



## Overview

We showed one way to read data into R using `read_csv` and `read.csv`. In this module, we will show you how to:

1. Select specific elements of an object by an index or logical condition
2. Renaming columns of a `data.frame`
3. Subset rows of a `data.frame`
4. Subset columns of a `data.frame`
5. Add/remove new columns to a `data.frame`
6. Order the columns of a `data.frame`
7. Order the rows of a `data.frame`



## Loading in dplyr and tidyverse

```
library(tidyverse)
```

— Attaching packages — tidyverse 1.3.0

```
✓ ggplot2 3.2.1    ✓ purrr  0.3.3
✓ tibble  2.1.3    ✓ stringr 1.4.0
✓ tidyr   1.0.0    ✓ forcats 0.4.0
✓ readr   1.3.1
```

— Conflicts — tidyverse\_conflicts()

```
✗ dplyr::filter() masks stats::filter()
✗ dplyr::lag()    masks stats::lag()
```

Note, when loading `dplyr`, it says objects can be “masked”/conflicts. That means if you use a function defined in 2 places, it uses the one that is loaded in **last**.

## Loading in dplyr and tidyverse

For example, if we print `filter`, then we see at the bottom `namespace:dplyr`, which means when you type `filter`, it will use the one from the `dplyr` package.

```
filter
```

```
function (.data, ..., .preserve = FALSE)
{
  UseMethod("filter")
}
<bytecode: 0x7fb65c85f6f0>
<environment: namespace:dplyr>
```

## Loading in dplyr and tidyverse

A `filter` function exists by default in the `stats` package, however. If you want to make sure you use that one, you use `PackageName::Function` with the colon-colon ("`::`") operator.

```
head(stats::filter, 2)
```

```
1 function (x, filter, method = c("convolution", "recursive"),  
2       sides = 2L, circular = FALSE, init = NULL)
```

This is important when loading many packages, and you may have some conflicts/masking.

## Creating a `data.frame` to work with

Here we use one of the datasets that comes with `jhu` called `jhu_cars`, which is a (copy of another called `mtcars`) create a toy `data.frame` named `df` using random data:

```
data(jhu_cars)
df = jhu_cars # df is a copy of jhu_cars
head(df) # changing df does **not** change jhu_cars
```

	car	mpg	cyl	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

## Creating a `data.frame` to work with

If we would like to create a `tibble` ("fancy" `data.frame`), we can use `as.tbl` or `as_tibble`.

```
tbl = as_tibble(df)
head(tbl)
```

```
# A tibble: 6 x 12
  car      mpg  cyl  disp  hp  drat    wt  qsec    vs  am  gear  ca
  <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
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
```



## No rownames in tibbles!

In the “tidy” data format, all information of interest is a variable (not a name). **as of tibble 2.0, rownames are removed.** For example, `mtcars` has each car name as a row name:

```
head(mtcars, 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(as_tibble(mtcars), 2)
```

```
# A tibble: 2 x 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
```

# Renaming Columns

## Renaming Columns of a `data.frame`: `dplyr`

To rename columns in `dplyr`, you use the `rename` command

```
df = dplyr::rename(df, MPG = mpg)
head(df)
```

	car	MPG	cyl	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

```
df = rename(df, mpg = MPG) # reset - don't need :: b/c not masked
```

## Renaming All Columns of a `data.frame`: `dplyr`

To rename all columns you use the `rename_all` command (with a function)

```
df_upper = dplyr::rename_all(df, toupper)
head(df_upper)
```

	CAR	MPG	CYL	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

# Lab Part 1

[Website](#)

# Subsetting Columns

## Subset columns of a `data.frame`:

We can grab the `carb` column using the `$` operator.

```
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 (gives a `tibble`!)

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

```
      mpg
1  21.0
2  21.0
3  22.8
4  21.4
5  18.7
6  18.1
7  14.3
8  24.4
9  22.8
10 19.2
11 17.8
12 16.4
13 17.3
14 15.2
15 10.4
16 10.4
17 14.7
18 32.4
19 30.4
20 33.9
21 21.5
22 15.5
23 15.2
24 13.3
25 19.2
26 27.3
27 26.0
28 30.4
29 15.8
30 19.7
31 15.0
32 21.4
```



## Subset columns of a `data.frame`: `dplyr`

If you wanted it to be a single vector (not a `tibble`), use `pull`:

