R Training 4

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5/7/2020

Loading packages & data

```
# Load packages
library(readxl)
```

```
## Warning: package 'readxl' was built under R version 3.4.4
```

```
library(readr)
```

```
## Warning: package 'readr' was built under R version 3.4.4
```

```
library(tidyverse)
```

```
## Warning in as.POSIXlt.POSIXct(Sys.time()): unknown timezone 'zone/tz/2019c.1.0/
## zoneinfo/America/New_York'
```

```
## -- Attaching packages --------------------------------- tidyverse 1.3.0 --
```

```
## v ggplot2 3.3.0     v dplyr   0.8.5
## v tibble  3.0.1     v stringr 1.4.0
## v tidyr   1.0.2     v forcats 0.5.0
## v purrr   0.3.3
```

```
## Warning: package 'stringr' was built under R version 3.4.4
```

```
## -- Conflicts ------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(janitor)
```

```
## Warning: package 'janitor' was built under R version 3.4.4
```

```
# Load agua chinon veg data
ac_data_raw <- read_excel("OCWR_AC_2019_Data.xlsx")
ac_data <- clean_names(ac_data_raw)

# Load weir oak restoration data
oak_data_raw <- read_csv("Weir_Oak_Restoration_Data_winter19_2.csv")
```

```
## Parsed with column specification:
## cols(
##   `Short ID` = col_character(),
##   Survival = col_logical(),
##   Quantity = col_double(),
##   `Height (cm)` = col_double(),
##   `Open Closed` = col_character(),
```

```
##   `Location UML` = col_character(),
##   `Water Yes No` = col_character(),
##   `Sampling Group` = col_character()
## )
```

```
oak_data <- clean_names(oak_data_raw)

# Oak data 1
oak_data_old <- read_csv("Weir_Oak_Restoration_Data_winter19.csv")
```

```
## Parsed with column specification:
## cols(
##   short_id = col_character(),
##   survival = col_logical(),
##   quantity = col_double(),
##   height_cm = col_double(),
##   open_closed = col_character(),
##   location_uml = col_character(),
##   water_yes_no = col_character(),
##   sampling_group = col_character()
## )
```

```
oak_data_old <- clean_names(oak_data_old)
```

Subsetting data

- my_df[1:3] (no comma) will subset my_df, returning the first three columns as a data frame.
- my_df[1:3,] (with comma, numbers to left of the comma) will subset my_df and return the first three rows as a data frame
- my_df[, 1:3] (with comma, numbers to right of the comma) will subset my_df and return the first three columns as a data frame, the same as my_df[1:3]

Common operators

- [*] multiply
- [/] divide
- [>] greater than
- [>=] greater than or equal to
- [<] less than
- [<=] less than or equal to
- [=] equal to
- [==] find a match in the data (for example, when filtering)

