Exploratory Data Analysis with dplyr

Functions

- `pull()`
- `select()`
- `unique()`
- `distinct()`
- `n_distinct()`
- `sort()`
- `filter()`
- `count()`
- `group_by()`
- `summarise()` (or `summarize()`)
- `arrange()`
- `disc()`
- `summary()`

```
library("dplyr")
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

`dplyr` package has a sample dataframe "storms".

```
storms
```

```
## # A tibble: 10,010 x 13
##    name   year month   day  hour   lat  long status category  wind pressure
##    <chr> <dbl> <dbl> <int> <dbl> <dbl> <dbl> <chr>  <ord>    <int>    <int>
##  1 Amy    1975     6    27     0  27.5 -79   tropi~ -1          25     1013
##  2 Amy    1975     6    27     6  28.5 -79   tropi~ -1          25     1013
##  3 Amy    1975     6    27    12  29.5 -79   tropi~ -1          25     1013
##  4 Amy    1975     6    27    18  30.5 -79   tropi~ -1          25     1013
##  5 Amy    1975     6    28     0  31.5 -78.8 tropi~ -1          25     1012
##  6 Amy    1975     6    28     6  32.4 -78.7 tropi~ -1          25     1012
##  7 Amy    1975     6    28    12  33.3 -78   tropi~ -1          25     1011
```

```
##  8 Amy    1975     6    28    18  34   -77   tropi~ -1          30     1006
##  9 Amy    1975     6    29     0  34.4 -75.8 tropi~ 0           35     1004
## 10 Amy    1975     6    29     6  34   -74.8 tropi~ 0           40     1002
## # ... with 10,000 more rows, and 2 more variables: ts_diameter <dbl>,
## #   hu_diameter <dbl>
```

We can check a documentation about "storms".

```
?storms # help(stomrs) works too
```

Exploratory Data Analysis

To get to know the data. First step of analysis.
1. Check data structure: first and last 5 rows, summarize statistics (mean, sd, etc), number of column and row...
2. Clean the data: deleting some rows, filtering, sorting, deleting or replacing missing values
3. Visualize the data: histogram, scatter plot

`pull()` extracts column as a vector.

```
pull(storms, year)
```

```
##     [1] 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975
##    [15] 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975 1975
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##  [9759] 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014
##  [9773] 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014 2014
##  [9787] 2014 2014 2014 2014 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9801] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9815] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9829] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9843] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9857] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9871] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9885] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9899] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9913] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9927] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9941] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9955] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9969] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9983] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
##  [9997] 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015 2015
```

`select()` extracts column as a table.

```
select(storms, year)
```

```
## # A tibble: 10,010 x 1
##     year
##    <dbl>
##  1  1975
##  2  1975
##  3  1975
##  4  1975
##  5  1975
##  6  1975
##  7  1975
##  8  1975
##  9  1975
```

```
## 10  1975
## # ... with 10,000 more rows
```

`unique()` returns only unique values.

```
unique(pull(storms, year))
```

```
##  [1] 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989
## [16] 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004
## [31] 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015
```

```
unique(select(storms, year))
```

```
## # A tibble: 41 x 1
##     year
##    <dbl>
##  1  1975
##  2  1976
##  3  1977
##  4  1978
##  5  1979
##  6  1980
##  7  1981
##  8  1982
##  9  1983
## 10  1984
## # ... with 31 more rows
```

`storms` has records during a 40-year period from 1975 to 2015.

```
max(pull(storms, year)) - min(pull(storms, year))
```

```
## [1] 40
```

Inspect the column `month`.

```
unique(pull(storms, month))
```

```
##  [1]  6  7  8  9 10 11 12  5  4  1
```

`sort()` sorts the order.

```
sort(unique(pull(storms, month))) # increasing order (default)
```

```
##  [1]  1  4  5  6  7  8  9 10 11 12
```

```
sort(unique(pull(storms, month)), decreasing = TRUE) # decreasing order
```

```
##  [1] 12 11 10  9  8  7  6  5  4  1
```

`sort()` takes only a vector, not a table.

