

# 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	1.513	16.89	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 can do a lot with data frames too.

## 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(rownames_to_column(df, "car"), 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

```
head(tibble(rownames_to_column(df, "car")), n = 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

# 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})
```

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

	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

## Take Care with Column Names

When you can, avoid spaces, special punctuation, or numbers in column names, as these require quotes 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.

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

```
df_rename <- rename(df, `MPG!` = MPG) # this will work  
head(df_rename, 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

You will need to refer to a column like this with most functions.



## Take Care with Column Names and Character Strings

These are the conventions, most options will work for most functions.

Backticks are typically for nonstandard variable names:

- those with spaces `col 1`
- those with punctuation `col.1`
- those that are just numbers `1`
- those that start with numbers `1st col`

Single or double quotes are typically used for character strings (data values that has characters):

- `"words"`
- `"phrases with spaces"`
- `'words'`
- `'phrases with spaces'`

## Be careful about copy pasting code!

Curly quotes will not work!

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

```
df_rename <- rename(df, `MPG!` = MPG) # this will work!
```

Also true for double quotes

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

```
df_rename <- rename(df, "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.

```
df_upper <- rename_with(df, toupper)
head(df_upper, 3)
```

	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

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

	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

# 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 use backticks around those column names
- quotes can be used for character values
- 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(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
```

## Subset columns of a data frame: dplyr

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

```
select(df, mpg)
```

	mpg
Mazda RX4	21.0
Mazda RX4 Wag	21.0
Datsun 710	22.8
Hornet 4 Drive	21.4
Hornet Sportabout	18.7
Valiant	18.1
Duster 360	14.3
Merc 240D	24.4
Merc 230	22.8
Merc 280	19.2
Merc 280C	17.8
Merc 450SE	16.4
Merc 450SL	17.3
Merc 450SLC	15.2
Cadillac Fleetwood	10.4
Lincoln Continental	10.4
Chrysler Imperial	14.7
Fiat 128	32.4
Honda Civic	30.4
Toyota Corolla	33.9
Toyota Corona	21.5
Dodge Challenger	15.5
AMC Javelin	15.2
Camaro Z28	13.3
Pontiac Firebird	19.2



## 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(df, 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(df, 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(df, 2)
```

	mpg	cyl	dis	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

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

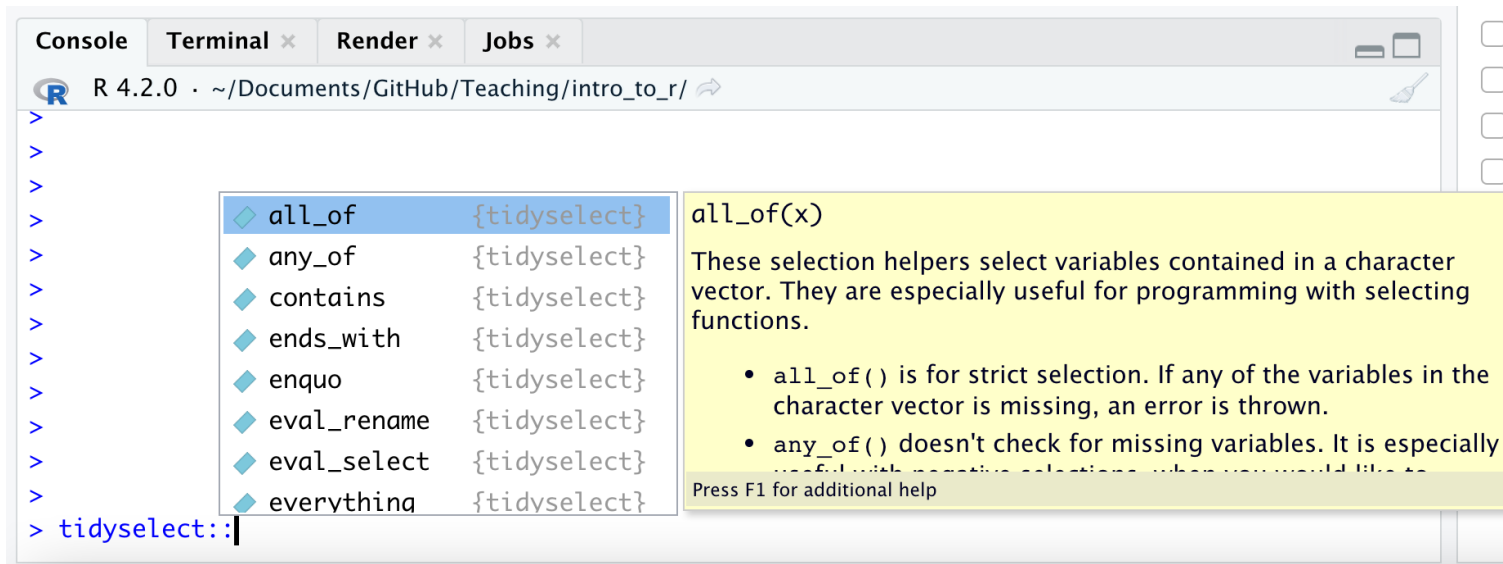
	cyl	carb
Mazda RX4	6	4
Mazda RX4 Wag	6	4
Datsun 710	4	1
Hornet 4 Drive	6	1
Hornet Sportabout	8	2
Valiant	6	1
Duster 360	8	4
Merc 240D	4	2
Merc 230	4	2
Merc 280	6	4
Merc 280C	6	4
Merc 450SE	8	3
Merc 450SL	8	3
Merc 450SLC	8	3
Cadillac Fleetwood	8	4
Lincoln Continental	8	4
Chrysler Imperial	8	4

