

MANIPULATING DATA WITH DPLYR

BASED ON R-ECOLOGY LESSON - DATA CARPENTRY

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WHAT IS DPLYR?

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 - ▶ Packages in R are basically sets of additional functions that let you do more stuff
- dplyr provides **easy tools** for the most common **data manipulation** tasks
- dplyr addresses this by porting much of the computation to C++
- An additional feature is the ability to work directly with data stored in an **external database**

WHAT IS DPLYR?

Before start to dig into dplyr functions we learn how to import data into R

- To download the data, run the following:

```
download.file("https://ndownloader.figshare.com/files/2292169",  
             "portal_data_joined.csv")
```

- You are now ready to load the data:

```
surveys <- read.csv('portal_data_joined.csv')
```

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```
surveys <- read.csv('portal_data_joined.csv')
```

- Converts data to tbl class. tbl's are easier to examine than data frames. R displays only the data that fits onscreen

```
surveys <- tbl_df(surveys)
```


WHAT IS DPLYR?

We're going to learn some of the *most common dplyr functions*:

- **select**
- **filter**
- **arrange**
- **mutate**
- **group_by**
- **summarize**

SELECT



FIGURE 1: Select

- To select columns of a data frame, use `select()`
 - ▶ The **first argument** to this function is the **data frame**
 - ▶ The **subsequent arguments** are the **columns to keep**

```
select(surveys, plot_id, species_id, weight)
```

SELECT

- select is much more powerful than just select the interest columns
 - ▶ You can remove one column

```
select(surveys, -weight)
```

SELECT

- select is much more powerful than just select the interest columns
 - ▶ You can remove one column

```
select(surveys, -weight)
```

* Select columns whose name contains a character string

```
select(surveys, contains("ec"))
```

SELECT

- Select columns whose name starts with a character string

```
select(surveys, starts_with("s"))
```

SELECT

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```
select(surveys, starts_with("s"))
```

- Select all columns between Sepal.Length and Petal.Width (inclusive).

```
select(surveys, plot_id:weight)
```

SELECT

- Select columns whose name starts with a character string

```
select(surveys, starts_with("s"))
```

- Select all columns between Sepal.Length and Petal.Width (inclusive).

```
select(surveys, plot_id:weight)
```

- Select every column

```
select(surveys, weight, everything())
```



FIGURE 2: Filter

- To select rows of a data frame, use `filter()`
 - ▶ The **first argument** to this function is the **data frame**
 - ▶ The **subsequent arguments** are the **conditions for the subsetting**

```
filter(surveys, year == 1995)
```


FILTER

- Extract rows that meet logical criteria

```
filter(surveys, year > 1995)
filter(surveys, year > 1995, day == 12)
filter(surveys, year > 1995, day == 12 | day == 24)
filter(surveys, year > 1995, day == 12 | (day == 24 & sex != "F"))
```

CHALLENGE

Subset the surveys dataset:

- The data from spring of 1999
- All the females heavier than 100 after 1995
- All the female heavier than 150 in days 11 and 18 and the males of NL specie

FILTER

- Extract rows that meet logical criteria

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filter(surveys, year > 1995)
filter(surveys, year > 1995, day == 12)
filter(surveys, year > 1995, day == 12 | day == 24)
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```

CHALLENGE

Subset the surveys dataset:

- The data from spring of 1999
- All the females heavier than 100 after 1995
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```
filter(surveys, year == 1999, month >= 3 & month <= 6 )
filter(surveys, sex == "F", weight > 100, year > 1995)
filter(surveys, (sex == "F" & (day == 11 | day == 18)) |
       (sex == "M" & species_id == "NL"))
```

But what if you wanted to **select and filter at the same time**?

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But what if you wanted to **select and filter at the same time**?

There are *three ways* to do this:

- use intermediate steps
 - ▶ you essentially create a temporary data frame and use that as input to the next function

```
tmp <- select(surveys, plot_id, species_id, weight)
filter(tmp, weight > 270)
```

But what if you wanted to **select and filter at the same time**?

There are *three* ways to do this:

- use intermediate steps

- ▶ you essentially create a temporary data frame and use that as input to the next function

