

# Intro to R

Subsetting Data in R

# Recap

- R functions as a calculator
- Use `c()` to **combine** vectors
- Use `<-` to save (assign) values to objects
- if you don't use `<-` to reassign objects that you want to modify, they will stay the same
- `length()`, `class()`, and `str()` tell you information about an object
- `head()` and `tail()` can also help you inspect an object
- `readr` has helpful functions like `read_csv()` that can help you import data into R

[Cheatsheet](#)

# Overview

In this module, we will show you how to:

1. Look at your data in different ways
2. Create a data frame and a tibble
3. Create new variables/make rownames a column
4. Rename columns of a data frame
5. Subset rows of a data frame
6. Subset columns of a data frame
7. Add/remove new columns to a data frame
8. Order the columns of a data frame
9. Order the rows of a data frame

# Setup

We will largely focus on the `dplyr` package which is part of the `tidyverse`.



Some resources on how to use `dplyr`:

- <https://dplyr.tidyverse.org/>
- <https://cran.r-project.org/web/packages/dplyr/vignettes/dplyr.html>
- <https://www.opencasestudies.org/>

# Why dplyr?



hadley commented on May 26, 2016

Member ...

The d is for dataframes, the plyr is to evoke pliers. Pronounce however you like.



The `dplyr` package is one of the most helpful packages for altering your data to get it into a form that is useful for creating visualizations, summarizing, or more deeply analyzing.

So you can imagine using pliers on your data.



## Loading in dplyr and tidyverse

See this website for a list of the packages included in the tidyverse:

<https://www.tidyverse.org/packages/>

```
library(tidyverse) # loads dplyr and other packages!
```

## Getting data to work with

Here we use one of the datasets that comes with base R called `mtcars`. We will now create a toy data frame named `df` using this data. This way we can alter `df` without worrying about changing `mtcars`.

```
df <- mtcars # df is a copy of mtcars  
head(df) # changing df does **not** change mtcars!
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

## Checking the data `dim()`

The `dim()`, `nrow()`, and `ncol()` functions are good options to check the dimensions of your data before moving forward.

```
dim(df) # rows, columns
```

```
[1] 32 11
```

```
nrow(df) # number of rows
```

```
[1] 32
```

```
ncol(df) # number of columns
```

```
[1] 11
```



## Checking the data: `glimpse()`

In addition to `head()` and `tail()`, the `glimpse()` function of the `dplyr` package is another great function to look at your data.

```
glimpse(df)
```

```
Rows: 32
```

```
Columns: 11
```

```
$ mpg   <dbl> 21.0, 21.0, 22.8, 21.4, 18.7, 18.1, 14.3, 24.4, 22.8, 19.2, 17.8,  
$ cyl   <dbl> 6, 6, 4, 6, 8, 6, 8, 4, 4, 6, 6, 8, 8, 8, 8, 8, 8, 4, 4, 4, 4, 8,  
$ disp  <dbl> 160.0, 160.0, 108.0, 258.0, 360.0, 225.0, 360.0, 146.7, 140.8, 16  
$ hp    <dbl> 110, 110, 93, 110, 175, 105, 245, 62, 95, 123, 123, 180, 180, 180  
$ drat  <dbl> 3.90, 3.90, 3.85, 3.08, 3.15, 2.76, 3.21, 3.69, 3.92, 3.92, 3.92,  
$ wt    <dbl> 2.620, 2.875, 2.320, 3.215, 3.440, 3.460, 3.570, 3.190, 3.150, 3.  
$ qsec  <dbl> 16.46, 17.02, 18.61, 19.44, 17.02, 20.22, 15.84, 20.00, 22.90, 18  
$ vs    <dbl> 0, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 1, 1, 1, 0,  
$ am    <dbl> 1, 1, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 1, 1, 0, 0,  
$ gear  <dbl> 4, 4, 4, 3, 3, 3, 3, 4, 4, 4, 4, 3, 3, 3, 3, 3, 3, 4, 4, 4, 3, 3,  
$ carb  <dbl> 4, 4, 1, 1, 2, 1, 4, 2, 2, 4, 4, 3, 3, 3, 4, 4, 4, 1, 2, 1, 1, 2,
```

## Checking your data: `slice_sample()`

What if you want to see the middle of your data? You can use the `slice_sample()` function of the `dplyr` package to see a random set of rows. You can specify the number of rows with the `n` argument or use a proportion with the `prop` argument.

```
slice_sample(df, n = 3)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Maserati Bora	15.0	8	301.0	335	3.54	3.57	14.60	0	1	5	8
Hornet Sportabout	18.7	8	360.0	175	3.15	3.44	17.02	0	0	3	2
Merc 230	22.8	4	140.8	95	3.92	3.15	22.90	1	0	4	2

```
slice_sample(df, prop = .2)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.60	0	1	5	8
Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1

# skimr package

```
library(skimr)
skim(df)
```

```
> skim(df)
```

```
— Data Summary —
```

	Values
Name	df
Number of rows	32
Number of columns	11

```
-----
Column type frequency:
  numeric
```

11

```
-----
Group variables
```

None

```
— Variable type: numeric —
```

	skim_variable	n_missing	complete_rate	mean	sd	p0	p25	p50	p75	p100	hist
1	mpg	0	1	20.1	6.03	10.4	15.4	19.2	22.8	33.9	
2	cyl	0	1	6.19	1.79	4	4	6	8	8	
3	disp	0	1	231.	124.	71.1	121.	196.	326	472	
4	hp	0	1	147.	68.6	52	96.5	123	180	335	
5	drat	0	1	3.60	0.535	2.76	3.08	3.70	3.92	4.93	
6	wt	0	1	3.22	0.978	1.51	2.58	3.32	3.61	5.42	
7	qsec	0	1	17.8	1.79	14.5	16.9	17.7	18.9	22.9	
8	vs	0	1	0.438	0.504	0	0	0	1	1	
9	am	0	1	0.406	0.499	0	0	0	1	1	
10	gear	0	1	3.69	0.738	3	3	4	4	5	
11	carb	0	1	2.81	1.62	1	2	2	4	8	

# Making data frames (base R) and tibbles (tidyverse)

# Creating data frames using base R data frame function

```
data.frame(df)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
Merc 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
Merc 450SE	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
Merc 450SL	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
Lincoln Continental	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4
Chrysler Imperial	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
AMC Javelin	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2
Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
Lotus Europa	29.4	4	95.1	113	3.77	1.510	16.00	1	1	5	2

## Keep in mind...

Need to assign the output of the function to keep the result!

```
df_updated <- data.frame(df)  
# this would overwrite the existing df object  
df <- data.frame(df)
```

## Or create a data frame when reading in the file

Or directly when reading in a csv with the `read.csv()` function (also base R)

```
# function comes from base R - no package loading required  
df_example_readr <- read.csv(file = "documents/data_analysis/data_file.csv")
```

## tibble

We can create a **fancier** version of the previous data frame which can be really helpful.