More on subsetting

```
# To return rows 1-3
ac_data[1:3]
```

```
## # A tibble: 1,732 x 3
##    desired_habitat          polygon_id    transect
##    <chr>                    <chr>            <dbl>
```

```
##  1 Weedy Control            Weedy Control        1
##  2 Weedy Control            Weedy Control        1
##  3 Weedy Control            Weedy Control        1
##  4 Weedy Control            Weedy Control        1
##  5 Weedy Control            Weedy Control        1
##  6 Weedy Control            Weedy Control        1
##  7 Mulefat Scrub/sage Scrub OW-M7                1
##  8 Mulefat Scrub/sage Scrub OW-M7                1
##  9 Mulefat Scrub/sage Scrub OW-M7                1
## 10 Mulefat Scrub/sage Scrub OW-M7                1
## # ... with 1,722 more rows
```

```
# To return columns 1-3
ac_data[1:3,]
```

```
## # A tibble: 3 x 10
##   desired_habitat polygon_id transect pin_number data_type species_code
##   <chr>           <chr>         <dbl>      <dbl> <chr>     <chr>
## 1 Weedy Control   Weedy Con~        1         NA A.Belt    SOLSPP
## 2 Weedy Control   Weedy Con~        1         NA A.Belt    AMBACA
## 3 Weedy Control   Weedy Con~        1         NA A.Belt    AMBPSI
## # ... with 4 more variables: scientific_name <chr>, native_non_native <chr>,
## #   functional_group <chr>, layer <chr>
```

```
# To return rows 1-3 (same as first option)
ac_data[,1:3]
```

```
## # A tibble: 1,732 x 3
##    desired_habitat          polygon_id    transect
##    <chr>                    <chr>            <dbl>
##  1 Weedy Control            Weedy Control        1
##  2 Weedy Control            Weedy Control        1
##  3 Weedy Control            Weedy Control        1
##  4 Weedy Control            Weedy Control        1
##  5 Weedy Control            Weedy Control        1
##  6 Weedy Control            Weedy Control        1
##  7 Mulefat Scrub/sage Scrub OW-M7                1
##  8 Mulefat Scrub/sage Scrub OW-M7                1
##  9 Mulefat Scrub/sage Scrub OW-M7                1
## 10 Mulefat Scrub/sage Scrub OW-M7                1
## # ... with 1,722 more rows
```

```
# Single brackets extract a list
ac_data[5]
```

```
## # A tibble: 1,732 x 1
##    data_type
##    <chr>
##  1 A.Belt
##  2 A.Belt
##  3 A.Belt
##  4 A.Belt
##  5 A.Belt
##  6 A.Belt
##  7 T.PI
##  8 T.PI
```

```
##  9 T.PI
## 10 T.PI
## # ... with 1,722 more rows
```

```
# Double brackets extract the items in a list
ac_data[[5]]
```

```
##    [1] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"
##    [9] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [17] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [25] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [33] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [41] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [49] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [57] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [65] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [73] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [81] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [89] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [97] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [105] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [113] "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [121] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [129] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [137] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [145] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [153] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [161] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [169] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [177] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [185] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt"
##  [193] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [201] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [209] "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [217] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [225] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [233] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [241] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [249] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [257] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [265] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [273] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [281] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [289] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [297] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [305] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [313] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"
##  [321] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [329] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
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##  [369] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [377] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
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##  [713] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [721] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [729] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [737] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
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##  [753] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [761] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [769] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [777] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [785] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [793] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [801] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [809] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
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##  [817] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [825] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [833] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"
##  [841] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [849] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [857] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [865] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [873] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [881] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [889] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [897] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [905] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [913] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [921] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [929] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [937] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
##  [945] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [953] "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [961] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [969] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [977] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [985] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [993] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1001] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1009] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1017] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1025] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1033] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1041] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"
## [1049] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1057] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1065] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1073] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1081] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1089] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1097] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1105] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1113] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1121] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
## [1129] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1137] "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1145] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1153] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1161] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1169] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1177] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1185] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1193] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1201] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1209] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
## [1217] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"
## [1225] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1233] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1241] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
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## [1249] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1257] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1265] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1273] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1281] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1289] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1297] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1305] "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1313] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1321] "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1329] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1337] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1345] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1353] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1361] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1369] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1377] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1385] "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1393] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1401] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1409] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1417] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1425] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1433] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1441] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1449] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1457] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1465] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1473] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1481] "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1489] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1497] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1505] "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1513] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1521] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1529] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1537] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1545] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1553] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1561] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1569] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1577] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1585] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1593] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1601] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1609] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1617] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"
## [1625] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1633] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1641] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1649] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1657] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1665] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1673] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
```

```
## [1681] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1689] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1697] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1705] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1713] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1721] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
## [1729] "A.Belt" "A.Belt" "A.Belt" "A.Belt"
```

```
# Double brackets are equivalent to using the "$" operator
ac_data$data_type
```

```
##    [1] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"
##    [9] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [17] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [25] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [33] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [41] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [49] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [57] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [65] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [73] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [81] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [89] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##   [97] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [105] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [113] "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [121] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [129] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [137] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [145] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [153] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [161] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [169] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [177] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [185] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt"
##  [193] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [201] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [209] "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [217] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [225] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [233] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [241] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [249] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [257] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [265] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [273] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [281] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [289] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [297] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [305] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [313] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"
##  [321] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [329] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [337] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [345] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
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```
##  [353] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [361] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [369] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [377] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [385] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [393] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [401] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [409] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [417] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [425] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [433] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [441] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [449] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [457] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [465] "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [473] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [481] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [489] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [497] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [505] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [513] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [521] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [529] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [537] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [545] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [553] "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [561] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [569] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [577] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [585] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [593] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [601] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [609] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [617] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [625] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [633] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [641] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [649] "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [657] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [665] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [673] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [681] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [689] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [697] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [705] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [713] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [721] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [729] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [737] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [745] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [753] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [761] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [769] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [777] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
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##  [785] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [793] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [801] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [809] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [817] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [825] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [833] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"
##  [841] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [849] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [857] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [865] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [873] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [881] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [889] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [897] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [905] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [913] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [921] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [929] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [937] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
##  [945] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
##  [953] "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [961] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [969] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [977] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [985] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
##  [993] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1001] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1009] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1017] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1025] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1033] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1041] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"
## [1049] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1057] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1065] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1073] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1081] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1089] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1097] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1105] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1113] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1121] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
## [1129] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1137] "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1145] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1153] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1161] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1169] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1177] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1185] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1193] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1201] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1209] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
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## [1217] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"
## [1225] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1233] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1241] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1249] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1257] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1265] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1273] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1281] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1289] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1297] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1305] "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1313] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1321] "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1329] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1337] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1345] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1353] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1361] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1369] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1377] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1385] "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1393] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1401] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1409] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1417] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1425] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1433] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1441] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1449] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1457] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1465] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1473] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1481] "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1489] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1497] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1505] "A.Belt" "A.Belt" "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1513] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1521] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1529] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1537] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1545] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1553] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1561] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1569] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1577] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1585] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1593] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1601] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1609] "T.PI"   "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt"
## [1617] "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "A.Belt" "T.PI"   "T.PI"
## [1625] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1633] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1641] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
```

```
## [1649] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1657] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1665] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1673] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1681] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1689] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1697] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1705] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1713] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"
## [1721] "T.PI"   "T.PI"   "T.PI"   "T.PI"   "T.PI"   "A.Belt" "A.Belt" "A.Belt"
## [1729] "A.Belt" "A.Belt" "A.Belt" "A.Belt"
```

