Data manipulation with dplyr

Data Transformation

Package

- `dplyr`

Goals

We will learn how to:

- select desired variables – `select()`
- rename your variables – `rename()`
- order them from lowest to highest values (or vice versa) – `arrange()`
- filter your data based on different conditions – `filter()`
- calculate different summary statistics such as mean or count – `summarise()`
- add new variables such as percentage – `mutate()`
- work with different functions more effectively – `%>%`
- save your results as comma separated file

Before we begin

- load packages `here` and `dplyr` (don't forget to install them firstly, if you haven't done so yet)
- open the project from last lecture (or create a new one if you don't have it)
- create a new script
- load data dartpoints.csv into your script
- if you are loading data with `here` function don't forget to check whether your data and script are in the **same folder** as your project
- create an object called *"sipky"* from the loaded database (with `<-`)

```
library(here)
library(dplyr)
sipky <- read.csv(here("dartpoints.csv"))
```

Selecting variables

- `select(dataframe, variable1, variable2)`
- sometimes you will need to remove variables you don't need in your work, to have your database more user friendly
- for example, you need only variables dealing with major proportions of the dartpoints, but your database have plenty of other variables which are making it difficult to observe, like here:

```
head(sipky)
```

```
  Name Catalog     TARL  Quad Length Width Thickness B.Width J.Width H.Length
1 Darl 41-0322 41CV0536 26/59   42.8  15.8       5.8    11.3    10.6     11.6
2 Darl 35-2946 41CV0235 21/63   40.5  17.4       5.8      NA    13.7     12.9
3 Darl 35-2921 41CV0132 20/63   37.5  16.3       6.1    12.1    11.3      8.2
4 Darl 36-3487 41CV0594 10/54   40.3  16.1       6.3    13.5    11.7      8.3
5 Darl 36-3321 41CV1023 12/58   30.6  17.1       4.0    12.6    11.2      8.9
6 Darl 35-2959 41CV0235 21/63   41.8  16.8       4.1    12.7    11.5     11.0
  Weight Blade.Sh Base.Sh Should.Sh Should.Or Haft.Sh Haft.Or
1    3.6        S       I         S         T       S       E
2    4.5        S       I         S         T       S       E
3    3.6        S       I         S         T       S       E
4    4.0        S       I         S         T       S       E
5    2.3        S       I         S         T       S       E
6    3.0        S       E         I         T       I       C
```

Selecting variables

- to create a new dataframe, simply use function `select` and define which variables you want to keep

```
sipky <- select(sipky, Name, Length, Width, Weight)
head(sipky)
```

```
  Name Length Width Weight
1 Darl   42.8  15.8    3.6
2 Darl   40.5  17.4    4.5
3 Darl   37.5  16.3    3.6
4 Darl   40.3  16.1    4.0
5 Darl   30.6  17.1    2.3
6 Darl   41.8  16.8    3.0
```

Renaming variables

- renaming your variables with function `rename(data, new_name = old_name)` can be useful when dealing with complicated code names or different languages
- Hint: don't forget to save object with new variable names by `<-`

```
sipky <- rename(sipky,
   typ = Name,
   delka = Length,
   sirka = Width,
   hmotnost = Weight)

head(sipky)
```

```
   typ delka sirka hmotnost
1 Darl  42.8  15.8      3.6
2 Darl  40.5  17.4      4.5
3 Darl  37.5  16.3      3.6
4 Darl  40.3  16.1      4.0
5 Darl  30.6  17.1      2.3
6 Darl  41.8  16.8      3.0
```

Arranging values in ascending order...

- here you can order your observations from the lowest to highest (or vice versa). To do so, use function `arrange(data, variable)`

```
head(arrange(sipky, delka))
```

```
   typ delka sirka hmotnost
1 Darl  30.6  17.1      2.3
2 Darl  31.2  15.6      2.5
3 Darl  32.0  16.0      3.3
4 Darl  32.4  14.5      2.5
5 Darl  33.1  17.4      4.2
6 Darl  33.5  16.6      3.2
```

...and in descending order

- if you want to order the values from higher to smaller just add `desc()`

```
head(arrange(sipky, desc(delka)))
```

```
         typ delka sirka hmotnost
1 Pedernales 109.5  49.3     28.8
2 Pedernales  84.0  21.2      9.3
3 Pedernales  78.3  28.1     14.8
4 Pedernales  70.4  30.4     13.1
5     Travis  69.0  20.9     11.4
6 Pedernales  67.2  27.1     15.3
```

Task: What will happen if you will try to order non-numerical variable, but a categorical variable (such as type of the dartpoint)?