## Creating a **tibble**

If we would like to create a **tibble** (“fancy” data frame), we can use the **tibble()** function.

```
tbl <- tibble(df)
tbl
```

```
# A tibble: 32 × 11
   mpg   cyl  disp    hp  drat    wt   qsec    vs  am  gear carb
  <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1    21     6   160   110   3.9    2.62  16.5     0     1     4     4
2    21     6   160   110   3.9    2.88  17.0     0     1     4     4
3   22.8     4   108    93   3.85    2.32  18.6     1     1     4     1
4   21.4     6   258   110   3.08    3.22  19.4     1     0     3     1
5   18.7     8   360   175   3.15    3.44  17.0     0     0     3     2
6   18.1     6   225   105   2.76    3.46  20.2     1     0     3     1
7   14.3     8   360   245   3.21    3.57  15.8     0     0     3     4
8   24.4     4   147.    62   3.69    3.19   20      1     0     4     2
9   22.8     4   141.    95   3.92    3.15  22.9     1     0     4     2
10  19.2     6   168.   123   3.92    3.44  18.3     1     0     4     4
# ... with 22 more rows
```

Note don't necessarily need to use **head()** - tibbles conveniently print a portion of the data.

## tibbles from read\_csv()

Alternatively we can read data files using the `tidyverse` with the `read_csv()` function of the `readr` package from the `tidyverse` to make a tibble.

```
df_example_readr <- read_csv(file = "documents/data_analysis/data_file.csv")
```

You may start to notice how the `tidyverse` package work well together!

# Summary of tibbles and data frames

## **Base R:**

Using `read.csv()` and `data.frame()` you can make data frames

## **Tidyverse (fancier version):**

Using `read_csv()` and `tibble()` you can make tibbles

We generally recommend using tibbles, but you are likely to run into lots of data frames with your work.

## Data frames vs tibbles

In the “tidy” data format, rownames are removed. For example, `df` has each car name as a row name. Here we use the `head()` function to see the first 2 rows of each using the `n` argument. In this case we would want to make the rownames a new column first before making into a tibble.

```
head(df, n = 2)
```

		mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda	RX4	21	6	160	110	3.9	2.620	16.46	0	1	4	4
Mazda	RX4 Wag	21	6	160	110	3.9	2.875	17.02	0	1	4	4

```
head(tibble(df), n = 2)
```

```
# A tibble: 2 × 11
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	21	6	160	110	3.9	2.88	17.0	0	1	4	4

## rownames\_to\_column function

If you run into losing a variable contained in your row names, you can also use `rownames_to_column` (of `tibble` package) to add it before turning it into a `tibble` to keep them:

```
# general format! not code!  
{data you are creating or changing} <- # reassign if you want to keep changes  
  rownames_to_column({data you are using},  
    {Name of column you are making from rownames})
```

```
head(df, n = 2)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	21	6	160	110	3.9	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21	6	160	110	3.9	2.875	17.02	0	1	4	4

```
df <- rownames_to_column(df, "car")  
head(df, n = 2)
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Mazda RX4	21	6	160	110	3.9	2.620	16.46	0	1	4	4
2	Mazda RX4 Wag	21	6	160	110	3.9	2.875	17.02	0	1	4	4

## Let's stick with the tibble version

```
tb <- tibble(df)
tb
```

```
# A tibble: 32 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4 ...	21	6	160	110	3.9	2.88	17.0	0	1	4	
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
4	Hornet 4 D...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	
5	Hornet Spo...	18.7	8	360	175	3.15	3.44	17.0	0	0	3	
6	Valiant	18.1	6	225	105	2.76	3.46	20.2	1	0	3	
7	Duster 360	14.3	8	360	245	3.21	3.57	15.8	0	0	3	
8	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	
9	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	
10	Merc 280	19.2	6	168.	123	3.92	3.44	18.3	1	0	4	

```
# ... with 22 more rows
```

# Renaming Columns

# Renaming Columns of a data frame or tibble

To rename columns in `dplyr`, you can use the `rename` function.

For example, let's rename `mpg` to `MPG`. Notice the new name is listed **first**!

*# general format! not code!*

```
{data you are creating or changing} <- rename({data you are using},  
                                              {New Name} = {Old name})
```

```
tb <- rename(tb, MPG = mpg)  
head(tb)
```

# A tibble: 6 × 12

	car <chr>	MPG <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4 W...	21	6	160	110	3.9	2.88	17.0	0	1	4	
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
4	Hornet 4 Dr...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	
5	Hornet Spor...	18.7	8	360	175	3.15	3.44	17.0	0	0	3	
6	Valiant	18.1	6	225	105	2.76	3.46	20.2	1	0	3	



## Take Care with Column Names

When you can, avoid spaces, special punctuation, or numbers in column names, as these require special treatment to refer to them.

See [https://jhudatascience.org/intro\\_to\\_r/quotes\\_vs\\_backticks.html](https://jhudatascience.org/intro_to_r/quotes_vs_backticks.html) for more guidance.

```
tb <- rename(tb, MPG! = MPG) # this will cause an error
```

```
tb_rename <- rename(tb, `MPG!` = MPG) # this will work  
head(tb_rename, 2)
```

```
# A tibble: 2 × 12  
  car      `MPG!`  cyl  disp  hp  drat   wt  qsec    vs  am  gear  ca  
  <chr>    <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <db  
1 Mazda RX4      21     6   160   110   3.9   2.62  16.5     0     1     4  
2 Mazda RX4 ...  21     6   160   110   3.9   2.88  17.0     0     1     4
```

## Unusual Column Names

It's best to avoid unusual column names where possible, as things get tricky later.

We just showed the use of ` backticks ` . You may see people use quotes as well.



Other atypical column names are those with:

- spaces
- number without characters
- number starting the name
- other punctuation marks (besides “\_” or “.” and not at the beginning)

## A solution!

Rename tricky column names so that you don't have to deal with them later!



## Be careful about copy pasting code!

Curly quotes will not work!

```
tb_rename <- rename(tb, 'MPG!' = MPG) # this will cause an error!
```

```
tb_rename <- rename(tb, `MPG!` = MPG) # this will work!
```

Also true for double quotes

```
tb_rename <- rename(tb, "MPG!" = MPG) # this will cause an error!
```

```
tb_rename <- rename(tb, "MPG!" = MPG) # this will work!
```

# Renaming all columns of a data frame: dplyr

To rename all columns you use the `rename_with()`. In this case we will use `toupper()` to make all letters upper case. Could also use `tolower()` function.

```
tb_upper <- rename_with(tb, toupper)
head(tb_upper, 3)
```

# A tibble: 3 × 12

	CAR	MPG	CYL	DISP	HP	DRAT	WT	QSEC	VS	AM	GEAR	CARB
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	Mazda RX4 W...	21	6	160	110	3.9	2.88	17.0	0	1	4	4
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1

```
tb <- rename_with(tb, tolower)
head(tb, 3)
```

# A tibble: 3 × 12

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	Mazda RX4 W...	21	6	160	110	3.9	2.88	17.0	0	1	4	4
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1

# Summary

- data frames are simpler version of a data table
- tibbles are fancier `tidyverse` version
- data frames are made with `data.frames()` and `read.csv()`
- tibbles are made with `tibble()` and `read_csv()` from `readr`
- if your original data has rownames, you need to use `rownames_to_column` before converting to tibble
- the `rename()` function of `dplyr` can help you rename columns
- avoid using punctuation (except underscores), spaces, and numbers (to start or alone) in column names
- if you must do a nonstandard column name - typically use backticks around it. See [https://jhudatascience.org/intro\\_to\\_r/quotes\\_vs\\_backticks.html](https://jhudatascience.org/intro_to_r/quotes_vs_backticks.html).
- avoid copy and pasting code from other sources - quotation marks will change!