```
# This returns an error.
# sort(unique(select(storms, month)))
```

`filter()` returns rows that meet a logical condition.

```
filter(storms, year == 1975) # extracts rows that year is 1975
```

```
## # A tibble: 86 x 13
##    name   year month   day  hour   lat  long status category  wind pressure
##    <chr> <dbl> <dbl> <int> <dbl> <dbl> <dbl> <chr>  <ord>    <int>    <int>
##  1 Amy    1975     6    27     0  27.5 -79   tropi~ -1          25     1013
##  2 Amy    1975     6    27     6  28.5 -79   tropi~ -1          25     1013
##  3 Amy    1975     6    27    12  29.5 -79   tropi~ -1          25     1013
##  4 Amy    1975     6    27    18  30.5 -79   tropi~ -1          25     1013
##  5 Amy    1975     6    28     0  31.5 -78.8 tropi~ -1          25     1012
##  6 Amy    1975     6    28     6  32.4 -78.7 tropi~ -1          25     1012
##  7 Amy    1975     6    28    12  33.3 -78   tropi~ -1          25     1011
##  8 Amy    1975     6    28    18  34   -77   tropi~ -1          30     1006
##  9 Amy    1975     6    29     0  34.4 -75.8 tropi~ 0           35     1004
## 10 Amy    1975     6    29     6  34   -74.8 tropi~ 0           40     1002
## # ... with 76 more rows, and 2 more variables: ts_diameter <dbl>,
## #   hu_diameter <dbl>
```

Create an object that year is 1975.

```
storms75 <- filter(storms, year == 1975)
```

How many kinds of storms in 1975?

```
unique(pull(storms75, name)) # 3 storms recorded in 1975
```

```
## [1] "Amy"      "Caroline" "Doris"
```

Another way to find how many kinds of storms in 1975 is `distinct()`. It returns a tibble (table) instead of a vector.

```
distinct(storms75, name)
```

```
## # A tibble: 3 x 1
##   name
##   <chr>
## 1 Amy
## 2 Caroline
## 3 Doris
```

`distinct()` takes only a table, not a vector.

```
# This returns an error.
# distinct(pull(storms75, name))
```

`n_distinct()` returns a number of unique values.

```r
n_distinct(select(storms75, wind))
```

```
## [1] 15
```

```r
unique(select(storms75, wind))
```

```
## # A tibble: 15 x 1
##     wind
##    <int>
##  1    25
##  2    30
##  3    35
##  4    40
##  5    45
##  6    50
##  7    55
##  8    60
##  9    65
## 10    70
## 11   100
## 12    90
## 13    20
## 14    75
## 15    95
```

`count()` returns frequencies of each value.

```r
count(storms75, name)
```

```
## # A tibble: 3 x 2
##   name         n
##   <chr>    <int>
## 1 Amy         30
## 2 Caroline    33
## 3 Doris       23
```

`group_by()` groups values. It is often used with `summarise()` to compute a summary on the specified column(s).

```r
summarise(group_by(storms75, name), avg_wind = mean(wind), avg_pressure = mean(pressure))
```

```
## # A tibble: 3 x 3
##   name     avg_wind avg_pressure
##   <chr>       <dbl>        <dbl>
## 1 Amy          46.5         995.
## 2 Caroline     38.9        1002.
## 3 Doris        73.7         983.
```

`summarize()` returns the same result , same usage ("summarise" and "summarize" are the synonyms).

```
summarize(group_by(storms75, name), avg_wind = mean(wind), avg_pressure = mean(pressure))
```

```
## # A tibble: 3 x 3
##   name     avg_wind avg_pressure
##   <chr>       <dbl>        <dbl>
## 1 Amy          46.5         995.
## 2 Caroline     38.9        1002.
## 3 Doris        73.7         983.
```

Store the output.

