Dplyr

What is the `tidyverse`?

> "The `tidyverse` is an **opinionated** collection of R packages designed for data science. All packages share an underlying design philosophy, grammar, and data structures."

Plan for today

- Learn basic syntax for nearly all `tidyverse` packages
- Introduce functions that come from the `dplyr` package
  - `filter()`
  - `select()`
  - `mutate()`
  - `summarize()`
  - `group_by()`

About the MIDUS dataset

Variables available in this data file:

- **Demographic variables**: age, sex
- **Physical health variables**: self-rated physical health, heart problems, father had heart attack, BMI
- **Mental health variables**: self-rated meantal health, self-esteem, life satisfaction *(life overall, work, health, relationship with spouse/partner, relationship with children)*, hostility *(stress reactivity & agression*)

Please load in `midus`, make sure:

- Make sure the variables `sex`, `heart_self`, and `heart_father` are `factor()` variables (rather than characters)
- Use the same `na.omit()` function to remove all `NA` values

Syntax & Piping

- All of the `tidyverse` packages use **piping** as a way to make code easier to read.
- Think of it kind of like making a cohesive paragraph of code, rather than scribbling down a bunch of random lines.
- The format looks like this:

```
originalData %>%
  function1(someVariable) %>%
  function2(someVariable) %>%
  function3(someVariable)
```

Syntax & Piping

```
originalData %>%
  function1(someVariable) %>%
  function2(someVariable) %>%
  function3(someVariable)
```

First thing that enters is your original data.frame. The end of the line has this `%>%` symbol. This is called a **pipe**.

Syntax & Piping

```
originalData %>%
  function1(someVariable) %>%
  function2(someVariable) %>%
  function3(someVariable)
```

Next up is some function that is performed on a variable. This variable COMES FROM the `originalData` data.frame. Another way to think about it is that the function *inherits* the data.frame from above. That means you don't need to keep re-typing `originalData`.

Again, the end of the line is followed by the `%>%` pipe operator.

Syntax & Piping

```
originalData %>%
  function1(someVariable) %>%
  function2(someVariable) %>%
  function3(someVariable)
```

Same thing for the next function. However, instead of inheriting from `originalData`, function 2 will inherit *the output* of function 1!

Again, the end of the line is followed by the `%>%` pipe operator.

Syntax & Piping

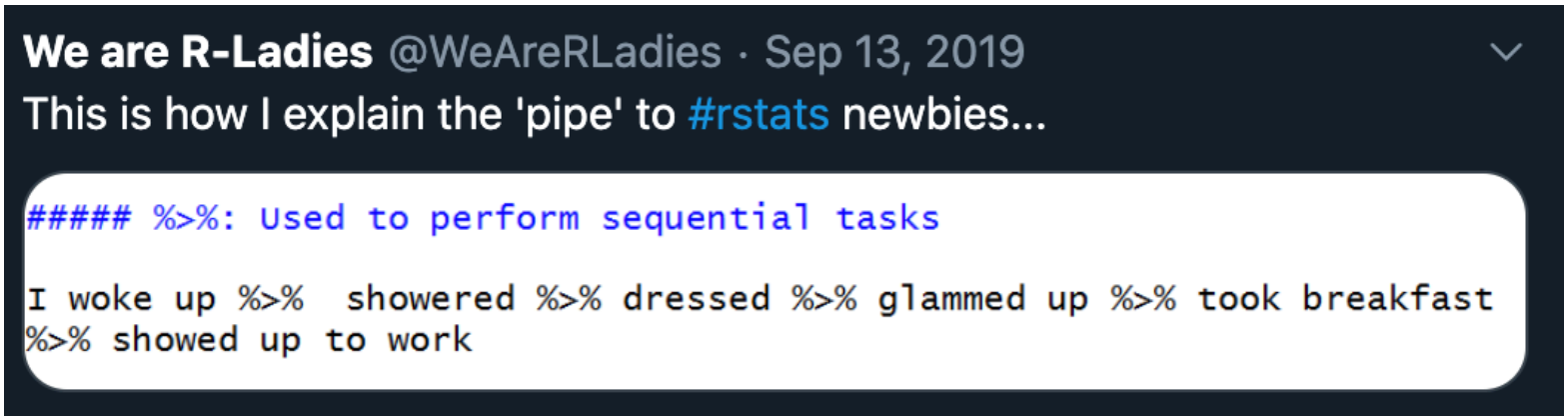
```
originalData %>%
  function1(someVariable) %>%
  function2(someVariable) %>%
  function3(someVariable)
```