# Lab Part 1

[Class Website](#)  
[Lab](#)

# Subsetting Columns



## Subset columns of a data frame - **tidyverse** way:

To grab (or “pull” out) the `carb` column the tidyverse way we can use the `pull` function:

```
pull(tb, carb)
```

```
[1] 4 4 1 1 2 1 4 2 2 4 4 3 3 3 4 4 4 1 2 1 1 2 2 4 2 1 2 2 4 6 8 2
```

## Subset columns of a data frame: dplyr

The `select` command from `dplyr` allows you to subset (still a `tibble`!)

```
select(tb, mpg)
```

```
# A tibble: 32 × 1
```

```
  mpg  
  <dbl>
```

```
1  21  
2  21  
3  22.8  
4  21.4  
5  18.7  
6  18.1  
7  14.3  
8  24.4  
9  22.8  
10 19.2
```

```
# ... with 22 more rows
```

## Select multiple columns

We can use `select` to select for multiple columns.

```
select(tb, mpg, car, gear)
```

```
# A tibble: 32 × 3
   mpg car          gear
<dbl> <chr>    <dbl>
1  21  Mazda RX4      4
2  21  Mazda RX4 Wag  4
3 22.8 Datsun 710      4
4 21.4 Hornet 4 Drive 3
5 18.7 Hornet Sportabout 3
6 18.1 Valiant     3
7 14.3 Duster 360   3
8 24.4 Merc 240D   4
9 22.8 Merc 230    4
10 19.2 Merc 280    4
# ... with 22 more rows
```

## Subset columns of a data frame: dplyr

Note that if you want the values (not a `tibble`), use `pull` - as it pulls out the data:

```
pull(tb, mpg)
```

```
[1] 21.0 21.0 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 17.8 16.4 17.3 15.2 10.4  
[16] 10.4 14.7 32.4 30.4 33.9 21.5 15.5 15.2 13.3 19.2 27.3 26.0 30.4 15.8 19.4  
[31] 15.0 21.4
```

```
# pull with select works too!
```

```
pull(select(tb, mpg))
```

```
[1] 21.0 21.0 22.8 21.4 18.7 18.1 14.3 24.4 22.8 19.2 17.8 16.4 17.3 15.2 10.4  
[16] 10.4 14.7 32.4 30.4 33.9 21.5 15.5 15.2 13.3 19.2 27.3 26.0 30.4 15.8 19.4  
[31] 15.0 21.4
```

## Select columns of a data frame: dplyr

The `select` command from `dplyr` allows you to subset columns matching patterns:

```
head(tb, 2)
```

```
# A tibble: 2 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	carb <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4 Wag	21	6	160	110	3.9	2.88	17.0	0	1	4	

```
select(tb, starts_with("c"))
```

```
# A tibble: 32 × 3
```

	car <chr>	cyl <dbl>	carb <dbl>
1	Mazda RX4	6	4
2	Mazda RX4 Wag	6	4
3	Datsun 710	4	1
4	Hornet 4 Drive	6	1
5	Hornet Sportabout	8	2
6	Valiant	6	1
7	Duster 360	8	4
8	Merc 240D	4	2
9	Merc 230	4	2
10	Merc 280	6	4

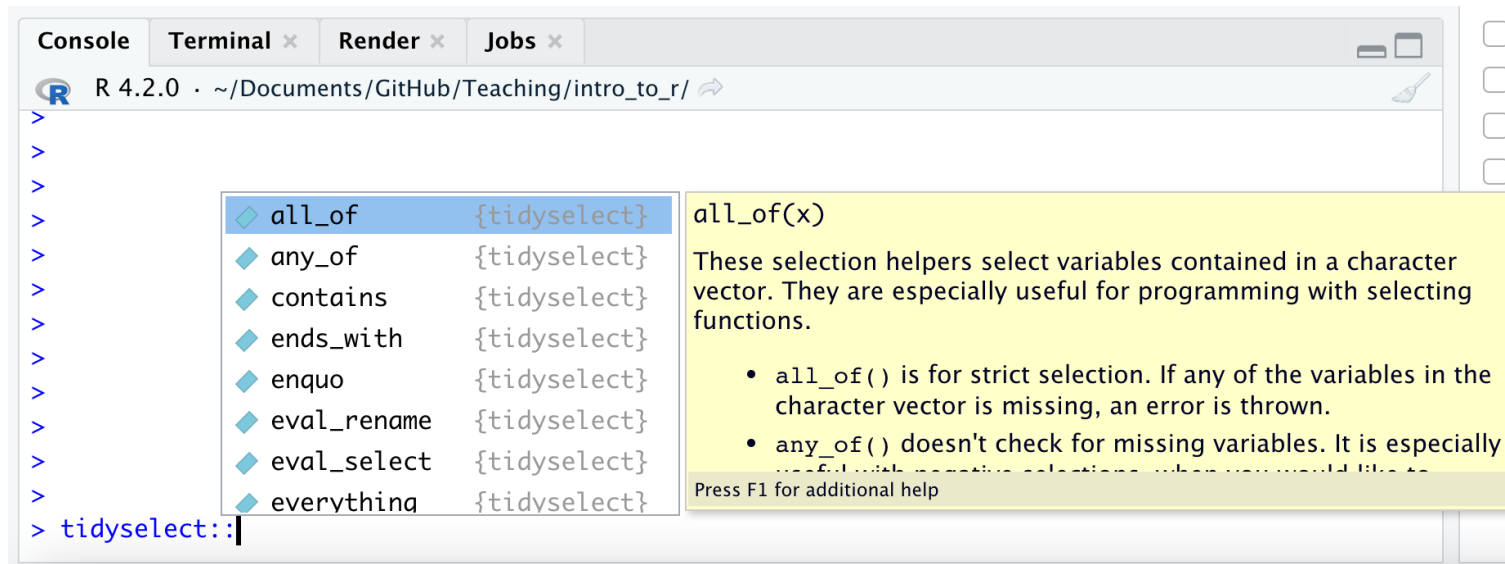
```
# ... with 22 more rows
```

## See the Select “helpers”

Here are a few:

```
last_col()  
starts_with()  
ends_with()  
contains() # like searching
```

Type `tidyselect::` in the **console** and see what RStudio suggests:



## Combining tidysselect helpers with regular selection

