

Data Tidying and Merging

EVR 628- Intro to Environmental Data Science

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Last week you were asked:

How much money have tuna purse seiners made since 2000 when fishing for bigeye tuna (*Thunnus obesus*) in the Eastern Pacific Ocean?

We made some simplifying assumptions and got some values (a total of 3,070 M USD since 2000, or about 127 M USD per year). You are now tasked with coming up with more refined estimates. For example, we will account for the fact that the price of fish varies every year.

How we will approach this:

- Find data that shows prices per year and species
- Read them, clean them, tidy them up (The “data tidying” part)
- Combine our catch data from last week with this new price data (The “merging” part)
- Re-calculate our total revenues since 2000

This will require three pipelines:

- Tidy price data (Exercise 1)
- Wrangle catch data (Exercise 2)
- Combine tidy prices and catch data (Exercise 3)

Pipelines 1 and 3 contain tools covered this week. You should already be familiar with pipeline 2.

Exercise 1: Tidying price data

Part A: Downloading the data

Post-it up

1. In a web browser, go to ffa.int. This is the website for the Pacific Islands Forum Fisheries Agency
2. Hover over “Publication and Statistics” on the top menu
3. Select “Statistics”
4. You will be taken to a site with five items. Download the zip folder called **Economic and Development Indicators and Statistics: Tuna Fishery of the Western and Central Pacific Ocean 2024**
5. As before, place the downloaded zip file in your EVR628/data/raw folder and proceed to extract it
6. Open the excel file called **Compendium of Economic and Development Statistics 2024** and study the **Contents** tab
7. Can you identify the price data that we need?
 - Which sheet
 - What range?

Post-it down

Part B: Reading excel data

Post-it up

1. Open your RStudio project for EVR628
2. In your console, install the `readxl` package: `install.packages("readxl")`
3. Start a **new** script called `tuna_analysis_prices.R`¹
4. Add the usual code commenting outline
5. We will need three packages: `readxl`, `janitor`, and `tidyverse`, load them at the top of your script using `library()`
6. Use `?read_excel()` to look at the documentation for the function
7. Use `read_excel()` to create a new object called `tuna_prices` and read the price data we need². Immediately pipe it into `clean_names`.

Post-it down

```
library(readxl)
library(janitor)
library(tidyverse)

tuna_prices <- read_excel(path = "data/raw/Economic-and-Development-Indicators-and-Statistics.xlsx",
                           sheet = "B. Prices",
                           range = "A35:E63",
                           na = "na") |>
  clean_names()
```

Part C: Inspecting price data

Be prepared to discuss the following points:

Post-it up

1. Inspect the column names of `tuna_prices` using `colnames()` in your console.
2. How many columns and rows do we have?
3. Any missing values?
4. Do we need to make the data wider or longer?
5. Using comments, write out what the target data should be (expand my code chunk see what I wrote)

¹I would typically suggest to overwrite whatever we had last week in `tuna_analysis.R` because GitHub would keep a version, but I understand you might want to keep the script as is

²Hint: You will need to specify a file path, a sheet, and a range of cells.

Post-it down

See an example of my description below

```
colnames(tuna_prices)

[1] "year"           "japan_fresha"   "japan_frozenb" "us_freshc"
[5] "us_frozend"

dim(tuna_prices)

[1] 28  5

tuna_prices |>
  filter_all(any_vars(is.na(.)))

# A tibble: 4 x 5
  year   japan_fresha   japan_frozenb   us_freshc   us_frozend
  <dbl>      <dbl>        <dbl>       <dbl>       <dbl>
1 1997       8204.        8169.        NA          NA
2 1998       7703.        6320.        NA          NA
3 1999       8809.        9093.        NA          NA
4 2000       9198.        8557.        NA          NA

# The final data set should have two columns: year and price. Since we have four
# prices (two markets, two presentations), I will use the average price per year.
# The tidy data set should therefore have four columns: year, market,
# presentation, and price.
```

Part D: Tidy your price data

Post-it up

1. Look at the documentation for your `pivot_*` function. What does it say about cases where `names_to` is of length > 1 ?
2. What about the `names_sep` argument?
3. Use the appropriate `pivot_*` function to reshape your data and save them to a new object called `tidy_tuna_prices`³

³Hint: Your `names_to` argument should be a character vector of with two items. `names_sep` should be inspired by our clever use of `snake_case`.