Finally, we get to function 3. It will inherit *the output* of function 2.

Notice that there is no `%>%` pipe operator at the end of this line. That's because this "paragraph" of code is now over.

Syntax & Piping

- These `%>%` pipes are used to perform **SEQUENTIAL** tasks!
- You can read the `%>%` as *and then...*



- Don't use `<-` *inside* the piped function. Only at the very beginning if you want to store the output.
- Keep `%>%` and the *end* of each line! Not at the beginning.
- Shortcut for inserting pipe:
  - `command` + `shift` + `m` for Mac users
  - `control` + `shift` + `m` for Windows users

`filter()` Function

To illustrate how this works, let's start with the `filter()` function. `filter()` is another way to subset your data.frame based on some condition. It is the `tidyverse` equivalent of `subset()`.

Let's say we want to make a new data.frame that included only female participants...

```
femaleMidus <- midus %>%
  filter(sex == "Female")
```

ID	sex	age	BMI	physical_health_self	mental_health_self	self_esteem	life
10011	Female	52	25.991	5	4	41	
10015	Female	53	32.121	3	3	31	
10023	Female	78	24.752	2	4	34	
10028	Female	63	24.049	5	5	42	
10030	Female	56	27.342	4	5	37	
10038	Female	57	39.598	3	2	26	

Spelling/capitalization etc. always count

Let's say we want to make a new data.frame that included only female participants...

```
femaleMidus <- midus %>%
  filter(sex == "female")
```

ID	sex	age	BMI	physical_health_self	mental_health_self	self_esteem	life_satisfac

Now with multiple logical operators

Let's say we want to make a new data.frame that included male participants who have reported having some form of heart problem and are over the age of 50.

```
oldMenHeart <- midus %>%
  filter(sex == "Male" & heart_self == "Yes" & age > 50)
```

ID	sex	age	BMI	physical_health_self	mental_health_self	self_esteem	life_s
10039	Male	53	31.872	1	4	35	
10067	Male	62	29.254	3	3	36	
10088	Male	79	29.289	4	4	34	
10131	Male	71	24.826	4	4	43	
10143	Male	57	25.105	3	5	35	
10173	Male	58	28.481	4	5	49	

Is `tidyverse` totally different from `base R`?

No! You still have:

- objects
- assignment of objects
- functions
- functions that take in arguments
- logical operators like `==` and `>`
- multiple logical operators like `&` and `|`

The only thing that's different is the inclusion of `%>%` and the way you build your "code paragraphs". But all of the principles that we've learned thus far, still apply to everything in the `tidyverse`.

`select()` function

This is another way to select variables. It can replace indexing, which is helpful when you are in these `tidyverse` code chunks (or paragraphs).

This function can take in column indexes, variable names, or both!

```
# first 3 columns only!
firstThree <- midus %>%
  select(1:3)
```

	ID	sex	age
1	10001	Male	61
2	10002	Male	69
6	10011	Female	52
8	10015	Female	53
10	10018	Male	49
11	10019	Male	51

`select()` function

```
# BMI, both heart_self and heart_father
otherThree <- midus %>%
  select(BMI, 10:11)
```

	BMI	heart_self	heart_father
1	26.263	No	No
2	24.077	No	Yes
6	25.991	No	No
8	32.121	No	Yes
10	22.499	No	No
11	29.987	No	No