```
head(tb, 2)
```

```
# A tibble: 2 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	car <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4 Wag	21	6	160	110	3.9	2.88	17.0	0	1	4	

```
select(tb, starts_with("d"), car)
```

```
# A tibble: 32 × 3
```

	disp <dbl>	drat <dbl>	car <chr>
1	160	3.9	Mazda RX4
2	160	3.9	Mazda RX4 Wag
3	108	3.85	Datsun 710
4	258	3.08	Hornet 4 Drive
5	360	3.15	Hornet Sportabout
6	225	2.76	Valiant
7	360	3.21	Duster 360
8	147.	3.69	Merc 240D
9	141.	3.92	Merc 230
10	168.	3.92	Merc 280
# ... with 22 more rows			

## Multiple tidyselect functions

Follows OR logic.

```
select(tb, starts_with("c"), ends_with("r"))
```

```
# A tibble: 32 × 4
```

	car <chr>	cyl <dbl>	carb <dbl>	gear <dbl>
1	Mazda RX4	6	4	4
2	Mazda RX4 Wag	6	4	4
3	Datsun 710	4	1	4
4	Hornet 4 Drive	6	1	3
5	Hornet Sportabout	8	2	3
6	Valiant	6	1	3
7	Duster 360	8	4	3
8	Merc 240D	4	2	4
9	Merc 230	4	2	4
10	Merc 280	6	4	4

```
# ... with 22 more rows
```



## Multiple patterns with tidyselect

Need to combine the patterns with the `c()` function.

```
select(tb, starts_with(c("c", "d")))
```

```
# A tibble: 32 × 5
```

	car <chr>	cyl <dbl>	carb <dbl>	disp <dbl>	drat <dbl>
1	Mazda RX4	6	4	160	3.9
2	Mazda RX4 Wag	6	4	160	3.9
3	Datsun 710	4	1	108	3.85
4	Hornet 4 Drive	6	1	258	3.08
5	Hornet Sportabout	8	2	360	3.15
6	Valiant	6	1	225	2.76
7	Duster 360	8	4	360	3.21
8	Merc 240D	4	2	147.	3.69
9	Merc 230	4	2	141.	3.92
10	Merc 280	6	4	168.	3.92

```
# ... with 22 more rows
```

# The `where()` function can help select columns of a specific class

`is.character()` and `is.numeric()` are often the most helpful

```
head(tb, 2)
```

```
# A tibble: 2 × 12
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	Mazda RX4 W..	21	6	160	110	3.9	2.88	17.0	0	1	4	4

```
select(tb, where(is.numeric))
```

```
# A tibble: 32 × 11
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	21	6	160	110	3.9	2.88	17.0	0	1	4	4
3	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1
4	21.4	6	258	110	3.08	3.22	19.4	1	0	3	1
5	18.7	8	360	175	3.15	3.44	17.0	0	0	3	2
6	18.1	6	225	105	2.76	3.46	20.2	1	0	3	1
7	14.3	8	360	245	3.21	3.57	15.8	0	0	3	4
8	24.4	4	147.	62	3.69	3.19	20	1	0	4	2
9	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	2
10	19.2	6	168.	123	3.92	3.44	18.3	1	0	4	4

```
# ... with 22 more rows
```

# Subsetting Rows

## Subset rows of a data frame: dplyr

The command in dplyr for subsetting rows is `filter`.

```
filter(tb, mpg > 20)
```

```
# A tibble: 14 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4 ...	21	6	160	110	3.9	2.88	17.0	0	1	4	
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
4	Hornet 4 D...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	
5	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	
6	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	
7	Fiat 128	32.4	4	78.7	66	4.08	2.2	19.5	1	1	4	
8	Honda Civic	30.4	4	75.7	52	4.93	1.62	18.5	1	1	4	
9	Toyota Cor...	33.9	4	71.1	65	4.22	1.84	19.9	1	1	4	
10	Toyota Cor...	21.5	4	120.	97	3.7	2.46	20.0	1	0	3	
11	Fiat X1-9	27.3	4	79	66	4.08	1.94	18.9	1	1	4	
12	Porsche 91...	26	4	120.	91	4.43	2.14	16.7	0	1	5	
13	Lotus Euro...	30.4	4	95.1	113	3.77	1.51	16.9	1	1	5	
14	Volvo 142E	21.4	4	121	109	4.11	2.78	18.6	1	1	4	

## Subset rows of a data frame: dplyr

You can have multiple logical conditions using the following:

- `==` : equals to
- `!=`: not equal to (`!` : not/negation)
- `>` / `<`: greater than / less than
- `>=` or `<=`: greater than or equal to / less than or equal to
- `&` : AND
- `|` : OR

## Common error for filter

If you try to filter for a column that does not exist it will not work:

- misspelled column name
- column that was already removed

## Subset rows of a data frame: dplyr

You can filter by two conditions using & or commas (must meet both conditions):

```
filter(tb, mpg > 20, cyl == 4) # same result
```

```
filter(tb, mpg > 20 & cyl == 4)
```

```
# A tibble: 11 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	displacement <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	carb <dbl>
1	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1
2	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	2
3	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	2
4	Fiat 128	32.4	4	78.7	66	4.08	2.2	19.5	1	1	4	1
5	Honda Civic	30.4	4	75.7	52	4.93	1.62	18.5	1	1	4	2
6	Toyota Cor...	33.9	4	71.1	65	4.22	1.84	19.9	1	1	4	1
7	Toyota Cor...	21.5	4	120.	97	3.7	2.46	20.0	1	0	3	1
8	Fiat X1-9	27.3	4	79	66	4.08	1.94	18.9	1	1	4	1
9	Porsche 91...	26	4	120.	91	4.43	2.14	16.7	0	1	5	2
10	Lotus Euro...	30.4	4	95.1	113	3.77	1.51	16.9	1	1	5	2
11	Volvo 142E	21.4	4	121	109	4.11	2.78	18.6	1	1	4	2

## Subset rows of a data frame: dplyr

If you want OR statements (meaning the data can meet either condition does not need to meet both), you need to use `|` between conditions:

```
filter(tb, mpg > 20 | cyl == 4)
```

```
# A tibble: 14 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4 ...	21	6	160	110	3.9	2.88	17.0	0	1	4	
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
4	Hornet 4 D...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	
5	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	
6	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	
7	Fiat 128	32.4	4	78.7	66	4.08	2.2	19.5	1	1	4	
8	Honda Civic	30.4	4	75.7	52	4.93	1.62	18.5	1	1	4	
9	Toyota Cor...	33.9	4	71.1	65	4.22	1.84	19.9	1	1	4	
10	Toyota Cor...	21.5	4	120.	97	3.7	2.46	20.0	1	0	3	
11	Fiat X1-9	27.3	4	79	66	4.08	1.94	18.9	1	1	4	
12	Porsche 91...	26	4	120.	91	4.43	2.14	16.7	0	1	5	
13	Lotus Euro...	30.4	4	95.1	113	3.77	1.51	16.9	1	1	5	
14	Volvo 142E	21.4	4	121	109	4.11	2.78	18.6	1	1	4	



## Subset rows of a data frame: dplyr

The `%in%` operator can be used find values from a pre-made list (using `c()`) for a **single column** at a time.