4. Your resulting tibble should have 104 rows and 4 columns and look like this:⁴

```
tidy_tuna_prices <- tuna_prices |>
  pivot_longer(cols = 2:5,
               names_to = c("market", "presentation"),
               names_sep = "_",
               values_to = "price",
               values_drop_na = T)

tidy_tuna_prices

# A tibble: 104 x 4
  year market presentation price
  <dbl> <chr>   <chr>      <dbl>
1 1997 japan   fresha     8204.
2 1997 japan   frozenb    8169.
3 1998 japan   fresha     7703.
4 1998 japan   frozenb    6320.
5 1999 japan   fresha     8809.
6 1999 japan   frozenb    9093.
7 2000 japan   fresha     9198.
8 2000 japan   frozenb    8557.
9 2001 japan   fresha     8260.
10 2001 japan  frozenb    5983.
# i 94 more rows
```

Post-it down

! Values in presentation

Note that the values in the `presentation` column are not ideal. They end in `a`, `b`, `c`, and `d` due to footnotes included in Excel. For now this doesn't matter because we will quickly remove them. We'll cover some text wrangling in Week 9.

Part E: Calculate mean annual price

Post-it up

1. Modify the pipeline that creates `tidy_tuna_prices` to get the mean price per year⁵

⁴Hint: If you have 112 rows, remember you can use `values_drop_na = T`

⁵Hint: You will use `group_by()` and `summarize()`, as well as `|>`

```

tidy_tuna_prices <- tuna_prices |>
  pivot_longer(cols = 2:5,
               names_to = c("market", "presentation"),
               names_sep = "_",
               values_to = "price",
               values_drop_na = T) |>
  group_by(year) |>
  summarize(price = mean(price))

tidy_tuna_prices

```

```

# A tibble: 28 x 2
  year   price
  <dbl> <dbl>
1 1997  8186.
2 1998  7011.
3 1999  8951.
4 2000  8877.
5 2001  5633.
6 2002  5342.
7 2003  5285.
8 2004  5739.
9 2005  5554.
10 2006  5177.
# i 18 more rows

```

Post-it down

Exercise 2: Tidying tuna catch data (again)

Part A: Read the tuna catch data

Note: You can copy-paste and modify your code from last week, but make sure your code is organized.

Post-it up

1. Read in the tuna catch data from last week
2. Filter it to retain bigeye tuna (BET) caught by the purse seine fleet (PS) since 2000
3. Calculate **total** catch by year. Your final data should have 24 rows and 2 columns, as below

Post-it down

```
# Load the data
tuna_data <- read_csv("data/raw/CatchByFlagGear/CatchByFlagGear1918-2023.csv") |>
  # Clean column names
  clean_names() |>
  # Rename some columns
  rename(year = ano_year,
         flag = bandera_flag,
         gear = arte_gear,
         species = especies_species,
         catch = t)

ps_tuna_data <- tuna_data |>
  filter(species == "BET", # Retain BET values only
         gear == "PS",      # Retain PS values only
         year >= 2000) |> # Retain data from 2000
  group_by(year) |>      # Specify that I am grouping by year
  # Tell summarize that I want to collapse the catch column by summing all its values
  summarize(catch = sum(catch))

ps_tuna_data
```

```
# A tibble: 24 x 2
  year   catch
  <dbl> <dbl>
1 2000  95283
2 2001  60518
3 2002  57422
4 2003  53051
5 2004  65471
6 2005  67895
7 2006  83837
8 2007  63451
9 2008  75028
10 2009  76800
# i 14 more rows
```

Exercise 3: Combine your catch and price data

Part A: Plan the join

1. Think about what type of join you want
2. What will be on the left and what will be on the right?
3. What is the key?
4. Write down, using human language, what you want to do.

Post-it up

Part B: Perform the join

1. Perform the join and save the output to an object called `tuna_revenues`
2. Create a new column that contains the annual revenue in M USD. Pay attention to the units.