`select()` function

To remove a variable, put a `-` (minus) sign in front of the variable you want to get rid of

```
# Keep all variables EXCEPT sex & physical_health_self
removal <- midus %>%
  select(-sex, -5)
```

	ID	age	BMI	mental_health_self	self_esteem	life_satisfaction	hostility	he
1	10001	61	26.263	4	42	7.750	5.5	N
2	10002	69	24.077	5	34	8.250	6.0	N
6	10011	52	25.991	4	41	7.000	5.5	N
8	10015	53	32.121	3	31	7.375	6.0	N
10	10018	49	22.499	4	41	8.500	6.0	N
11	10019	51	29.987	5	38	7.625	4.5	N

`mutate()` function

`mutate()` is kind of tricky. On it's own, will simply add a new variable to the end of your data.frame based on something.

For example, if we wanted to get the square root of BMI...

```
sqrtMidus <- midus %>%
  mutate(BMI_sqrt = sqrt(BMI))

head(sqrtMidus)
```

```
##      ID    sex age    BMI physical_health_self mental_health_self self_este
## 1 10001   Male  61 26.263                    2                   4          
## 2 10002   Male  69 24.077                    5                   5          
## 3 10011 Female  52 25.991                    5                   4          
## 4 10015 Female  53 32.121                    3                   3          
## 5 10018   Male  49 22.499                    4                   4          
## 6 10019   Male  51 29.987                    4                   5          
##   life_satisfaction hostility heart_self heart_father BMI_sqrt
## 1             7.750       5.5         No           No 5.124744
## 2             8.250       6.0         No          Yes 4.906832
## 3             7.000       5.5         No           No 5.098137
## 4             7.375       6.0         No          Yes 5.667539
```

`mutate()` function

BUT, you can add different endings (suffixes) to it

- `mutate_at()`
- `mutate_all()`
- `mutate_if()`

I find `mutate_at()` to be the most useful, personally. It is especially nice for making sure the variables you need to be factors are actually factors!

Note: you can add suffixes `_at`, `_all`, and `_if` to many `tidyverse` functions! `mutate()` happens to be the one where I find this most useful, so I'm using it as an example.

`mutate()` function

For example, to set up the `midus` data.frame, you were asked to make sure that `sex`, `heart_self`, and `heart_father` were all considered factors. Your code probably looked something like:

```
midus$sex <- factor(midus$sex)
midus$heart_self <- factor(midus$heart_self)
midus$heart_father <- factor(midus$heart_father)
```

When instead, it could look something like this:

```
midus <- midus %>%
  mutate_at(vars(2, 10, 11), list(factor))
```

- `vars(2, 10, 11)` says "OK, I'm going to mutate some variables. Which ones?"
- `list(factor)` says, "give me a list of functions you want me to apply to each of the variables you fed me"

Note: I have found that the help documentation for some of these functions has not updated accordingly. Search the internet and pay attention to your package version number.

THERE IS NO RIGHT WAY TO CODE!

Whether you used this...

```
midus$sex <- factor(midus$sex)
midus$heart_self <- factor(midus$heart_self)
midus$heart_father <- factor(midus$heart_father)
```

...or this...

```
midus <- midus %>%
  mutate_at(vars(2, 10, 11), list(factor))
```

....**doesn't matter at all!** The only things that count are:

- Were you able to do what you wanted to?
- Can YOU read the code and know what it's doing?
- Can SOMEONE ELSE read the code and know what it's doing?

A `filter()` & `mutate_at()` example

Let's say we `filter()` so that we only have females in our data.set.

```
femalesOnly <- midus %>%
  filter(sex == "Female")
```

In our new data.frame, the variable `sex` should only have 1 level for "Female". That is, all the "Male" participants have been removed. So as a factor, there should only be 1 category or 1 level. Let's check:

```
levels(femalesOnly$sex)
```

```
## [1] "Female" "Male"
```

Uh oh! That's not quite right.