## 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:



## 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

# Lab Part 2

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

# Subsetting Rows

## Subset rows of a data frame: dplyr

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

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

	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
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
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
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	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2

## 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



## Subset rows of a data frame: dplyr

The `%in%` operator can be used find values from a pre-made list (using `c()`):

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

			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

## Subset rows of a data frame: dplyr

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

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

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
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
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
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	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2

```
filter(df, mpg > 20, cyl == 4)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
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
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
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	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	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 the pipe `|` between conditions:

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

	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
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
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
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	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2

## 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(df,carb) == 4)
```

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

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

	carb
Mazda RX4	TRUE
Mazda RX4 Wag	TRUE
Datsun 710	FALSE
Hornet 4 Drive	FALSE
Hornet Sportabout	FALSE
Valiant	FALSE
Duster 360	TRUE
Merc 240D	FALSE
Merc 230	FALSE
Merc 280	TRUE
Merc 280C	TRUE
Merc 450SE	FALSE
Merc 450SL	FALSE
Merc 450SLC	FALSE
Cadillac Fleetwood	TRUE
Lincoln Continental	TRUE
Chrysler Imperial	TRUE
Fiat 128	FALSE

## **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(df, cyl)
```

	cyl
Mazda RX4	6
Datsun 710	4
Hornet Sportabout	8

```
distinct(df, cyl, gear)
```

	cyl	gear
Mazda RX4	6	4
Datsun 710	4	4
Hornet 4 Drive	6	3
Hornet Sportabout	8	3
Toyota Corona	4	3
Porsche 914-2	4	5
Ford Pantera L	8	5
Ferrari Dino	6	5

## Summary

- `filter()` can be used to filter out rows based on logical conditions
- `==` 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()`
- `which()` shows you where values meet a condition
- `distinct()` helps you filter for unique values

# Lab Part 3

[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(df, mpg > 20 & cyl == 4), cyl, hp)
```

	cyl	hp
Datsun 710	4	93
Merc 240D	4	62
Merc 230	4	95
Fiat 128	4	66
Honda Civic	4	52
Toyota Corolla	4	65
Toyota Corona	4	97
Fiat X1-9	4	66
Porsche 914-2	4	91
Lotus Europa	4	113
Volvo 142E	4	109

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



## Assigning Temporary Objects

One can also create temporary objects and reassign them:

```
df2 <- filter(df, mpg > 20 & cyl == 4)  
df2 <- select(df2, cyl, hp)
```

```
head(df2, 4)
```

	cyl	hp
Datsun 710	4	93
Merc 240D	4	62
Merc 230	4	95
Fiat 128	4	66

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

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

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

	cyl	hp
Datsun 710	4	93
Merc 240D	4	62
Merc 230	4	95
Fiat 128	4	66
Honda Civic	4	52
Toyota Corolla	4	65
Toyota Corona	4	97
Fiat X1-9	4	66
Porsche 914-2	4	91
Lotus Europa	4	113
Volvo 142E	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})
```

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

## Removing columns of a data frame: dplyr

The `NULL` method is still very common.

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