Post-it down

```
tuna_revenues <- ps_tuna_data |>
  left_join(tidy_tuna_prices, by = join_by(year)) |>
  mutate(revenue = price * catch / 1e6)
```

```
tuna_revenues
```

```
# A tibble: 24 x 4
  year   catch   price revenue
  <dbl>   <dbl>   <dbl>   <dbl>
1 2000  95283  8877.   846.
2 2001  60518  5633.   341.
3 2002  57422  5342.   307.
4 2003  53051  5285.   280.
5 2004  65471  5739.   376.
6 2005  67895  5554.   377.
7 2006  83837  5177.   434.
8 2007  63451  5054.   321.
9 2008  75028  5636.   423.
10 2009  76800  6175.   474.
# i 14 more rows
```

Part C: Answer the questions again

1. How much TOTAL revenue since 2000?
2. How much mean ANNUAL revenue since 2000?
3. Make a figure
4. How do these plot and numbers compare to what we found [last week](#)?

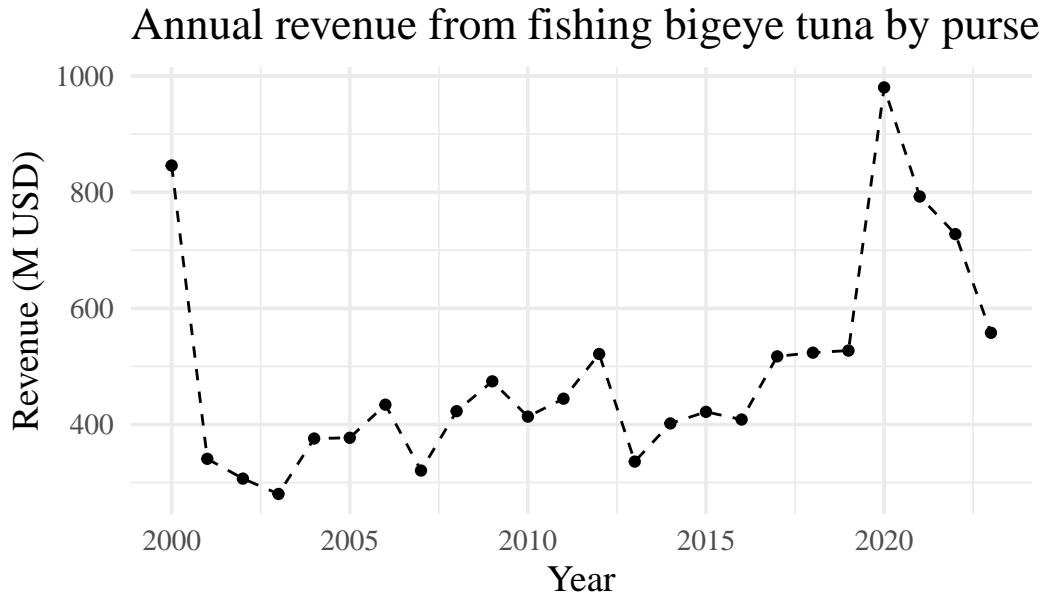
```
sum(tuna_revenues$revenue)
```

```
[1] 11752.32
```

```
mean(tuna_revenues$revenue)
```

```
[1] 489.68
```

```
# Build plot
ggplot(data = tuna_revenues,                               # Specify my data
        mapping = aes(x = year, y = revenue)) + # And my aesthetics
        geom_line(linetype = "dashed") +          # Add a dashed line
        geom_point() +                          # With points on top
        labs(x = "Year",                      # Add some labels
              y = "Revenue (M USD)",
              title = "Annual revenue from fishing bigeye tuna by purse seine vessels",
              caption = "Data come from the IATTC") +
# Modify the theme
theme_minimal(base_size = 14,                           # Font size 14
              base_family = "Times")           # Font family Times
```



Extra exercises for you to practice

The following four exercises use data that are built directly in R. You will need to copy and paste the provided code in your console (or R script) to make sure the objects appear in your environment.