```
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 19.7  
[31] 15.0 21.4
```

## Select columns of a `data.frame`: `dplyr`

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

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

	mpg	cyl
1	21.0	6
2	21.0	6
3	22.8	4
4	21.4	6
5	18.7	8
6	18.1	6
7	14.3	8
8	24.4	4
9	22.8	4
10	19.2	6
11	17.8	6
12	16.4	8
13	17.3	8
14	15.2	8
15	10.4	8
16	10.4	8
17	14.7	8
18	32.4	4
19	30.4	4
20	33.9	4
21	21.5	4
22	15.5	8
23	15.2	8
24	13.3	8
25	19.2	8
26	27.3	4
27	26.0	4
28	30.4	4
29	15.8	8
30	19.7	6
31	15.0	8
32	21.4	4

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

	car	cyl	carb
1	Mazda RX4	6	4

## See the Select “helpers”

Run the command:

```
??tidyselect::select_helpers
```

Here are a few:

```
one_of()  
last_col()  
ends_with()  
contains() # like searching  
matches() # Matches a regular expression - cover later
```

# Lab Part 2

[Website](#)

# Subsetting Rows

## Subset rows of a `data.frame`: `dplyr`

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

```
filter(df, mpg > 20 | mpg < 14)
```

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
2	Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
3	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
4	Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
5	Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
6	Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
7	Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
8	Lincoln Continental	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4
9	Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
10	Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
11	Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
12	Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
13	Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
14	Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
15	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
16	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
17	Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2

Note, no `$` or subsetting is necessary. R “knows” `mpg` refers to a column of `df`.

## Subset rows of a `data.frame`: `dplyr`

You can have multiple logical conditions using the following:

- `==` : equals 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`

By default, you can separate conditions by commas, and `filter` assumes these statements are joined by `&`:

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

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
2	Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
3	Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
4	Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
5	Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
6	Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
7	Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
8	Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
9	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
10	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
11	Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2

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

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
2	Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
3	Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
4	Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
5	Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
6	Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
7	Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
8	Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
9	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
10	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
11	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`

If you want OR statements, you need to do the pipe `|` explicitly:

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

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
2	Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
3	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
4	Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
5	Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
6	Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
7	Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
8	Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
9	Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
10	Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
11	Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
12	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
13	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
14	Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2

# Lab Part 3

[Website](#)

## 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
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

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)
```

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

Recently, 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
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 new columns to a `data.frame`: base R

You can add a new column, called `newcol` to `df`, using the `$` operator:

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

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

## Adding columns to a `data.frame`: `dplyr`

The `$` method is very common.

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

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

		car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	newcol
1		Mazda RX4	21	6	160	110	3.9	2.620	16.46	0	1	4	4	1.190909
2		Mazda RX4 Wag	21	6	160	110	3.9	2.875	17.02	0	1	4	4	1.306818



## Creating conditional variables

One frequently-used tool is creating variables with conditions.

A general function for creating new variables based on existing variables is the `ifelse()` function, which “returns a value with the same shape as `test` which is filled with elements selected from either `yes` or `no` depending on whether the element of `test` is `TRUE` or `FALSE`.”

```
ifelse(test, yes, no)

# test: an object which can be coerced
#       to logical mode.
# yes:  return values for true elements of test.
# no:   return values for false elements of test.
```

## Adding columns to a `data.frame`: `dplyr`

Combined with `ifelse(condition, TRUE, FALSE)`, it can give you:

```
df = mutate(df,  
             disp_cat = ifelse(  
               disp <= 200,  
               "Low",  
               ifelse(disp <= 400,  
                      "Medium",  
                      "High")  
             )  
)  
head(df$disp_cat)
```

```
[1] "Low"    "Low"    "Low"    "Medium" "Medium" "Medium"
```

## Adding columns to a `data.frame`: dplyr

Alternatively, `case_when` provides a clean syntax as well:

```
df = mutate(df,  
             disp_cat2 = case_when(  
               disp <= 200 ~ "Low",  
               disp > 200 & disp <= 400 ~ "Medium",  
               disp > 400 ~ "High",  
             ))  
head(df$disp_cat2)  
  
[1] "Low"    "Low"    "Low"    "Medium" "Medium" "Medium"
```

## Removing columns to a `data.frame`: base R

You can remove a column by assigning to `NULL`:

```
df$newcol = NULL
```

## Removing columns to a `data.frame`: `dplyr`

The `NULL` method is still very common.

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

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

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

  

	disp_cat2
1	Low
2	Low
3	Low
4	Medium
5	Medium
6	Medium

## Removing columns to a `data.frame`: `dplyr`

Remove `newcol` and `drat`

```
select(df, -one_of("newcol", "drat"))
```

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

  

	disp_cat2
1	Low
2	Low
3	Low
4	Medium
5	Medium
6	Medium

Ordering columns

## 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	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	cat
1	1.190909	Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	
2	1.306818	Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	
3	1.054545	Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	
4	1.461364	Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	
5	1.563636	Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	
6	1.572727	Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	

  

	disp_cat	disp_cat2
1	Low	Low
2	Low	Low
3	Low	Low
4	Medium	Medium
5	Medium	Medium
6	Medium	Medium