```
tmp <- select(surveys, plot_id, species_id, weight)
filter(tmp, weight > 270)
```

- nested functions

- ▶ one function inside of another

```
filter(select(surveys, plot_id, species_id, weight), weight > 270)
```

- pipes

- ▶ pipes let you take the output of one function and send it directly to the next

```
select(surveys, plot_id, species_id, weight) %>%  
  filter(weight > 270)
```

- pipes

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```
select(surveys, plot_id, species_id, weight) %>%  
  filter(weight > 270)
```

- Pipes in R look like %>% and are made available via the magrittr package, installed automatically with dplyr

PIPES

- pipes

- ▶ pipes let you take the output of one function and send it directly to the next

```
select(surveys, plot_id, species_id, weight) %>%  
  filter(weight > 270)
```

- Pipes in R look like %>% and are made available via the magrittr package, installed automatically with dplyr
- **%>% takes the object on its left and passes it as the first argument to the function on its right**, we don't need to explicitly include it as an argument to the filter() and select() functions anymore

```
surveys %>%  
  filter(weight < 5) %>%  
  select(species_id, sex, weight)
```


CHALLENGE

- Filter females from specie NL and select year and weight
- Filter male from 1995 and report all columns apart for month
- Filter 1995, rodent and report column: taxa, year and then all the others

CHALLENGE

- Filter females from specie NL and select year and weight
- Filter male from 1995 and report all columns apart for month
- Filter 1995, rodent and report column: taxa, year and then all the others

```
surveys %>%  
  filter(sex == "F", species_id == "NL") %>%  
  select(year, weight)
```

```
surveys %>%  
  filter(sex == "M", year == 1995) %>%  
  select(-month)
```

```
surveys %>%  
  filter(year == 1995, taxa == "Rodent") %>%  
  select(taxa, year, everything())
```

MUTATE

Frequently you'll want to **create new columns based on the values in existing columns**

For this we'll use **mutate()**

```
surveys %>%  
  mutate(weight_kg = weight / 1000) %>%  
  select(weight, weight_kg)
```

MUTATE

Frequently you'll want to **create new columns based on the values in existing columns**

For this we'll use **mutate()**

```
surveys %>%  
  mutate(weight_kg = weight / 1000) %>%  
  select(weight, weight_kg)
```

The first few rows of the output are full of NAs, so if we wanted to remove those

```
surveys %>%  
  filter(!is.na(weight)) %>%  
  mutate(weight_kg = weight / 1000) %>%  
  select(weight, weight_kg)
```

CHALLENGE

Create a new data frame from the survey data that meets the following criteria:

- contains only the `species_id` column and a new column called `hindfoot_half` containing values that are half the `hindfoot_length` values.
- In the `hindfoot_half` column, there are no NAs and all values are less than 30.

CHALLENGE

Create a new data frame from the survey data that meets the following criteria:

- contains only the `species_id` column and a new column called `hindfoot_half` containing values that are half the `hindfoot_length` values.
- In the `hindfoot_half` column, there are no NAs and all values are less than 30.

```
surveys %>%  
  filter(!is.na(hindfoot_length)) %>%  
  mutate(hindfoot_half = hindfoot_length / 2) %>%  
  select(species_id, hindfoot_half)
```

GROUP_BY AND SUMMARIZE

Many data analysis tasks can be approached using the **split-apply-combine** paradigm:

- **split** the data into groups
- **apply** some analysis to each group
- **combine** the results



FIGURE 3: Group_by and summarize

GROUP_BY AND SUMMARIZE

```
surveys %>%  
  group_by(sex) %>%  
  summarize(mean_weight = mean(weight, na.rm = TRUE))
```

CHALLENGE

Remove the first row of the output that contains not male or female

GROUP_BY AND SUMMARIZE

- You can also group by multiple columns:

```
surveys %>%  
  filter(!is.na(weight)) %>%  
  group_by(sex, species_id) %>%  
  summarize(mean_weight = mean(weight))
```