Filtering

- function `filter(data, variable <operator> value)` allows you to filter your data based on different conditions, for example minimal weight, type of the dartpoint, etc
- logical and mathematical operators: ==, !=, <, >, >=, <=, &, |, etc (use `?dplyr::filter` for more details)

- here we use `>` to get only dartpoints with the length higher than 80 cm

```
filter(sipky, delka > 80)
```

```
         typ delka sirka hmotnost
1 Pedernales 109.5  49.3     28.8
2 Pedernales  84.0  21.2      9.3
```

- and here we use `==` to choose only those dartpoints which are of type "Travis"

```
filter(sipky, typ == "Travis")
```

```
      typ delka sirka hmotnost
1  Travis  56.5  21.1      9.5
2  Travis  54.6  22.4     10.4
3  Travis  46.3  21.3      7.5
4  Travis  57.6  18.9      8.7
5  Travis  49.1  21.4      6.9
6  Travis  64.6  21.5     15.0
7  Travis  69.0  20.9     11.4
8  Travis  40.1  18.4      6.3
9  Travis  41.5  19.2      7.5
10 Travis  46.3  17.9      5.9
11 Travis  39.6  21.5      5.4
```

- alternatively, you can exclude all points of a type "Travis" by negation `!=`

```
head(filter(sipky, typ != "Travis"))
```

```
   typ delka sirka hmotnost
1 Darl  42.8  15.8      3.6
2 Darl  40.5  17.4      4.5
3 Darl  37.5  16.3      3.6
4 Darl  40.3  16.1      4.0
5 Darl  30.6  17.1      2.3
6 Darl  41.8  16.8      3.0
```

- add `&` if you want to filter with more than one condition, for example here we will filter all points which are type "Wells" **AND** are heavier than 10 grams

```
filter(sipky, typ == "Wells" & hmotnost > 10)
```

```
    typ delka sirka hmotnost
1 Wells  65.4  25.1     12.6
2 Wells  58.9  24.4     10.5
3 Wells  63.1  24.7     16.3
```

- Task: instead of `&` try operator `|` (**OR**) and see how the result differs

Filtering based on a vector

- you can make your code less complicated when you create vector from desired values and then filter all observations which fall into that vector by using operator `%in%`

```
vyber <- c("Pedernales", "Ensor")

head(filter(sipky, typ %in% vyber))
```

```
    typ delka sirka hmotnost
1 Ensor  43.5  20.1      4.6
2 Ensor  42.1  20.8      5.4
3 Ensor  42.1  25.1      5.9
4 Ensor  43.1  20.0      5.1
5 Ensor  37.5  21.8      4.7
6 Ensor  55.2  22.5      7.2
```

Summaries

- we already know some functions to calculate basic summaries, for example function `mean`

```
mean(sipky$delka)
```

```
[1] 49.33077
```

- but if you want to create a new dataframe from calculated statistics, function `summarise(data, new_variable = summary_statistics)` is much more helpfull
- for summary statistics you can use different functions: `mean()`, `median()`, `sd()`, `min()`…, (use `?summarise` for more details)

```
summarise(sipky, delka_prumer = mean(delka))
```

```
  delka_prumer
1     49.33077
```

- you can also calculate more summaries:

```r
summarise(sipky,
    delka_prumer = mean(delka),
    delka_sd = sd(delka),
    delka_min = min(delka),
    delka_max = max(delka),
    pocet = n())
```

```
  delka_prumer delka_sd delka_min delka_max pocet
1     49.33077 12.73619      30.6     109.5    91
```

Grouping

- summaries above were applied on whole dataframe. Here we will learn how to calculate summaries for each type of the dartpoint by using `group_by(data, variable_to_be_grouped_by)`

```r
sipky_typ <- group_by(sipky, typ)
```