Exercise 1: Pivot Longer Practice

Scenario: You are a TA and have been given grade data where each row represents a student and columns represent their scores on assignments 1-4. You need to calculate the mean grade for each student.⁶

```
# Create the dataset
student_scores <- tribble(
  ~student_id, ~assignment_1, ~assignment_2, ~assignment_3, ~assignment_4,
  "S001", 85, 92, 78, 88,
  "S002", 91, 89, 95, 82,
  "S003", 76, 84, 91, 79,
```

⁶Hint: Use `pivot_longer()` to transform this data so that each row represents one student-assignment-score combination, then use `group_by()` and `summarize()` to calculate the mean grade for each student.

```
"S004", 88, 93, 87, 94  
)
```

```
student_scores
```

```
# A tibble: 4 x 5  
  student_id assignment_1 assignment_2 assignment_3 assignment_4  
  <chr>        <dbl>        <dbl>        <dbl>        <dbl>  
1 S001          85          92          78          88  
2 S002          91          89          95          82  
3 S003          76          84          91          79  
4 S004          88          93          87          94
```

How I did it:

```
student_scores_long <- student_scores |>  
  pivot_longer(cols = starts_with("assignment"), # All columns from assignment_1 to assignment_4  
               names_to = "assignment", # Create new column called "assignment" with the column name  
               values_to = "score") # Create new column called "score" with the value  
  
student_means <- student_scores_long |>  
  group_by(student_id) |> # Group rows by student_id  
  summarize(mean_grade = mean(score)) # Calculate mean score for each student  
  
student_means # View the result  
  
# A tibble: 4 x 2  
  student_id mean_grade  
  <chr>        <dbl>  
1 S001          85.8  
2 S002          89.2  
3 S003          82.5  
4 S004          90.5
```

Exercise 2: Pivot Wider Practice

Scenario: You have hurricane exposure data from different Florida counties. You are asked to build a figure showing the relationship between pressure and wind speed. Modify the data as needed and build a figure.⁷

⁷Hint: Use `pivot_wider()` to transform this data so that each row represents a county and each metric becomes its own column.

```

# Create the dataset
hurricane_data <- tribble(
  ~county, ~metric, ~measurement,
  "Miami-Dade", "pressure", 950,
  "Miami-Dade", "precipitation", 12.5,
  "Miami-Dade", "wind_speed", 85,
  "Broward", "pressure", 955,
  "Broward", "precipitation", 8.3,
  "Broward", "wind_speed", 72,
  "Palm Beach", "pressure", 960,
  "Palm Beach", "precipitation", 6.1,
  "Palm Beach", "wind_speed", 68,
  "Monroe", "pressure", 945,
  "Monroe", "precipitation", 15.2,
  "Monroe", "wind_speed", 95
)

hurricane_data

```

	county	metric	measurement
	<chr>	<chr>	<dbl>
1	Miami-Dade	pressure	950
2	Miami-Dade	precipitation	12.5
3	Miami-Dade	wind_speed	85
4	Broward	pressure	955
5	Broward	precipitation	8.3
6	Broward	wind_speed	72
7	Palm Beach	pressure	960
8	Palm Beach	precipitation	6.1
9	Palm Beach	wind_speed	68
10	Monroe	pressure	945
11	Monroe	precipitation	15.2
12	Monroe	wind_speed	95