```
select(df, - newcol)
```

	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

**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(df, -c("newcol", "drat"))
```

	mpg	cyl	disp	hp	wt	qsec	vs	am	gear	carb
Mazda RX4	21.0	6	160.0	110	2.620	16.46	0	1	4	4
Mazda RX4 Wag	21.0	6	160.0	110	2.875	17.02	0	1	4	4
Datsun 710	22.8	4	108.0	93	2.320	18.61	1	1	4	1
Hornet 4 Drive	21.4	6	258.0	110	3.215	19.44	1	0	3	1
Hornet Sportabout	18.7	8	360.0	175	3.440	17.02	0	0	3	2
Valiant	18.1	6	225.0	105	3.460	20.22	1	0	3	1
Duster 360	14.3	8	360.0	245	3.570	15.84	0	0	3	4
Merc 240D	24.4	4	146.7	62	3.190	20.00	1	0	4	2
Merc 230	22.8	4	140.8	95	3.150	22.90	1	0	4	2
Merc 280	19.2	6	167.6	123	3.440	18.30	1	0	4	4
Merc 280C	17.8	6	167.6	123	3.440	18.90	1	0	4	4
Merc 450SE	16.4	8	275.8	180	4.070	17.40	0	0	3	3
Merc 450SL	17.3	8	275.8	180	3.730	17.60	0	0	3	3
Merc 450SLC	15.2	8	275.8	180	3.780	18.00	0	0	3	3
Cadillac Fleetwood	10.4	8	472.0	205	5.250	17.98	0	0	3	4
Lincoln Continental	10.4	8	460.0	215	5.424	17.82	0	0	3	4
Chrysler Imperial	14.7	8	440.0	230	5.345	17.42	0	0	3	4
Fiat 128	32.4	4	78.7	66	2.200	19.47	1	1	4	1
Honda Civic	30.4	4	75.7	52	1.615	18.52	1	1	4	2
Toyota Corolla	33.9	4	71.1	65	1.835	19.90	1	1	4	1
Toyota Corona	21.5	4	120.1	97	2.465	20.01	1	0	3	1
Dodge Challenger	15.5	8	318.0	150	3.520	16.87	0	0	3	2
AMC Javelin	15.2	8	304.0	150	3.435	17.20	0	0	3	2

Ordering columns

## Ordering the columns of a data frame: dplyr

The `select` function can reorder columns.

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



## Ordering the columns of a data frame: dplyr

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

```
select(df, newcol, everything())
```

	newcol	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Mazda RX4	1.190909	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4
Mazda RX4 Wag	1.306818	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4
Datsun 710	1.054545	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1
Hornet 4 Drive	1.461364	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1
Hornet Sportabout	1.563636	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2
Valiant	1.572727	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1

## Ordering the columns of a data frame: dplyr

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

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

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4	1.190909
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4	1.306818
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1	1.054545
Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1	1.461364
Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2	1.563636
Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1	1.572727

# Ordering the column names of a data frame: alphabetically

```
order(colnames(df))
```

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

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

	am	carb	cyl	disp	drat	gear	hp	mpg	newcol	qsec	vs
Mazda RX4	1	4	6	160.0	3.90	4	110	21.0	1.1909091	16.46	0
Mazda RX4 Wag	1	4	6	160.0	3.90	4	110	21.0	1.3068182	17.02	0
Datsun 710	1	1	4	108.0	3.85	4	93	22.8	1.0545455	18.61	1
Hornet 4 Drive	0	1	6	258.0	3.08	3	110	21.4	1.4613636	19.44	1
Hornet Sportabout	0	2	8	360.0	3.15	3	175	18.7	1.5636364	17.02	0
Valiant	0	1	6	225.0	2.76	3	105	18.1	1.5727273	20.22	1
Duster 360	0	4	8	360.0	3.21	3	245	14.3	1.6227273	15.84	0
Merc 240D	0	2	4	146.7	3.69	4	62	24.4	1.4500000	20.00	1
Merc 230	0	2	4	140.8	3.92	4	95	22.8	1.4318182	22.90	1
Merc 280	0	4	6	167.6	3.92	4	123	19.2	1.5636364	18.30	1
Merc 280C	0	4	6	167.6	3.92	4	123	17.8	1.5636364	18.90	1
Merc 450SE	0	3	8	275.8	3.07	3	180	16.4	1.8500000	17.40	0
Merc 450SL	0	3	8	275.8	3.07	3	180	17.3	1.6954545	17.60	0
Merc 450SLC	0	3	8	275.8	3.07	3	180	15.2	1.7181818	18.00	0
Cadillac Fleetwood	0	4	8	472.0	2.93	3	205	10.4	2.3863636	17.98	0
Lincoln Continental	0	4	8	460.0	3.00	3	215	10.4	2.4654545	17.82	0
Chrysler Imperial	0	4	8	440.0	3.23	3	230	14.7	2.4295455	17.42	0
Fiat 128	1	1	4	78.7	4.08	4	66	32.4	1.0000000	19.47	1
Honda Civic	1	2	4	75.7	4.93	4	52	30.4	0.7340909	18.52	1
Toyota Corolla	1	1	4	71.1	4.22	4	65	33.9	0.8340909	19.90	1
Toyota Corona	0	1	4	120.1	3.70	3	97	21.5	1.1204545	20.01	1
Dodge Challenger	0	2	8	318.0	2.76	3	150	15.5	1.6000000	16.87	0
AMC Javelin	0	2	8	304.0	3.15	3	150	15.2	1.5613636	17.30	0

