```

Interpretation:

- sets the random seed to ensure reproducibility of random sampling.
- `test_data <- flights %>% slice_sample(prop=0.2)` creates a testing dataset (test_data) by randomly sampling 20% of the rows from the flights dataset without replacement.