```
filter(tb, mpg %in% c(20, 21, 22))
```

```
# A tibble: 2 × 12
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	Mazda RX4 W...	21	6	160	110	3.9	2.88	17.0	0	1	4	4

```
filter(tb, mpg == 20 | mpg == 21 | mpg == 22) #equivalent
```

```
# A tibble: 2 × 12
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	Mazda RX4 W...	21	6	160	110	3.9	2.88	17.0	0	1	4	4

## Subset rows of a data frame: dplyr

The `%in%` operator can be used find values from a pre-made list (using `c()`) for a **single column** at a time.

```
filter(tb, gear %in% c(4,5), cyl %in% c(6,5))
```

```
# A tibble: 5 × 12
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	Mazda RX4 W...	21	6	160	110	3.9	2.88	17.0	0	1	4	4
3	Merc 280	19.2	6	168.	123	3.92	3.44	18.3	1	0	4	4
4	Merc 280C	17.8	6	168.	123	3.92	3.44	18.9	1	0	4	4
5	Ferrari Dino	19.7	6	145	175	3.62	2.77	15.5	0	1	5	6

## Be careful with column names and **filter**

This will not work the way you might expect! Best to stick with nothing but the column name if it is a typical name.

```
filter(tb, "mpg" > 20)
```

```
# A tibble: 32 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4 ...	21	6	160	110	3.9	2.88	17.0	0	1	4	
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
4	Hornet 4 D...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	
5	Hornet Spo...	18.7	8	360	175	3.15	3.44	17.0	0	0	3	
6	Valiant	18.1	6	225	105	2.76	3.46	20.2	1	0	3	
7	Duster 360	14.3	8	360	245	3.21	3.57	15.8	0	0	3	
8	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	
9	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	
10	Merc 280	19.2	6	168.	123	3.92	3.44	18.3	1	0	4	

```
# ... with 22 more rows
```

## Don't use quotes for atypical names

Atypical names are those with punctuation, spaces, start with a number, or are just a number.

```
tb <- rename(tb, `mpg!` = mpg)
```

```
filter(tb, "mpg!" > 22) # will not work correctly
```

```
# A tibble: 32 × 12
```

	car <chr>	`mpg!` <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	
2	Mazda RX4...	21	6	160	110	3.9	2.88	17.0	0	1	4	
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
4	Hornet 4 ...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	
5	Hornet Sp...	18.7	8	360	175	3.15	3.44	17.0	0	0	3	
6	Valiant	18.1	6	225	105	2.76	3.46	20.2	1	0	3	
7	Duster 360	14.3	8	360	245	3.21	3.57	15.8	0	0	3	
8	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	
9	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	
10	Merc 280	19.2	6	168.	123	3.92	3.44	18.3	1	0	4	

```
# ... with 22 more rows
```

## Be careful with column names and **filter**

Using backticks works!

```
filter(tb, `mpg!` > 22)
```

```
# A tibble: 9 × 12
```

	car <chr>	`mpg!` <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
2	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	
3	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	
4	Fiat 128	32.4	4	78.7	66	4.08	2.2	19.5	1	1	4	
5	Honda Civic	30.4	4	75.7	52	4.93	1.62	18.5	1	1	4	
6	Toyota Cor...	33.9	4	71.1	65	4.22	1.84	19.9	1	1	4	
7	Fiat X1-9	27.3	4	79	66	4.08	1.94	18.9	1	1	4	
8	Porsche 91...	26	4	120.	91	4.43	2.14	16.7	0	1	5	
9	Lotus Euro...	30.4	4	95.1	113	3.77	1.51	16.9	1	1	5	

## Be careful with column names and **filter**

```
filter(tb, "car" == "Ferrari Dino") # this will not work
```

```
# A tibble: 0 × 12  
# ... with 12 variables: car <chr>, mpg! <dbl>, cyl <dbl>, disp <dbl>, hp <dbl>,  
#   drat <dbl>, wt <dbl>, qsec <dbl>, vs <dbl>, am <dbl>, gear <dbl>,  
#   carb <dbl>
```

## Be careful with column names and **filter**

```
filter(tb, car == "Ferrari Dino") # this works!
```

```
# A tibble: 1 × 12
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Ferrari Di...	19.7	6	145	175	3.62	2.77	15.5	0	1	5	

## **filter()** is tricky

Try not use anything special for the column names in `filter()`. This is why it is good to not use atypical column names. Then you can just use the column name!

So let's get rid of our unusual name in our data again.

```
tb <- rename(tb, mpg = `mpg!`)
```



**Always good to check each step!**

Did the filter work the way you expected? Did the dimensions change?



<https://media.giphy.com/media/5b5OU7aUekfdSAER5I/giphy.gif>

## **distinct()** function

To filter for distinct values from a variable, multiple variables, or an entire tibble you can use the `distinct()` function from the `dplyr` package.

```
distinct(tb, cyl)
```

```
# A tibble: 3 × 1
  cyl
<dbl>
1     6
2     4
3     8
```

```
distinct(tb, cyl, gear)
```

```
# A tibble: 8 × 2
  cyl gear
<dbl> <dbl>
1     6     4
2     4     4
3     6     3
4     8     3
5     4     3
6     4     5
7     8     5
8     6     5
```

## Summary

- `pull()` to get values out of a data frame/tibble
- `select()` is the tidyverse way to get a tibble with only certain columns
- you can `select()` based on patterns in the column names
- you can also `select()` based on column class with the `where()` function
- you can combine multiple tidyselect functions together like `select(starts_with("C"), ends_with("state"))`
- you can combine multiple patterns with the `c()` function like `select(starts_with(c("A", "C")))`
- `filter()` can be used to filter out rows based on logical conditions
- avoid using quotes when referring to column names with `filter()`

## Summary Continued

- `==` is the same as equivalent to
- `&` means both conditions must be met to remain after `filter()`
- `|` means either conditions needs to be met to remain after `filter()`
- `distinct()` helps you filter for unique values

# Lab Part 2

[Class Website](#)  
[Lab](#)

## Combining **filter** and **select**

You can combine `filter` and `select` to subset the rows and columns, respectively, of a data frame:

```
select(filter(tb, mpg > 20), cyl)
```

```
# A tibble: 14 × 1
```

```
  cyl  
  <dbl>  
1     6  
2     6  
3     4  
4     6  
5     4  
6     4  
7     4  
8     4  
9     4  
10    4  
11    4  
12    4  
13    4  
14    4
```

# Nesting

In R, the common way to perform multiple operations is to wrap functions around each other in a “nested” form.

```
head(select(tb, car, cyl), 2)
```

```
# A tibble: 2 × 2
  car      cyl
<chr>    <dbl>
1 Mazda RX4      6
2 Mazda RX4 Wag  6
```

## Nesting can get confusing looking

```
select(filter(tb, mpg > 20 & cyl == 4), cyl, hp)
```

```
# A tibble: 11 × 2
```

	cyl <dbl>	hp <dbl>
1	4	93
2	4	62
3	4	95
4	4	66
5	4	52
6	4	65
7	4	97
8	4	66
9	4	91
10	4	113
11	4	109