## 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 example, let say we just wanted `wt` to be first.

```
head(df)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4	1.190909
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4	1.306818
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1	1.054545
Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1	1.461364
Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2	1.563636
Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1	1.572727

```
df_carb <- relocate(df, wt,  
                    .before = mpg)
```

```
df_carb
```

	wt	mpg	cyl	disp	hp	drat	qsec	vs	am	gear	carb
Mazda RX4	2.620	21.0	6	160.0	110	3.90	16.46	0	1	4	4
Mazda RX4 Wag	2.875	21.0	6	160.0	110	3.90	17.02	0	1	4	4
Datsun 710	2.320	22.8	4	108.0	93	3.85	18.61	1	1	4	1
Hornet 4 Drive	3.215	21.4	6	258.0	110	3.08	19.44	1	0	3	1
Hornet Sportabout	3.440	18.7	8	360.0	175	3.15	17.02	0	0	3	2
Valiant	3.460	18.1	6	225.0	105	2.76	20.22	1	0	3	1
Duster 360	3.570	14.3	8	360.0	245	3.21	15.84	0	0	3	4
Merc 240D	3.190	24.4	4	146.7	62	3.69	20.00	1	0	4	2

Ordering rows

## Ordering the rows of a data frame: dplyr

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

```
arrange(df, mpg)
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
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
Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
Chrysler Imperial	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.60	0	1	5	8
Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
AMC Javelin	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2
Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.50	0	1	5	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 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.50	0	1	5	6
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
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2
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

## Ordering the rows of a data frame: dplyr

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

```
arrange(df, desc(mpg))
```

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
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
Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	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
Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2
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
Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.50	0	1	5	6
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
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
Merc 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
Merc 450SL	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
Merc 450SE	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.50	0	1	5	4
Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3

# Ordering the rows of a data frame: dplyr

You can combine increasing and decreasing orderings:

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

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
Lincoln Continental	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4
Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
Chrysler Imperial	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.60	0	1	5	8
Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
AMC Javelin	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2
Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.50	0	1	5	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 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.50	0	1	5	6
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
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2
Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1



## 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 `%>%`
- `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})
```

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

## A note about base R:

The `$` operator is similar to `pull()`. 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
```

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.

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

	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4	1.190909
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4	1.306818
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1	1.054545

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

## Lab Part 4

[Class Website](#)

[Lab](#)



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Extra Slides - 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] "mpg"    "cyl"    "disp"   "hp"     "drat"   "wt"     "qsec"   "vs"
[9] "am"     "gear"   "carb"   "newcol"
```

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

	MPG	CYL	DISP	hp	drat	wt	qsec	vs	am	gear	carb	newcol
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4	1.190909
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4	1.306818
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1	1.054545
Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1	1.461364
Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2	1.563636
Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1	1.572727

```
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	hp	DRAT	wt	qsec	vs	am	gear	carb	newcol
Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4	1.190909
Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4	1.306818
Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1	1.054545
Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1	1.461364
Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2	1.563636
Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1	1.572727

```
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	hp	drat	wt	qsec	vs	am	gear	carb	newcol
Mazda	RX4	21.0	6	160	110	3.90	2.62	16.46	0	1	4	4	1.190909
Datsun	710	22.8	4	108	93	3.85	2.32	18.61	1	1	4	1	1.054545

## 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 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
```

```
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] 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 19.2
[31] 15.0 21.4
```

```
tbl[, 1]
```

```
# 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
```

```
tbl[, "mpg"]
```

## Subset columns of a data frame:

We can select multiple columns using multiple column names:

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

	mpg	cyl
Mazda RX4	21.0	6
Mazda RX4 Wag	21.0	6
Datsun 710	22.8	4
Hornet 4 Drive	21.4	6
Hornet Sportabout	18.7	8
Valiant	18.1	6
Duster 360	14.3	8
Merc 240D	24.4	4
Merc 230	22.8	4
Merc 280	19.2	6
Merc 280C	17.8	6
Merc 450SE	16.4	8
Merc 450SL	17.3	8
Merc 450SLC	15.2	8
Cadillac Fleetwood	10.4	8
Lincoln Continental	10.4	8
Chrysler Imperial	14.7	8
Fiat 128	32.4	4
Honda Civic	30.4	4
Toyota Corolla	33.9	4
Toyota Corona	21.5	4
Dodge Challenger	15.5	8
AMC Javelin	15.2	8
Camaro Z28	13.3	8
Pontiac Firebird	19.2	8