Basic statistics

```
# Mean
mean(oak_data$height_cm)
```

```
## [1] 8.627288
```

```
# Median
median(oak_data$height_cm)
```

```
## [1] 9
```

```
# Standard deviation
sd(oak_data$height_cm)
```

```
## [1] 8.833833
```

```
# Highest number
max(oak_data$height_cm)
```

```
## [1] 63
```

```
# Lowest number
min(oak_data$height_cm)
```

```
## [1] 0
```

```
# Summarize data
summary(oak_data)
```

```
##    short_id           survival          quantity        height_cm
##  Length:1202        Mode :logical   Min.   : 0.000   Min.   : 0.000
##  Class :character   FALSE:525       1st Qu.: 0.000   1st Qu.: 0.000
##  Mode  :character   TRUE :677       Median : 1.000   Median : 9.000
##                                     Mean   : 0.891   Mean   : 8.627
##                                     3rd Qu.: 1.000   3rd Qu.:15.000
##                                     Max.   :10.000   Max.   :63.000
##  open_closed        location_uml       water_yes_no       sampling_group
##  Length:1202        Length:1202        Length:1202        Length:1202
##  Class :character   Class :character   Class :character   Class :character
##  Mode  :character   Mode  :character   Mode  :character   Mode  :character
##
##
##
```

Basic statistics - troubleshooting

```
# Mean
mean(oak_data_old$height_cm)
```

```
## [1] NA
```

```
# If there are NA values, then introduce na.rm = TRUE to exclude those values from analysis
mean(oak_data_old$height_cm, na.rm = TRUE)
```

```
## [1] 9.313383
```

```
# Standard deviation
sd(oak_data_old$height_cm, na.rm = TRUE)
```

```
## [1] 25.3822
```

```
# Highest number
max(oak_data_old$height_cm, na.rm = TRUE)
```

```
## [1] 834
```

```
# Lowest number
min(oak_data_old$height_cm, na.rm = TRUE)
```

```
## [1] 0
```

```
# Identify problem rows
which(is.na(oak_data_old$height_cm)) #819
```

```
## [1] 819
```

```
which(grepl(834, oak_data_old$height_cm)) #933
```

```
## [1] 933
```

```
# Edit data
# Method 1
oak_data_new <- oak_data_old[-c(819, 933), ]
View(oak_data_new)

# Method 2
oak_data_new <- oak_data_old[ !(oak_data_old$short_id %in% c("U_C_33_1", "U_C_04_3")), ]
View(oak_data_new)

# It is always safer to delete data according to some sort of identifying value than to delete by row n
```