## Ordering the columns of a `data.frame`: `dplyr`

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

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

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb	disp_cat2
1	Mazda RX4	21.0	6	160	110	3.90	2.620	16.46	0	1	4	4	Low
2	Mazda RX4 Wag	21.0	6	160	110	3.90	2.875	17.02	0	1	4	4	Low
3	Datsun 710	22.8	4	108	93	3.85	2.320	18.61	1	1	4	1	Low
4	Hornet 4 Drive	21.4	6	258	110	3.08	3.215	19.44	1	0	3	1	Medium
5	Hornet Sportabout	18.7	8	360	175	3.15	3.440	17.02	0	0	3	2	Medium
6	Valiant	18.1	6	225	105	2.76	3.460	20.22	1	0	3	1	Medium

  

	disp_cat2	newcol
1	Low	1.190909
2	Low	1.306818
3	Low	1.054545
4	Medium	1.461364
5	Medium	1.563636
6	Medium	1.572727

Ordering rows

## Ordering the rows of a `data.frame`: `dplyr`

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

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

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
2	Lincoln Continental	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4
3	Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
4	Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
5	Chrysler Imperial	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
6	Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.60	0	1	5	8
7	Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
8	AMC Javelin	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2
9	Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
10	Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.50	0	1	5	4
11	Merc 450SE	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
12	Merc 450SL	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
13	Merc 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
14	Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
15	Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
16	Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
17	Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
18	Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.50	0	1	5	6
19	Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
20	Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
21	Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
22	Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2
23	Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
24	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
25	Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
26	Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
27	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
28	Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
29	Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
30	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
31	Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
32	Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
	newcol	disp_cat	disp_cat2									
1	2.3863636	High	High									
2	2.4654545	High	High									
3	1.7454545	Medium	Medium									
4	1.6227273	Medium	Medium									

## Ordering the rows of a `data.frame`: `dplyr`

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

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

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1
2	Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
3	Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
4	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
5	Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
6	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
7	Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
8	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
9	Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
10	Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
11	Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
12	Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2
13	Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
14	Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
15	Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.50	0	1	5	6
16	Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
17	Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
18	Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
19	Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
20	Merc 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
21	Merc 450SL	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
22	Merc 450SE	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
23	Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.50	0	1	5	4
24	Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
25	Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
26	AMC Javelin	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2
27	Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.60	0	1	5	8
28	Chrysler Imperial	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
29	Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
30	Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
31	Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
32	Lincoln Continental	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4

	newcol	disp_cat	disp_cat2
1	0.8340909	Low	Low
2	1.0000000	Low	Low
3	0.7340909	Low	Low
4	0.6877273	Low	Low
5	0.8795455	Low	Low

## Ordering the rows of a `data.frame`: `dplyr`

It is a bit more straightforward to mix increasing and decreasing orderings:

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

	car	mpg	cyl	disp	hp	drat	wt	qsec	vs	am	gear	carb
1	Lincoln Continental	10.4	8	460.0	215	3.00	5.424	17.82	0	0	3	4
2	Cadillac Fleetwood	10.4	8	472.0	205	2.93	5.250	17.98	0	0	3	4
3	Camaro Z28	13.3	8	350.0	245	3.73	3.840	15.41	0	0	3	4
4	Duster 360	14.3	8	360.0	245	3.21	3.570	15.84	0	0	3	4
5	Chrysler Imperial	14.7	8	440.0	230	3.23	5.345	17.42	0	0	3	4
6	Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.60	0	1	5	8
7	Merc 450SLC	15.2	8	275.8	180	3.07	3.780	18.00	0	0	3	3
8	AMC Javelin	15.2	8	304.0	150	3.15	3.435	17.30	0	0	3	2
9	Dodge Challenger	15.5	8	318.0	150	2.76	3.520	16.87	0	0	3	2
10	Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.50	0	1	5	4
11	Merc 450SE	16.4	8	275.8	180	3.07	4.070	17.40	0	0	3	3
12	Merc 450SL	17.3	8	275.8	180	3.07	3.730	17.60	0	0	3	3
13	Merc 280C	17.8	6	167.6	123	3.92	3.440	18.90	1	0	4	4
14	Valiant	18.1	6	225.0	105	2.76	3.460	20.22	1	0	3	1
15	Hornet Sportabout	18.7	8	360.0	175	3.15	3.440	17.02	0	0	3	2
16	Pontiac Firebird	19.2	8	400.0	175	3.08	3.845	17.05	0	0	3	2
17	Merc 280	19.2	6	167.6	123	3.92	3.440	18.30	1	0	4	4
18	Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.50	0	1	5	6
19	Mazda RX4	21.0	6	160.0	110	3.90	2.620	16.46	0	1	4	4
20	Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875	17.02	0	1	4	4
21	Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215	19.44	1	0	3	1
22	Volvo 142E	21.4	4	121.0	109	4.11	2.780	18.60	1	1	4	2
23	Toyota Corona	21.5	4	120.1	97	3.70	2.465	20.01	1	0	3	1
24	Merc 230	22.8	4	140.8	95	3.92	3.150	22.90	1	0	4	2
25	Datsun 710	22.8	4	108.0	93	3.85	2.320	18.61	1	1	4	1
26	Merc 240D	24.4	4	146.7	62	3.69	3.190	20.00	1	0	4	2
27	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.70	0	1	5	2
28	Fiat X1-9	27.3	4	79.0	66	4.08	1.935	18.90	1	1	4	1
29	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.90	1	1	5	2
30	Honda Civic	30.4	4	75.7	52	4.93	1.615	18.52	1	1	4	2
31	Fiat 128	32.4	4	78.7	66	4.08	2.200	19.47	1	1	4	1
32	Toyota Corolla	33.9	4	71.1	65	4.22	1.835	19.90	1	1	4	1