## Assigning Temporary Objects

One can also create temporary objects and reassign them:

```
tb2 <- filter(tb, mpg > 20 & cyl == 4)
tb2 <- select(tb2, cyl, hp)
```

```
head(tb2, 4)
```

```
# A tibble: 4 × 2
```

	cyl	hp
	<dbl>	<dbl>
1	4	93
2	4	62
3	4	95
4	4	66

## Using the **pipe** (comes with **dplyr**):

The pipe `%>%` makes this much more readable. It reads left side “pipes” into right side. RStudio CMD/Ctrl + Shift + M shortcut. Pipe `tb` into `filter`, then pipe that into `select`:

```
tb %>% filter(mpg > 20 & cyl == 4) %>% select(cyl, hp)
```

```
# A tibble: 11 × 2
```

	cyl <dbl>	hp <dbl>
1	4	93
2	4	62
3	4	95
4	4	66
5	4	52
6	4	65
7	4	97
8	4	66
9	4	91
10	4	113
11	4	109

# Adding/Removing Columns

## Adding columns to a data frame: dplyr (tidyverse way)

The `mutate` function in `dplyr` allows you to add or modify columns of a data frame.

*# General format - Not the code!*

```
{data object to update} <- mutate({data to use},  
                                {new variable name} = {new variable source})
```

```
tb <- mutate(tb, newcol = wt / 2.2)  
head(tb, 4)
```

# A tibble: 4 × 13

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazd...	21	6	160	110	3.9	2.62	16.5	0	1	4	4	1.19
2	Mazd...	21	6	160	110	3.9	2.88	17.0	0	1	4	4	1.31
3	Dats...	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1	1.05
4	Horn...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	1	1.46

# Use mutate to modify existing columns

The `mutate` function in `dplyr` allows you to add or modify columns of a data frame.

*# General format - Not the code!*

```
{data object to update} <- mutate({data to use},  
                                {variable name to change} = {variable modification})
```

```
tb <- mutate(tb, wt = wt * 2)  
head(tb, 4)
```

# A tibble: 4 × 13

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazd...	21	6	160	110	3.9	5.24	16.5	0	1	4	4	1.19
2	Mazd...	21	6	160	110	3.9	5.75	17.0	0	1	4	4	1.31
3	Dats...	22.8	4	108	93	3.85	4.64	18.6	1	1	4	1	1.05
4	Horn...	21.4	6	258	110	3.08	6.43	19.4	1	0	3	1	1.46

# You can pipe data into mutate

```
tb <- tb %>% mutate(wt = wt / 2)
head(tb, 4)
```

```
# A tibble: 4 × 13
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazd...	21	6	160	110	3.9	2.62	16.5	0	1	4	4	1.19
2	Mazd...	21	6	160	110	3.9	2.88	17.0	0	1	4	4	1.31
3	Dats...	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1	1.05
4	Horn...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	1	1.46

## Removing columns of a data frame: dplyr

The `NULL` method is still very common.

The `select` function can remove a column with minus (-):

```
select(tb, - newcol)
```

```
# A tibble: 6 × 12
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	carb <dbl>
1	Mazda RX4	21	6	160	110	3.9	2.62	16.5	0	1	4	4
2	Mazda RX4 W...	21	6	160	110	3.9	2.88	17.0	0	1	4	4
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1
4	Hornet 4 Dr...	21.4	6	258	110	3.08	3.22	19.4	1	0	3	1
5	Hornet Spor...	18.7	8	360	175	3.15	3.44	17.0	0	0	3	2
6	Valiant	18.1	6	225	105	2.76	3.46	20.2	1	0	3	1

**Or, you can simply select the columns you want to keep, ignoring the ones you want to remove.**

# Removing columns in a data frame: dplyr

You can use `c()` to list the columns to remove.

Remove `newcol` and `drat`:

```
select(tb, -c("newcol", "drat"))
```

```
# A tibble: 32 × 11
```

car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	carb <dbl>
1 Mazda RX4	21	6	160	110	2.62	16.5	0	1	4	4
2 Mazda RX4 Wag	21	6	160	110	2.88	17.0	0	1	4	4
3 Datsun 710	22.8	4	108	93	2.32	18.6	1	1	4	1
4 Hornet 4 Drive	21.4	6	258	110	3.22	19.4	1	0	3	1
5 Hornet Sportabout	18.7	8	360	175	3.44	17.0	0	0	3	2
6 Valiant	18.1	6	225	105	3.46	20.2	1	0	3	1
7 Duster 360	14.3	8	360	245	3.57	15.8	0	0	3	4
8 Merc 240D	24.4	4	147.	62	3.19	20	1	0	4	2
9 Merc 230	22.8	4	141.	95	3.15	22.9	1	0	4	2
10 Merc 280	19.2	6	168.	123	3.44	18.3	1	0	4	4

```
# ... with 22 more rows
```



Ordering columns

# Ordering the columns of a data frame: dplyr

The `select` function can reorder columns.

```
head(tb, 2)
```

```
# A tibble: 2 × 13
  car      mpg  cyl  disp  hp  drat  wt  qsec  vs  am  gear  carb  newo
<chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 Mazd...    21     6   160   110   3.9   2.62  16.5    0     1     4     4     1.
2 Mazd...    21     6   160   110   3.9   2.88  17.0    0     1     4     4     1.
```

```
select(tb, cyl, mpg, wt, car) %>%
head(2)
```

```
# A tibble: 2 × 4
  cyl  mpg  wt car
<dbl> <dbl> <dbl> <chr>
1     6    21  2.62 Mazda RX4
2     6    21  2.88 Mazda RX4 Wag
```

# Ordering the columns of a data frame: dplyr

The `select` function can reorder columns. Put `newcol` first, then select the rest of columns:

```
select(tb, newcol, everything())
```

```
# A tibble: 3 × 13
  newcol car    mpg  cyl  disp   hp  drat   wt  qsec   vs   am  gear  carb
  <dbl> <chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1  1.19 Mazd...  21     6  160  110  3.9   2.62  16.5    0     1     4     4
2  1.31 Mazd...  21     6  160  110  3.9   2.88  17.0    0     1     4     4
3  1.05 Dats... 22.8    4  108   93  3.85  2.32  18.6    1     1     4     1
```

# Ordering the columns of a data frame: dplyr

Put `newcol` at the end ("remove, everything, then add back in"):

```
select(tb, -newcol, everything(), newcol)
```

```
# A tibble: 3 × 13
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	Mazd...	21	6	160	110	3.9	2.62	16.5	0	1	4	4	1.19
2	Mazd...	21	6	160	110	3.9	2.88	17.0	0	1	4	4	1.31
3	Dats...	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1	1.05

# Ordering the column names of a data frame: alphabetically

Using the base R `order()` function.