GROUP_BY AND SUMMARIZE

- You can also group by multiple columns:

```
surveys %>%  
  filter(!is.na(weight)) %>%  
  group_by(sex, species_id) %>%  
  summarize(mean_weight = mean(weight))
```

* If you want to display more data:

```
surveys %>%  
  filter(!is.na(weight)) %>%  
  group_by(sex, species_id) %>%  
  summarize(mean_weight = mean(weight)) %>%  
  print(n = 15)
```

GROUP_BY AND SUMMARIZE

- Once the data are grouped, you can also summarize multiple variables at the same time

```
surveys %>%  
  filter(!is.na(weight)) %>%  
  group_by(sex, species_id) %>%  
  summarize(mean_weight = mean(weight),  
             min_weight = min(weight)) %>%  
  print(n = 15)
```

GROUP_BY AND SUMMARIZE

- Once the data are grouped, you can also summarize multiple variables at the same time

```
surveys %>%  
  filter(!is.na(weight)) %>%  
  group_by(sex, species_id) %>%  
  summarize(mean_weight = mean(weight),  
             min_weight = min(weight)) %>%  
  print(n = 15)
```

- * How to know the number of observations found for each factor or combination of factors

```
surveys %>%  
  group_by(sex) %>%  
  tally
```

tally() is the action applied to the groups created by group_by() and counts the total number of records for each category

ARRANGE

- Last but not least the verb to sort your data.frame

```
select(surveys, plot_id, species_id, weight) %>%  
  arrange(desc(weight))
```

CHALLENGE 1 ==TODO==

- 1 How many individuals were caught in each `plot_type` surveyed?
- 2 Use `group_by()` and `summarize()` to find the mean, min, and max hindfoot length for each species (using `species_id`).
- 3 What was the heaviest animal measured in each year? Return the columns `year`, `genus`, `species_id`, and `weight`.
- 4 You saw above how to count the number of individuals of each sex using a combination of `group_by()` and `tally()`. How could you get the same result using `group_by()` and `summarize()`? Hint: see `?n`.

CHALLENGE 1

- ❶ How many individuals were caught in each plot_type surveyed?

```
## Answer 1
surveys %>%
  group_by(plot_type) %>%
  tally
```

CHALLENGE 1

- ❶ How many individuals were caught in each plot_type surveyed?

```
## Answer 1
surveys %>%
  group_by(plot_type) %>%
  tally
```

2. Use `group_by()` and `summarize()` to find the mean, min, and max hindfoot length for each species (using `species_id`).

```
## Answer 2
surveys %>%
  filter(!is.na(hindfoot_length)) %>%
  group_by(species_id) %>%
  summarize(
    mean_hindfoot_length = mean(hindfoot_length),
    min_hindfoot_length = min(hindfoot_length),
    max_hindfoot_length = max(hindfoot_length)
  )
```


CHALLENGE 1

- 8 What was the heaviest animal measured in each year? Return the columns year, genus, species_id, and weight.

```
## Answer 3
surveys %>%
  filter(!is.na(weight)) %>%
  group_by(year) %>%
  filter(weight == max(weight)) %>%
  select(year, genus, species, weight) %>%
  arrange(year)
```

CHALLENGE 1

- ③ What was the heaviest animal measured in each year? Return the columns year, genus, species_id, and weight.

```
## Answer 3
surveys %>%
  filter(!is.na(weight)) %>%
  group_by(year) %>%
  filter(weight == max(weight)) %>%
  select(year, genus, species, weight) %>%
  arrange(year)
```

4. Get the same result using `group_by()` and `summarize()`?

```
## Answer 4
surveys %>%
  group_by(sex) %>%
  summarize(n = n())
```

CHALLENGE 2

Recall yesterday challenge and try to solve it using dplyr

- Which is the average age?
- Which is the maximum female weight?
- Which is the minimum male weight?
- How many are the male over 180cm?
- Which is their average age?
- Who is the younger and lighter female?
- Who is the person with the minimum BMI $[\text{weight}/\text{height}^2]$?