```
avg_wind_pressure <- summarise(group_by(storms75, name), avg_wind = mean(wind), avg_pressure = mean(pres
avg_wind_pressure # ordered by name alphabetically
```

```
## # A tibble: 3 x 3
##   name     avg_wind avg_pressure
##   <chr>       <dbl>        <dbl>
## 1 Amy          46.5         995.
## 2 Caroline     38.9        1002.
## 3 Doris        73.7         983.
```

`arrange()` orders rows and returns an ordered table.

```
arrange(avg_wind_pressure, avg_wind) # order by average wind in increasing order
```

```
## # A tibble: 3 x 3
##   name     avg_wind avg_pressure
##   <chr>       <dbl>        <dbl>
## 1 Caroline     38.9        1002.
## 2 Amy          46.5         995.
## 3 Doris        73.7         983.
```

`desc()` orders decreasingly.

```
arrange(avg_wind_pressure, desc(avg_wind))
```

```
## # A tibble: 3 x 3
##   name     avg_wind avg_pressure
##   <chr>       <dbl>        <dbl>
## 1 Doris        73.7         983.
## 2 Amy          46.5         995.
## 3 Caroline     38.9        1002.
```

The difference between `sort()` and `arrange()` is that `sort()` takes a vector and returns a vector, while `arrange()` takes a table and returns a table.

Focus on Amy in 1975.

```
amy75 <- filter(storms75, name == "Amy")
amy75
```

```
## # A tibble: 30 x 13
##    name   year month   day  hour   lat  long status category  wind pressure
##    <chr> <dbl> <dbl> <int> <dbl> <dbl> <dbl> <chr>  <ord>    <int>    <int>
##  1 Amy    1975     6    27     0  27.5 -79   tropi~ -1          25     1013
##  2 Amy    1975     6    27     6  28.5 -79   tropi~ -1          25     1013
##  3 Amy    1975     6    27    12  29.5 -79   tropi~ -1          25     1013
##  4 Amy    1975     6    27    18  30.5 -79   tropi~ -1          25     1013
##  5 Amy    1975     6    28     0  31.5 -78.8 tropi~ -1          25     1012
##  6 Amy    1975     6    28     6  32.4 -78.7 tropi~ -1          25     1012
##  7 Amy    1975     6    28    12  33.3 -78   tropi~ -1          25     1011
##  8 Amy    1975     6    28    18  34   -77   tropi~ -1          30     1006
##  9 Amy    1975     6    29     0  34.4 -75.8 tropi~ 0           35     1004
## 10 Amy    1975     6    29     6  34   -74.8 tropi~ 0           40     1002
## # ... with 20 more rows, and 2 more variables: ts_diameter <dbl>,
## #   hu_diameter <dbl>
```

Inspect `amy75`.

```
distinct(amy75, status)
```

```
## # A tibble: 2 x 1
##   status
##   <chr>
## 1 tropical depression
## 2 tropical storm
```

```
distinct(amy75, month)
```

```
## # A tibble: 2 x 1
##   month
##   <dbl>
## 1     6
## 2     7
```

```
count(distinct(amy75, day)) # How many days was Amy active?
```

```
## # A tibble: 1 x 1
##       n
##   <int>
## 1     8
```

`summary()` shows the statistical summary.