```
order(colnames(tb))
```

```
[1] 10  1 12  3  4  6 11  5  2 13  8  9  7
```

```
tb %>% select(order(colnames(tb)))
```

```
# A tibble: 32 × 13
```

	am	car	carb	cyl	disp	drat	gear	hp	mpg	newcol	qsec	vs
	<dbl>	<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1	1	Mazda RX4	4	6	160	3.9	4	110	21	1.19	16.5	0
2	1	Mazda RX4...	4	6	160	3.9	4	110	21	1.31	17.0	0
3	1	Datsun 710	1	4	108	3.85	4	93	22.8	1.05	18.6	1
4	0	Hornet 4 ...	1	6	258	3.08	3	110	21.4	1.46	19.4	1
5	0	Hornet Sp...	2	8	360	3.15	3	175	18.7	1.56	17.0	0
6	0	Valiant	1	6	225	2.76	3	105	18.1	1.57	20.2	1
7	0	Duster 360	4	8	360	3.21	3	245	14.3	1.62	15.8	0
8	0	Merc 240D	2	4	147.	3.69	4	62	24.4	1.45	20	1
9	0	Merc 230	2	4	141.	3.92	4	95	22.8	1.43	22.9	1
10	0	Merc 280	4	6	168.	3.92	4	123	19.2	1.56	18.3	1

```
# ... with 22 more rows, and 1 more variable: wt <dbl>
```

# Ordering the columns of a data frame: dplyr

In addition to `select` we can also use the `relocate()` function of dplyr to rearrange the columns for more complicated moves.

For example, let say we just wanted `wt` to be before `cyl`.

```
head(tb, 1)
```

```
# A tibble: 1 × 13
  car      mpg  cyl disp  hp drat   wt  qsec    vs  am gear carb newcol
<chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 Mazd...   21     6  160  110   3.9  2.62  16.5     0   1   4    4   1.19
```

```
tb_carb <- relocate(tb, wt, .before = cyl)
```

```
head(tb_carb, 1)
```

```
# A tibble: 1 × 13
  car      mpg  wt  cyl disp  hp drat   qsec    vs  am gear carb newcol
<chr> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 Mazd...   21  2.62     6  160  110   3.9  16.5     0   1   4    4   1.19
```

Ordering rows

## Ordering the rows of a data frame: dplyr

The `arrange` function can reorder rows By default, `arrange` orders in increasing order:

```
arrange(tb, mpg)
```

```
# A tibble: 32 × 13
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Cadillac F...	10.4	8	472	205	2.93	5.25	18.0	0	0	3	
2	Lincoln Co...	10.4	8	460	215	3	5.42	17.8	0	0	3	
3	Camaro Z28	13.3	8	350	245	3.73	3.84	15.4	0	0	3	
4	Duster 360	14.3	8	360	245	3.21	3.57	15.8	0	0	3	
5	Chrysler I...	14.7	8	440	230	3.23	5.34	17.4	0	0	3	
6	Maserati B...	15	8	301	335	3.54	3.57	14.6	0	1	5	
7	Merc 450SLC	15.2	8	276.	180	3.07	3.78	18	0	0	3	
8	AMC Javelin	15.2	8	304	150	3.15	3.44	17.3	0	0	3	
9	Dodge Chal...	15.5	8	318	150	2.76	3.52	16.9	0	0	3	
10	Ford Pante...	15.8	8	351	264	4.22	3.17	14.5	0	1	5	

```
# ... with 22 more rows, and 1 more variable: newcol <dbl>
```



## Ordering the rows of a data frame: dplyr

Use the `desc` to arrange the rows in descending order:

```
arrange(tb, desc(mpg))
```

```
# A tibble: 32 × 13
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Toyota Cor...	33.9	4	71.1	65	4.22	1.84	19.9	1	1	4	
2	Fiat 128	32.4	4	78.7	66	4.08	2.2	19.5	1	1	4	
3	Honda Civic	30.4	4	75.7	52	4.93	1.62	18.5	1	1	4	
4	Lotus Euro...	30.4	4	95.1	113	3.77	1.51	16.9	1	1	5	
5	Fiat X1-9	27.3	4	79	66	4.08	1.94	18.9	1	1	4	
6	Porsche 91...	26	4	120.	91	4.43	2.14	16.7	0	1	5	
7	Merc 240D	24.4	4	147.	62	3.69	3.19	20	1	0	4	
8	Datsun 710	22.8	4	108	93	3.85	2.32	18.6	1	1	4	
9	Merc 230	22.8	4	141.	95	3.92	3.15	22.9	1	0	4	
10	Toyota Cor...	21.5	4	120.	97	3.7	2.46	20.0	1	0	3	

```
# ... with 22 more rows, and 1 more variable: newcol <dbl>
```

## Ordering the rows of a data frame: dplyr

You can combine increasing and decreasing orderings:

```
arrange(tb, mpg, desc(hp))
```

```
# A tibble: 32 × 13
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	ca <dbl>
1	Lincoln Co...	10.4	8	460	215	3	5.42	17.8	0	0	3	
2	Cadillac F...	10.4	8	472	205	2.93	5.25	18.0	0	0	3	
3	Camaro Z28	13.3	8	350	245	3.73	3.84	15.4	0	0	3	
4	Duster 360	14.3	8	360	245	3.21	3.57	15.8	0	0	3	
5	Chrysler I...	14.7	8	440	230	3.23	5.34	17.4	0	0	3	
6	Maserati B...	15	8	301	335	3.54	3.57	14.6	0	1	5	
7	Merc 450SLC	15.2	8	276.	180	3.07	3.78	18	0	0	3	
8	AMC Javelin	15.2	8	304	150	3.15	3.44	17.3	0	0	3	
9	Dodge Chal...	15.5	8	318	150	2.76	3.52	16.9	0	0	3	
10	Ford Pante...	15.8	8	351	264	4.22	3.17	14.5	0	1	5	

```
# ... with 22 more rows, and 1 more variable: newcol <dbl>
```

## Summary

- `select()` and `filter()` can be combined together
- you can do sequential steps in a few ways:
  1. nesting them inside one another using parentheses ( )
  2. creating intermediate data objects in between
  3. using pipes `%>%` (like “then” statements)
- `select()` and `relocate()` can be used to reorder columns
- `arrange()` can be used to reorder rows
- can remove rows with `filter()`
- can remove a column in a few ways:
  1. using `select()` with negative sign in front of column name(s)
  2. not selecting it (without negative sign)

## Summary cont...

- `mutate()` can be used to create new variables or modify them

```
# General format - Not the code!  
{data object to update} <- mutate({data to use},  
                                   {new variable name} = {new variable source})
```

```
tb <- mutate(tb, newcol = wt/2.2)
```

## A note about base R:

The `$` operator is similar to `pull()`. This is the base R way to do this:

```
tb$carb
```

```
[1] 4 4 1 1 2 1 4 2 2 4 4 3 3 3 4 4 4 1 2 1 1 2 2 4 2 1 2 2 4 6 8 2
```

Although it is easier (for this one task), mixing and matching the `$` operator with tidyverse functions usually doesn't work. Therefore, we want to let you know about it in case you see it, but we suggest that you try working with the tidyverse way.