How I did it:

```

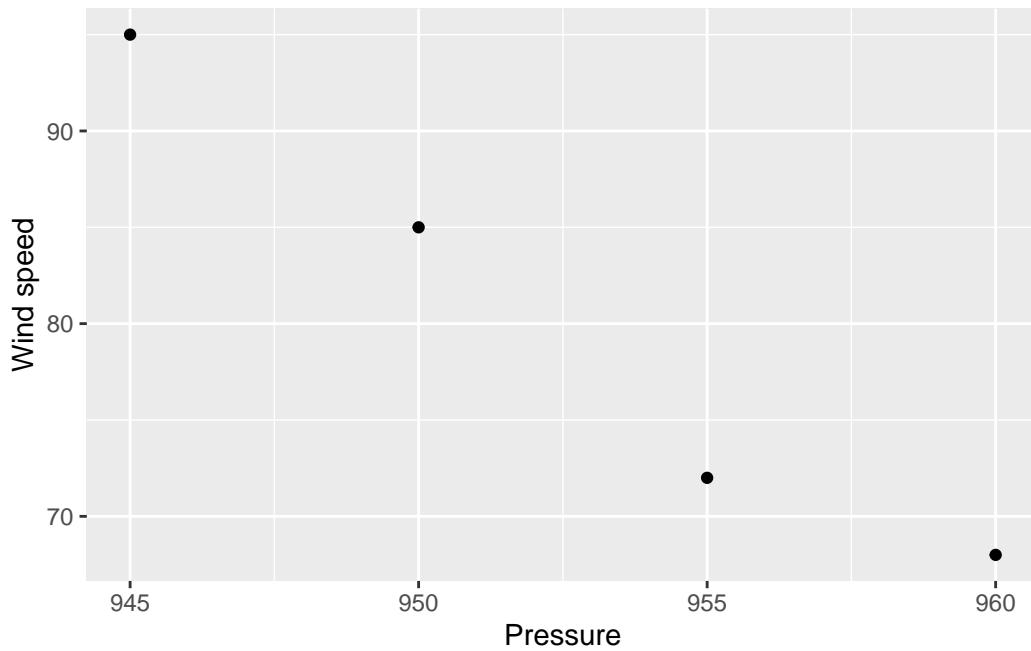
hurricane_wide <- hurricane_data |>
  pivot_wider(names_from = metric,      # Use values in "metric" column as new column names
             values_from = measurement) # Use values in "measurement" column to fill new col

hurricane_wide                                # Now each county is a row with separate columns for p

```

```
# A tibble: 4 x 4
  county      pressure precipitation wind_speed
  <chr>        <dbl>          <dbl>        <dbl>
1 Miami-Dade     950         12.5         85
2 Broward        955          8.3          72
3 Palm Beach     960          6.1          68
4 Monroe         945         15.2         95
```

```
ggplot(hurricane_wide,
       aes(x = pressure, y = wind_speed)) +
  geom_point() +
  labs(x = "Pressure",
       y = "Wind speed")
```



Exercise 3: Joining Data Practice

Scenario: You have two datasets - one with student information and another with their enrollment details. You need to be able to identify the names of students taking stats courses.

```
# Create the datasets
students <- tribble(
```

```

~student_id, ~name, ~age,
"S001", "Alice Johnson", 20,
"S002", "Bob Smith", 22,
"S003", "Carol Davis", 19,
"S004", "David Wilson", 21,
"S005", "Eva Brown", 23
)

enrollments <- tribble(
  ~stdt_identifier, ~course, ~credits,
  "S001", "Statistics", 3,
  "S001", "Biology", 4,
  "S002", "Statistics", 3,
  "S003", "Chemistry", 4,
  "S004", "Statistics", 3,
  "S004", "Physics", 4,
  "S006", "Math", 3
)

```

`students`

```

# A tibble: 5 x 3
  student_id name      age
  <chr>     <chr>    <dbl>
1 S001      Alice Johnson 20
2 S002      Bob Smith    22
3 S003      Carol Davis  19
4 S004      David Wilson 21
5 S005      Eva Brown   23

```

`enrollments`

```

# A tibble: 7 x 3
  stdt_identifier course    credits
  <chr>          <chr>    <dbl>
1 S001            Statistics 3
2 S001            Biology    4
3 S002            Statistics 3
4 S003            Chemistry  4
5 S004            Statistics 3
6 S004            Physics    4
7 S006            Math       3

```

How I did it:

```
combined_data <- students |>
  left_join(enrollments, by = join_by(student_id == stdt_identifier)) # Keep all students, ma

combined_data                                # View the combined data

# A tibble: 7 x 5
# ... with 5 variables:
#   student_id     name      age course  credits
#   <chr>        <chr>    <dbl> <chr>    <dbl>
# 1 S001         Alice Johnson  20 Statistics 3
# 2 S001         Alice Johnson  20 Biology    4
# 3 S002         Bob Smith    22 Statistics 3
# 4 S003         Carol Davis   19 Chemistry 4
# 5 S004         David Wilson  21 Statistics 3
# 6 S004         David Wilson  21 Physics   4
# 7 S005         Eva Brown    23 <NA>       NA

statistics_students <- combined_data |>
  filter(course == "Statistics") |> # Keep only rows where course equals "Statistics"
  select(name, course)               # Keep only the name and course columns

statistics_students                                # View the result

# A tibble: 3 x 2
# ... with 2 variables:
#   name      course
#   <chr>    <chr>
# 1 Alice Johnson Statistics
# 2 Bob Smith    Statistics
# 3 David Wilson  Statistics
```

Exercise 4: Sharks!