CHALLENGE 2

Re-create the data.frame

```
n <- 1:10
sex <- rep(c('male', 'female'), 5)
age <- c(23, 22, 21, 22, 24, 30, 23, 29, 19, 29)
weight <- c(72, 90, 120, 80, 75, 65, 91, 58, 78, 50)
height <- c(171, 185, 210, 170, 189, 150, 168, 165, 188, 143)
df <- data.frame(n = n, sex = sex, age = age, weight = weight,
                 height = height)
df
```

CHALLENGE 2

- Which is the average age?

```
df %>% mutate(mean_age = mean(age))
```

CHALLENGE 2

- Which is the average age?

```
df %>% mutate(mean_age = mean(age))
```

- Which is the maximum female weight?

```
df %>% filter(sex == "female") %>%  
  filter(weight == max(weight))
```

```
df %>% filter(sex == "female") %>%  
  top_n(1, weight)
```

CHALLENGE 2

- Which is the average age?

```
df %>% mutate(mean_age = mean(age))
```

- Which is the maximum female weight?

```
df %>% filter(sex == "female") %>%  
  filter(weight == max(weight))
```

```
df %>% filter(sex == "female") %>%  
  top_n(1, weight)
```

- Which is the minimum male weight?

```
df %>% filter(sex == "male") %>%  
  filter(weight == min(weight))
```

CHALLENGE 2

- How many are the male over 180cm?

```
df %>% filter(sex == "male") %>% filter(height > 180) %>%  
  count()
```


CHALLENGE 2

- How many are the male over 180cm?

```
df %>% filter(sex == "male") %>% filter(height > 180) %>%  
  count()
```

- Which is their average age?

```
df %>% filter(sex == "male") %>% filter(height > 180) %>%  
  summarise(mean(age))
```

CHALLENGE 2

- How many are the male over 180cm?

```
df %>% filter(sex == "male") %>% filter(height > 180) %>%  
  count()
```

- Which is their average age?

```
df %>% filter(sex == "male") %>% filter(height > 180) %>%  
  summarise(mean(age))
```

- Who is the younger and lighter female?

```
df %>% filter(sex == "female") %>%  
  filter(age == min(age)) %>%  
  filter(weight == min(weight))
```

CHALLENGE 2

- Who is the person with the minimum BMI $[\text{weight}/\text{height}^2]$?

```
df %>% mutate(BMI = weight/height^2) %>%  
  filter(BMI == min(BMI))
```

EXPORTING DATA

- Now that you have learned how to use dplyr to **extract information** from or summarize your raw data, you may want to **export these new datasets** to share them with your collaborators
- Similar to the read.csv() function used for reading CSVs into R, there is a write.csv() function that generates CSV files from data frames
- Before using write.csv(), we are going to create a new folder, data_output
 - ▶ We don't want to write generated datasets in **the same directory as our raw data**

EXPORTING DATA

- In preparation for our next lesson on plotting, we are going to prepare a cleaned up version of the dataset that doesn't include any missing data

```
surveys_complete <- surveys %>%  
  filter(species_id != "",           # remove missing species_id  
         !is.na(weight),           # remove missing weight  
         !is.na(hindfoot_length),  # remove missing hindfoot_length  
         sex != "")                # remove missing sex  
  
## Extract the most common species_id  
species_counts <- surveys_complete %>%  
  group_by(species_id) %>%  
  tally %>%  
  filter(n >= 50)  
  
## Only keep the most common species  
surveys_complete <- surveys_complete %>%  
  filter(species_id %in% species_counts$species_id)
```

EXPORTING DATA

- To make sure that everyone has the same dataset, check that `surveys_complete` has 30463 rows and 13 columns by typing `dim(surveys_complete)`
- Now that our dataset is ready, we can save it as a CSV file in our `data_output` folder

```
write.csv(surveys_complete,  
          file = "data_output/surveys_complete.csv",  
          row.names=FALSE)
```