- at first sight, you don´t see any differences, but they will be visible after applying function `summarise`

```r
summarise(sipky_typ, delka_prumer = mean(delka))
```

```
# A tibble: 5 x 2
  typ        delka_prumer
  <fct>             <dbl>
1 Darl               39.8
2 Ensor              42.7
3 Pedernales         57.9
4 Travis             51.4
5 Wells              53.1
```

- you can also calculate more summaries at once and use `round` to remove unnecessary decimals:

```r
summarise(sipky_typ,
    delka_prumer = round(mean(delka), 1),
    pocet = n())
```

```
# A tibble: 5 x 3
  typ        delka_prumer pocet
  <fct>             <dbl> <int>
1 Darl               39.8    28
2 Ensor              42.7    10
3 Pedernales         57.9    32
4 Travis             51.4    11
5 Wells              53.1    10
```

- Task: save the result as a new dataframe "sipky_sum" for later work

```
sipky_sum <- summarise(sipky_typ,
    delka_prumer = round(mean(delka), 1),
    pocet = n())
```

Mutate

- function **mutate** creates a new variable, here we will show how to add variable with percentages
- note: **sum** calculates a **total sum** of values from chosen variable (in this case - "pocet")

```
mutate(sipky_sum,
   procento = pocet/sum(pocet)*100)
```

```
# A tibble: 5 x 4
  typ        delka_prumer pocet procento
  <fct>             <dbl> <int>    <dbl>
1 Darl               39.8    28     30.8
2 Ensor              42.7    10     11.0
3 Pedernales         57.9    32     35.2
4 Travis             51.4    11     12.1
5 Wells              53.1    10     11.0
```

- Hint: you can again remove unnecessary decimals by adding **round** but be careful with the right number of the brackets **()**!

```
mutate(sipky_sum,
   procento = round(pocet/sum(pocet)*100, 0))
```

```
# A tibble: 5 x 4
  typ        delka_prumer pocet procento
  <fct>             <dbl> <int>    <dbl>
1 Darl               39.8    28       31
2 Ensor              42.7    10       11
3 Pedernales         57.9    32       35
4 Travis             51.4    11       12
5 Wells              53.1    10       11
```

Pipe operator

- when applying plenty of transformation on one dataset "pipe operator" (**%>%**) could make your work easier and code shorter and more readable
- notice you don´t need to repeat the name of the dataframe into every function arguments, since you already specified it in the begining of the "pipe"

```
sipky %>%
  filter(delka > 70) %>%
  arrange(delka)
```

```
         typ delka sirka hmotnost
1 Pedernales  70.4  30.4     13.1
2 Pedernales  78.3  28.1     14.8
3 Pedernales  84.0  21.2      9.3
4 Pedernales 109.5  49.3     28.8
```

More complex summarising with dplyr and pipe

```
sipky %>%
  group_by(typ) %>%
  summarise(
    delka_prum = round(mean(delka), 1),
    hmotnost_prum = round(mean(hmotnost), 1),
    pocet = n()) %>%
  mutate(procento = round(pocet/sum(pocet)*100, 1)) %>%
  arrange(desc(pocet))
```

```
# A tibble: 5 x 5
  typ        delka_prum hmotnost_prum pocet procento
  <fct>           <dbl>         <dbl> <int>    <dbl>
1 Pedernales       57.9          10.6    32     35.2
2 Darl             39.8           4.4    28     30.8
3 Travis           51.4           8.6    11     12.1
4 Ensor            42.7           5.1    10     11
5 Wells            53.1           8.7    10     11
```