Scenario: You have swimming data from beachgoers and bull shark detection data from acoustic telemetry during fourth of July. The swimming data tell you when someone entered and left the water. The shark detection data tells you which sharks were detected within the acoustic array in front of the beach, and the time of detection. Who was in the water while a shark was nearby?⁸

⁸Hint: Look at the documentation for `join_by()`. What does it say about “Overlap helpers”? You’ll want to use the `between()` function.

```

# Create the datasets
swimming_data <- tribble(
  ~name, ~swim_start, ~swim_end,
  "Alice", "2024-07-04 10:30:00", "2024-07-04 11:15:00",
  "Bob", "2024-07-04 10:45:00", "2024-07-04 11:30:00",
  "Carol", "2024-07-04 11:00:00", "2024-07-04 11:45:00",
  "David", "2024-07-04 11:20:00", "2024-07-04 12:00:00",
  "Eva", "2024-07-04 12:10:00", "2024-07-04 12:45:00"
) |>
  mutate(swim_start = as_datetime(swim_start),
         swim_end = as_datetime(swim_end))

shark_detections <- tribble(
  ~shark_id, ~detection_time,
  "SH001", "2024-07-04 09:40:00",
  "SH002", "2024-07-04 11:25:00",
  "SH003", "2024-07-04 11:35:00"
) |>
  mutate(detection_time = as_datetime(detection_time))

swimming_data

```

```

# A tibble: 5 x 3
  name   swim_start      swim_end
  <chr> <dttm>          <dttm>
1 Alice  2024-07-04 10:30:00 2024-07-04 11:15:00
2 Bob    2024-07-04 10:45:00 2024-07-04 11:30:00
3 Carol  2024-07-04 11:00:00 2024-07-04 11:45:00
4 David  2024-07-04 11:20:00 2024-07-04 12:00:00
5 Eva    2024-07-04 12:10:00 2024-07-04 12:45:00

```

```
shark_detections
```

```

# A tibble: 3 x 2
  shark_id detection_time
  <chr>     <dttm>
1 SH001    2024-07-04 09:40:00
2 SH002    2024-07-04 11:25:00
3 SH003    2024-07-04 11:35:00

```

How I did it:

```

swimmer_shark_overlap <- shark_detections |>
  inner_join(swimming_data,                      # Note that I am using an inner join. Play with inner
             by = join_by(between(detection_time, swim_start, swim_end))) # Find swimmers in

swimmer_shark_overlap                         # View all the overlap data

# A tibble: 5 x 5
  shark_id detection_time     name   swim_start      swim_end
  <chr>     <dttm>          <chr>  <dttm>          <dttm>
1 SH002    2024-07-04 11:25:00 Bob    2024-07-04 10:45:00 2024-07-04 11:30:00
2 SH002    2024-07-04 11:25:00 Carol   2024-07-04 11:00:00 2024-07-04 11:45:00
3 SH002    2024-07-04 11:25:00 David   2024-07-04 11:20:00 2024-07-04 12:00:00
4 SH003    2024-07-04 11:35:00 Carol   2024-07-04 11:00:00 2024-07-04 11:45:00
5 SH003    2024-07-04 11:35:00 David   2024-07-04 11:20:00 2024-07-04 12:00:00

at_risk_swimmers <- swimmer_shark_overlap |>
  group_by(name) |> # Keep only the columns we want to see
  summarize(n_sharks_near = n_distinct(shark_id))

at_risk_swimmers                         # These swimmers were in the water when sharks were detected

# A tibble: 3 x 2
  name   n_sharks_near
  <chr>       <int>
1 Bob            1
2 Carol          2
3 David          2

```