```
summary(amy75) # Full stats
```

```
##      name                year          month            day
##  Length:30          Min.   :1975   Min.   :6.000   Min.   : 1.00
##  Class :character   1st Qu.:1975   1st Qu.:6.000   1st Qu.: 2.25
##  Mode  :character   Median :1975   Median :6.000   Median :27.00
##                     Mean   :1975   Mean   :6.467   Mean   :16.27
##                     3rd Qu.:1975   3rd Qu.:7.000   3rd Qu.:28.75
##                     Max.   :1975   Max.   :7.000   Max.   :30.00
##
##       hour            lat             long           status          category
##  Min.   : 0.0   Min.   :27.50   Min.   :-79.00   Length:30          -1: 8
##  1st Qu.: 1.5   1st Qu.:33.80   1st Qu.:-76.70   Class :character   0 :22
##  Median : 6.0   Median :36.05   Median :-70.35   Mode  :character   1 : 0
##  Mean   : 8.6   Mean   :35.42   Mean   :-69.78                      2 : 0
##  3rd Qu.:12.0   3rd Qu.:37.30   3rd Qu.:-65.30                      3 : 0
##  Max.   :18.0   Max.   :44.50   Max.   :-51.60                      4 : 0
##                                                                     5 : 0
##       wind          pressure       ts_diameter   hu_diameter
##  Min.   :25.00   Min.   : 981.0   Min.   : NA   Min.   : NA
##  1st Qu.:31.25   1st Qu.: 986.0   1st Qu.: NA   1st Qu.: NA
##  Median :50.00   Median : 987.0   Median : NA   Median : NA
##  Mean   :46.50   Mean   : 995.1   Mean   :NaN   Mean   :NaN
##  3rd Qu.:60.00   3rd Qu.:1005.5   3rd Qu.: NA   3rd Qu.: NA
##  Max.   :60.00   Max.   :1013.0   Max.   : NA   Max.   : NA
##                                   NA's   :30    NA's   :30
```

```
summary(select(amy75, wind)) # stats only for wind
```

```
##       wind
##  Min.   :25.00
##  1st Qu.:31.25
##  Median :50.00
##  Mean   :46.50
##  3rd Qu.:60.00
##  Max.   :60.00
```

Exercises

1) Use "dplyr" functions/commands to create a table (e.g. tibble) storm_names_1980s containing the name and year of storms recorded during the 1980s (i.e. from 1980 to 1989).

```
storm_names_1980s <- distinct(filter(storms, year >= 1980 & year <= 1989), name, year)
storm_names_1980s
```

```
## # A tibble: 70 x 2
##    name      year
##    <chr>    <dbl>
##  1 Bonnie    1980
##  2 Charley   1980
##  3 Georges   1980
##  4 Danielle  1980
##  5 Hermine   1980
##  6 Ivan      1980
```

```
##  7 Jeanne    1980
##  8 Karl      1980
##  9 Emily     1981
## 10 Floyd     1981
## # ... with 60 more rows
```

2) Use "dplyr" functions/commands to create a table (e.g. tibble) storms_per_year containing the number of storms recorded in each year (i.e. counts or frequencies of storms in each year). This table should contain two columns: year values in the first column, and number of storms in the second column.

```
storms_per_year <- count(storms, year)
storms_per_year
```

```
## # A tibble: 41 x 2
##     year     n
##    <dbl> <int>
##  1  1975    86
##  2  1976    52
##  3  1977    53
##  4  1978    54
##  5  1979   301
##  6  1980   161
##  7  1981   164
##  8  1982   105
##  9  1983    79
## 10  1984   236
## # ... with 31 more rows
```

3) Use "dplyr" functions/commands to create a table (e.g. tibble) storm_records_per_year containing three columns: 1) name of storm, 2) year of storm, and 3) count for number of records (of the corresponding storm).

```
storm_records_per_year <- count(storms, name, year)
storm_records_per_year
```

```
## # A tibble: 426 x 3
##    name      year     n
##    <chr>    <dbl> <int>
##  1 AL011993  1993     8
##  2 AL012000  2000     4
##  3 AL021992  1992     5
##  4 AL021994  1994     6
##  5 AL021999  1999     4
##  6 AL022000  2000    12
##  7 AL022001  2001     5
##  8 AL022003  2003     4
##  9 AL022006  2006     5
## 10 AL031987  1987    32
## # ... with 416 more rows
```

4) Use "dplyr" functions/commands to display the different (unique) types of storm status.