Visualising your summaries

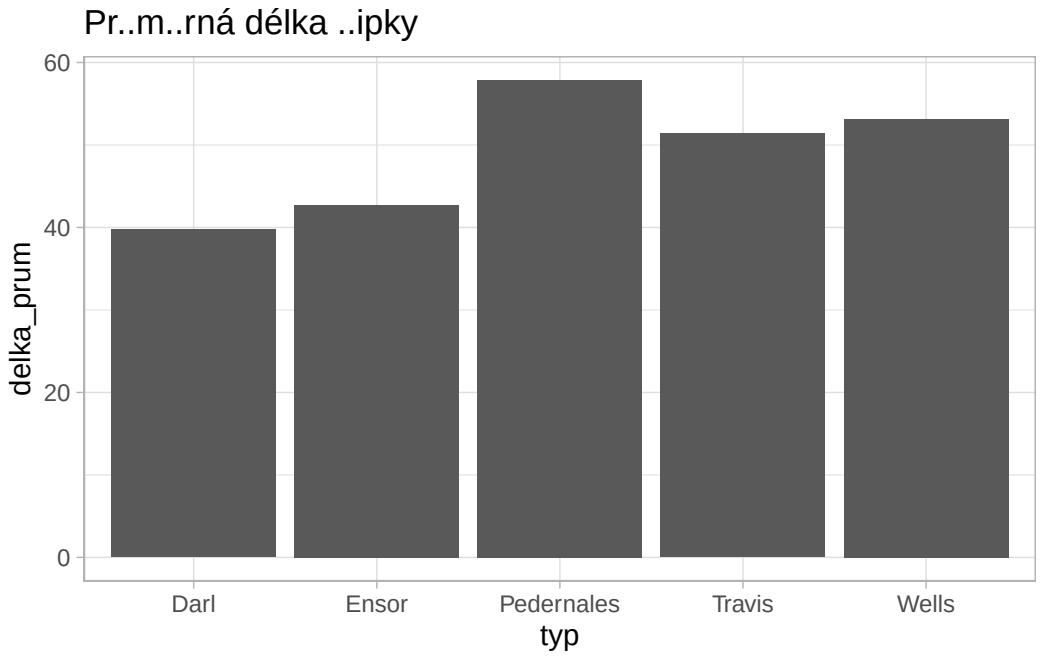
```
sipky %>%
  group_by(typ) %>%
  summarise(
    delka_prum = mean(delka),
    hmotnost_prum = mean(hmotnost),
    pocet = n()) %>%
  mutate(procento = round(pocet/sum(pocet)*100, 1)) %>%
  arrange(desc(pocet))
```

```
# A tibble: 5 x 5
  typ        delka_prum hmotnost_prum pocet procento
  <fct>           <dbl>         <dbl> <int>    <dbl>
1 Pedernales       57.9          10.6    32     35.2
2 Darl             39.8           4.41   28     30.8
3 Travis           51.4           8.59   11     12.1
4 Ensor            42.7           5.06   10     11
5 Wells            53.1           8.68   10     11
```

Visualising your summaries

```
sipky %>%
  group_by(typ) %>%
  summarise(
    delka_prum = mean(delka),
    hmotnost_prum = mean(hmotnost),
    pocet = n()) %>%
  mutate(procento = round(pocet/sum(pocet)*100, 1)) %>%
```

```
  arrange(desc(pocet)) %>%
  ggplot() +
  aes(x = typ, y = delka_prum) +
  geom_col() +
  labs(title = "Průměrná délka šipky") +
  theme_light()
```



Saving your results

- use `write.csv` for saving your results as a comma separated file

```
sipky %>%
  group_by(typ) %>%
  summarise(
    delka_prum = mean(delka),
    hmotnost_prum = mean(hmotnost),
    pocet = n()) %>%
  mutate(procento = round(pocet/sum(pocet)*100, 1)) %>%
  arrange(desc(pocet)) %>%
  write.csv(here("sipky_result.csv"))
```

- or save your summarised data frame as an object and save it later

```
sipky_result <- sipky %>%
  group_by(typ) %>%
  summarise(
    delka_prum = mean(delka),
    hmotnost_prum = mean(hmotnost),
    pocet = n()) %>%
  mutate(procento = round(pocet/sum(pocet)*100, 1)) %>%
  arrange(desc(pocet))

write.csv(sipky_result, here("sipky_result.csv"))
```

Exercise

1. Create new a script in your project folder and save.
2. Load packages necessary for: (a) loading, (b) transformation, and (c) visualization of data.
3. Load database `bacups.csv` and save it as an object.
4. Create a new dataframe having only variables `H`, `RD` and `Phase`.
5. Try to use pipes `%>%`.
6. Rename the variables to `height`, `rimdiameter` and `phase`.
7. For each phase calculate following summary statistics:
   - **mean** and **median** vessel height,
   - **standard deviation** of vessel height,
   - **correlation** between height and rim diameter, and
   - **number** of vessels.
8. Calculate percentage of vessels in each phase.
9. Arrange the results from highest to lowest mean values.
10. Save your result as a CSV file
11. Are height of vessels or rim diameter normally distributed? Why/why not?