## Adding new columns to a data frame: base R

You can add a new column (or modify an existing one) using the `$` operator instead of `mutate`.

Just want you to be aware of this as it is very common.

```
tb$newcol <- tb$wt/2.2  
head(tb, 3)
```

```
# A tibble: 3 × 13
```

	car <chr>	mpg <dbl>	cyl <dbl>	disp <dbl>	hp <dbl>	drat <dbl>	wt <dbl>	qsec <dbl>	vs <dbl>	am <dbl>	gear <dbl>	carb <dbl>	newcol <dbl>
1	Mazd...	21	6	160	110	3.9	2.62	16.5	0	1	4	4	1.18
2	Mazd...	21	6	160	110	3.9	2.88	17.0	0	1	4	4	1.25
3	Dats...	22.8	4	108	93	3.85	2.32	18.6	1	1	4	1	1.10

Even though `$` is easier for creating new columns, `mutate` is really powerful, so it's worth getting used to.

## Lab Part 3

[Class Website](#)

[Lab](#)



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Extra Slides



## `which()` function

Instead of removing rows like `filter`, `which()` simply shows where the values occur if they pass a specific condition. We will see that this can be helpful later when we want to select and filter in more complicated ways.

```
which(select(tb,carb) == 4)
```

```
[1] 1 2 7 10 11 15 16 17 24 29
```

```
select(tb, carb) == 4
```

	carb
[1,]	TRUE
[2,]	TRUE
[3,]	FALSE
[4,]	FALSE
[5,]	FALSE
[6,]	FALSE
[7,]	TRUE
[8,]	FALSE
[9,]	FALSE
[10,]	TRUE
[11,]	TRUE
[12,]	FALSE
[13,]	FALSE
[14,]	FALSE
[15,]	TRUE
[16,]	TRUE
[17,]	TRUE
[18,]	FALSE

base R subsetting

## Subset columns of a data frame:

We can grab the `carb` column using the `$` operator. This is the base R way to do this:

```
df$carb
```

```
[1] 4 4 1 1 2 1 4 2 2 4 4 3 3 3 4 4 4 1 2 1 1 2 2 4 2 1 2 2 4 6 8 2
```

## Remove a column in base R

```
df$mpg <- NULL
```

## Renaming Columns of a data frame: base R

We can use the `colnames` function to extract and/or directly reassign column names of `df`:

```
colnames(df) # just prints
```

```
[1] "car"  "mpg"  "cyl"  "disp" "hp"    "drat" "wt"    "qsec" "vs"    "am"  
[11] "gear" "carb"
```

```
colnames(df)[1:3] <- c("MPG", "CYL", "DISP") # reassigns  
head(df)
```

		MPG	CYL	DISP	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Mazda	RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
2	Mazda	RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
3	Datsun	710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
4	Hornet	4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
5	Hornet	Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
6	Valiant		18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

```
colnames(df)[1:3] <- c("mpg", "cyl", "disp") #reset - just to keep consistent
```

## Renaming Columns of a data frame: base R

We can assign the column names, change the ones we want, and then re-assign the column names:

```
cn <- colnames(df)
cn[ cn == "drat" ] <- "DRAT"
colnames(df) <- cn
head(df)
```

		mpg	cyl	disp	disp	hp	DRAT	wt	qsec	vs	am	gear	carb
1	Mazda	RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
2	Mazda	RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
3	Datsun	710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
4	Hornet	4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
5	Hornet	Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
6	Valiant		18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

```
colnames(df)[ colnames(df) == "DRAT" ] <- "drat" #reset
```

## Subset rows of a data frame with indices:

Let's select **rows** 1 and 3 from **df** using brackets:

```
df[ c(1, 3), ]
```

		mpg	cyl	disp	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Mazda	RX4	21.0	6	160	110	3.90	2.62	16.46	0	1	4	4
3	Datsun	710	22.8	4	108	93	3.85	2.32	18.61	1	1	4	1

## Subset columns of a data frame:

We can also subset a data frame using the bracket `[, ]` subsetting.

For data frames and matrices (2-dimensional objects), the brackets are `[rows, columns]` subsetting. We can grab the x column using the index of the column or the column name ("carb")

```
df[, 11]
```

```
[1] 4 4 4 3 3 3 3 4 4 4 4 3 3 3 3 3 3 4 4 4 3 3 3 3 3 4 5 5 5 5 5 4
```

```
df[, "carb"]
```

```
[1] 4 4 1 1 2 1 4 2 2 4 4 3 3 3 4 4 4 1 2 1 1 2 2 4 2 1 2 2 4 6 8 2
```



## Another difference between **tbl** and data frame:

Mostly, **tbl** (tibbles) are the same as data frames, except they don't print all lines. When subsetting only one column using brackets, a data frame will return the values, but a **tbl** will return a **tbl**

```
df[, 1]
```

```
[1] "Mazda RX4"           "Mazda RX4 Wag"       "Datsun 710"
[4] "Hornet 4 Drive"      "Hornet Sportabout"   "Valiant"
[7] "Duster 360"          "Merc 240D"           "Merc 230"
[10] "Merc 280"            "Merc 280C"           "Merc 450SE"
[13] "Merc 450SL"          "Merc 450SLC"         "Cadillac Fleetwood"
[16] "Lincoln Continental" "Chrysler Imperial"   "Fiat 128"
[19] "Honda Civic"         "Toyota Corolla"      "Toyota Corona"
[22] "Dodge Challenger"    "AMC Javelin"         "Camaro Z28"
[25] "Pontiac Firebird"    "Fiat X1-9"           "Porsche 914-2"
[28] "Lotus Europa"        "Ford Pantera L"      "Ferrari Dino"
[31] "Maserati Bora"       "Volvo 142E"
```

```
tbl[, 1]
```

```
# A tibble: 32 × 1
```

```
  mpg
<dbl>
1   21
2   21
3  22.8
4  21.4
5  18.7
6  18.1
```

## Subset columns of a data frame:

We can select multiple columns using multiple column names:

```
df[, c("mpg", "cyl")]
```

		mpg	cyl
1	Mazda RX4	21.0	
2	Mazda RX4 Wag	21.0	
3	Datsun 710	22.8	
4	Hornet 4 Drive	21.4	
5	Hornet Sportabout	18.7	
6	Valiant	18.1	
7	Duster 360	14.3	
8	Merc 240D	24.4	
9	Merc 230	22.8	
10	Merc 280	19.2	
11	Merc 280C	17.8	
12	Merc 450SE	16.4	
13	Merc 450SL	17.3	
14	Merc 450SLC	15.2	
15	Cadillac Fleetwood	10.4	
16	Lincoln Continental	10.4	
17	Chrysler Imperial	14.7	
18	Fiat 128	32.4	
19	Honda Civic	30.4	
20	Toyota Corolla	33.9	
21	Toyota Corona	21.5	
22	Dodge Challenger	15.5	
23	AMC Javelin	15.2	
24	Camaro Z28	13.3	
25	Pontiac Firebird	19.2	