```r
# they are all the same (but the last one returns a vector)
distinct(storms, status)
```

```
## # A tibble: 3 x 1
##   status
##   <chr>
## 1 tropical depression
## 2 tropical storm
## 3 hurricane
```

```r
unique(select(storms, status))
```

```
## # A tibble: 3 x 1
##   status
##   <chr>
## 1 tropical depression
## 2 tropical storm
## 3 hurricane
```

```r
unique(pull(storms, status))
```

```
## [1] "tropical depression" "tropical storm"      "hurricane"
```

5) Use "dplyr" functions/commands to display the different types of storm categories.

```r
distinct(storms, category)
```

```
## # A tibble: 7 x 1
##   category
##   <ord>
## 1 -1
## 2 0
## 3 1
## 4 3
## 5 2
## 6 5
## 7 4
```

6) Use "dplyr" functions/commands to create a table (e.g. tibble) storms_categ5 containing the name and year of those storms of category 5.

```r
storms_categ5 <- select(filter(storms, category == 5), name, year)
storms_categ5
```

```
## # A tibble: 68 x 2
##    name     year
##    <chr>   <dbl>
##  1 Anita    1977
##  2 Anita    1977
```

```
##  3 David    1979
##  4 David    1979
##  5 David    1979
##  6 David    1979
##  7 David    1979
##  8 David    1979
##  9 David    1979
## 10 Gilbert  1988
## # ... with 58 more rows
```

7) Use "dplyr" functions/commands to display a table showing the status, avg_pressure (average pressure), and avg_wind (average wind speed), for each type of storm category. This table should contain four columns: 1) category, 2) status, 3) avg_pressure, and 4) avg_wind.

```
summarise(group_by(storms, category, status), avg_pressure = mean(pressure), avg_wind = mean(wind))
```

```
## # A tibble: 8 x 4
## # Groups:   category [7]
##   category status              avg_pressure avg_wind
##   <ord>    <chr>                      <dbl>    <dbl>
## 1 -1       tropical depression        1008.     27.3
## 2 0        tropical storm              999.     45.8
## 3 1        hurricane                   982.     70.9
## 4 1        tropical storm              975      70
## 5 2        hurricane                   967.     89.4
## 6 3        hurricane                   954.    105.
## 7 4        hurricane                   940.    122.
## 8 5        hurricane                   916.    145.
```

8) Use "dplyr" functions/commands to create a table (e.g. tibble) max_wind_per_storm containing three columns: 1) year of storm, 2) name of storm, and 3) max_wind maximum wind speed record (for that storm).

```
max_wind_per_storm <- summarise(group_by(storms, year, name), max_wind = max(wind))
max_wind_per_storm
```

```
## # A tibble: 426 x 3
## # Groups:   year [41]
##     year name     max_wind
##    <dbl> <chr>       <int>
##  1  1975 Amy            60
##  2  1975 Caroline      100
##  3  1975 Doris          95
##  4  1976 Belle         105
##  5  1976 Gloria         90
##  6  1977 Anita         150
##  7  1977 Clara          65
##  8  1977 Evelyn         70
##  9  1978 Amelia         45
## 10  1978 Bess           45
## # ... with 416 more rows
```

9) Use "dplyr" functions/commands to create a table (e.g. tibble) max_wind_per_year containing three columns: 1) year of storm, 2) name of storm, and 3) wind maximum wind speed record (for that year). Arrange rows by wind speed in decreasing order.

```
max_wind_per_year <- arrange(summarise(group_by(storms, year),
                                       name = name[which.max(wind)],
                                       max_wind = max(wind)),
                             desc(max_wind))
max_wind_per_year
```

```
## # A tibble: 41 x 3
##     year name    max_wind
##    <dbl> <chr>      <int>
##  1  1988 Gilbert      160
##  2  2005 Wilma        160
##  3  1998 Mitch        155
##  4  1977 Anita        150
##  5  1979 David        150
##  6  1992 Andrew       150
##  7  2007 Dean         150
##  8  2003 Isabel       145
##  9  2004 Ivan         145
## 10  1989 Hugo         140
## # ... with 31 more rows
```