A `filter()` & `mutate_at()` example

Let's tell R to make `sex` into a factor again (kind of like re-populate the variable).

```
femalesOnly <- midus %>%
  filter(sex == "Female") %>%
  mutate_at(vars(sex), list(factor))

# check the levels again
levels(femalesOnly$sex)
```

```
## [1] "Female"
```

Now we got it! You could have first done the `filter()` function, ended the code chunk/paragraph, and then typed: `femalesOnly$sex <- factor(femalesOnly$sex)`. The downside to this is that it's nice to keep all your functions (verbs/actions) in one place, if you can.

`summarize()` function

This is great for summarizing your data *(shocking, I know 😲)*

Remember that awfulness for making bar plots? This is how we can do it easily!

```
midus %>%
  summarize(meanAge = mean(age))
```

```
##    meanAge
## 1 56.09118
```

`summarize()` function

You can go crazy with this!

```
midus %>%
  summarize(meanAge = mean(age), # mean
            sdAge = sd(age), # standard deviation
            varAge = var(age), # variance
            medianAge = median(age)) # median
```

```
##    meanAge    sdAge   varAge medianAge
## 1 56.09118 12.30031 151.2976        55
```

Fun fact: the person that wrote much of the `tidyverse` packages is from New Zealand, where they use British spellings. Therefore, `summarise()` is the exact same thing as `summarize()`. Your tab-complete might fill in the British versions!

`group_by()` function

We can make `summarize()` even more powerful by adding the `group_by()` function.

You will NOT see anything directly change to your data.frame if you were to just run this factor. However, on the back end (behind the scenes), it tells R to do something *for each level of a categorical variable*.

If we want the mean age of those with and without heart problems:

```
midus %>%
  group_by(heart_self) %>%
  summarize(meanAge = mean(age))
```

```
## # A tibble: 2 x 2
##   heart_self meanAge
##   <fct>         <dbl>
## 1 No             54.6
## 2 Yes            63.0
```

group_by() function

We can go crazy with this too!

```
midus %>%
  group_by(heart_self, sex) %>%
  summarize(meanAge = mean(age),
            sdAge = sd(age),
            meanBMI = mean(BMI),
            sdBMI = sd(BMI))
```

```
## # A tibble: 4 x 6
## # Groups:   heart_self [2]
##   heart_self sex    meanAge sdAge meanBMI sdBMI
##   <fct>      <fct>    <dbl> <dbl>   <dbl> <dbl>
## 1 No         Female    54.9  12.3    27.5  6.42
## 2 No         Male      54.3  11.5    28.2  4.74
## 3 Yes        Female    61.2  11.8    28.0  6.60
## 4 Yes        Male      64.6  11.1    28.9  4.92
```

Pro Tips

As you can see, the suite of `tidyverse` packages can be really, really helpful! Some things to keep in mind:

- You can put a non-tidyverse function into one of these code chunks (paragraphs)
  - If you do this, you sometimes need to give the function an input argument. Use the `.` for this.
  - Ex: `midus %>% na.omit(.)`
- You can have as many functions in each paragraph as you want. Just remember that everything is *sequential*!
  - If the output of your paragraph isn't what you think it should be, go line by line until you find the problem. Do NOT include the `%>%` when you run the line of code, though! R will wait for you to finish your sentence...

Other useful `dplyr` functions

- `recode()` is great for recoding variables. I especially like this for when you have something like `1` and `2` reflecting categorical variables. Recode them into something more meaningful! This is often nested within a `mutate()` or `mutate_at()` function.
- `rename()` for renaming columns
- `arrange()` will order the rows of a data.frame by some column.
- `n_distinct()` finds the number of unique entries. For example, if you have "male" and "female", the result of `n_distinct()` should be 2, even if there are thousands of rows. Now let's say there's a spelling error in one of these rows (e.g., "feemale"), now the result of `n_distinct()` will be 3...that should let you know there's a problem.
- lots & lots of others...