	newcol	disp_cat	disp_cat2
1	2.4654545	High	High
2	2.3863636	High	High
3	1.7454545	Medium	Medium
4	1.6227273	Medium	Medium
5	2.4295455	High	High

## Transmutation

The `transmute` function in `dplyr` combines both the `mutate` and `select` functions. One can create new columns and keep the only the columns wanted:

```
transmute(df, newcol2 = wt/2.2, mpg, hp)
```

	newcol2	mpg	hp
1	1.1909091	21.0	110
2	1.3068182	21.0	110
3	1.0545455	22.8	93
4	1.4613636	21.4	110
5	1.5636364	18.7	175
6	1.5727273	18.1	105
7	1.6227273	14.3	245
8	1.4500000	24.4	62
9	1.4318182	22.8	95
10	1.5636364	19.2	123
11	1.5636364	17.8	123
12	1.8500000	16.4	180
13	1.6954545	17.3	180
14	1.7181818	15.2	180
15	2.3863636	10.4	205
16	2.4654545	10.4	215
17	2.4295455	14.7	230
18	1.0000000	32.4	66
19	0.7340909	30.4	52
20	0.8340909	33.9	65
21	1.1204545	21.5	97
22	1.6000000	15.5	150
23	1.5613636	15.2	150
24	1.7454545	13.3	245
25	1.7477273	19.2	175
26	0.8795455	27.3	66
27	0.9727273	26.0	91
28	0.6877273	30.4	113
29	1.4409091	15.8	264
30	1.2590909	19.7	175
31	1.6227273	15.0	335
32	1.2636364	21.4	109

# Lab Part 4

[Website](#)

Extra Slides



## 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"
[7] "wt"       "qsec"     "vs"       "am"       "gear"     "carb"
[13] "newcol"   "disp_cat" "disp_cat2"
```

```
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	
	newcol	disp_cat	disp_cat2										
1	1.190909	Low	Low										
2	1.306818	Low	Low										
3	1.054545	Low	Low										
4	1.461364	Medium	Medium										
5	1.563636	Medium	Medium										
6	1.572727	Medium	Medium										

```
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

  

	newcol	disp_cat	disp_cat2
1	1.190909	Low	Low
2	1.306818	Low	Low
3	1.054545	Low	Low
4	1.461364	Medium	Medium
5	1.563636	Medium	Medium
6	1.572727	Medium	Medium

```
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	newcol
1	Mazda RX4	21.0	6	160	110	3.90	2.62	16.46	0	1	4	4	1.190909	
3	Datsun 710	22.8	4	108	93	3.85	2.32	18.61	1	1	4	1	1.054545	

  

	disp_cat	disp_cat2
1	Low	Low
3	Low	Low

## 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 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
```

## Biggest 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 a vector, 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 x 1
  car
  <chr>
1 Mazda RX4
2 Mazda RX4 Wag
3 Datsun 710
4 Hornet 4 Drive
5 Hornet Sportabout
6 Valiant
7 Duster 360
8 Merc 240D
9 Merc 230
10 Merc 280
# ... with 22 more rows
```

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

```
# A tibble: 32 x 1
  mpg
  <dbl>
1 21
2 21
```

## 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	
26	Fiat X1-9	27.3	
27	Porsche 914-2	26.0	
28	Lotus Europa	30.4	
29	Ford Pantera L	15.8	
30	Ferrari Dino	19.7	
31	Maserati Bora	15.0	
32	Volvo 142E	21.4	

## No rownames in tibbles!

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

```
head(rownames_to_column(mtcars, var = "car"), 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(as_tibble(rownames_to_column(mtcars, var = "car")), 2)
```

```
# A tibble: 2 x 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 Wag  21     6   160   110   3.9  2.88  17.0     0     1     4     4
```