

# BANA4137 Homework 2

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1/22/2021

## BANA4137 Homework 2

Libraries being used

```
library(tidyverse)

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

## v ggplot2 3.3.3      v purrr   0.3.4
## v tibble  3.0.5      v dplyr  1.0.3
## v tidyr   1.1.2      v stringr 1.4.0
## v readr   1.4.0      v forcats 0.5.0

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

1. Read in data

```
flights <-
  read.csv(
    "CVG_Flights.csv",
    header = TRUE,
    stringsAsFactors = FALSE,
    na.strings = ""
  )

airports <-
  read.csv(
    "airports.csv",
    header = TRUE,
    stringsAsFactors = FALSE,
    na.strings = ""
  )

airlines <-
  read.csv(
    "airlines.csv",
    header = TRUE,
    stringsAsFactors = FALSE,
    na.strings = ""
  )
```

2. How many rows are there in each data frame?

```
nrow(flights)
```

```
## [1] 7763
```

```
nrow(airports)
```

```
## [1] 322
```

```
nrow(airlines)
```

```
## [1] 14
```

3. How many columns are there in each data frame?

```
ncol(flights)
```

```
## [1] 27
```

```
ncol(airports)
```

```
## [1] 7
```

```
ncol(airlines)
```

```
## [1] 2
```

4. Merge all three data frames into one data frame, according to the IATA code for airlines and airports.

```
first_dataframe <- left_join(flights,
                             airlines,
                             by=c("AIRLINE"="IATA_CODE"))
head(first_dataframe)
```

```
##   FLIGHT_DATE AIRLINE FLIGHT_NUMBER ORIGIN_AIRPORT DESTINATION_AIRPORT
## 1  1/1/2015     MQ       3355         CVG             MIA
## 2  1/1/2015     MQ       3597         CVG             DFW
## 3  1/1/2015     OO       4811         BNA             CVG
## 4  1/1/2015     DL       2315         CVG             ATL
## 5  1/1/2015     F9       1308         IAD             CVG
## 6  1/1/2015     DL       1502         CVG             TPA
##   SCHEDULED_DEPARTURE DEPARTURE_TIME DEPARTURE_DELAY TAXI_OUT WHEELS_OFF
## 1      6:00:00 AM      5:56:00 AM          -4      15 6:11:00 AM
## 2      6:00:00 AM           <NA>           NA      NA      <NA>
## 3      6:45:00 AM      6:37:00 AM          -8      16 6:53:00 AM
## 4      7:10:00 AM      7:08:00 AM          -2      36 7:44:00 AM
## 5      7:15:00 AM      7:05:00 AM         -10      11 7:16:00 AM
```

|      |                     |                  |                              |                            |
|------|---------------------|------------------|------------------------------|----------------------------|
| ## 6 | 7:20:00 AM          | 7:19:00 AM       | -1                           | 9 7:28:00 AM               |
| ##   | SCHEDULED_TIME      | ELAPSED_TIME     | AIR_TIME                     | DISTANCE WHEELS_ON TAXI_IN |
| ## 1 | 153                 | 150              | 123                          | 948 8:14:00 AM 12          |
| ## 2 | 165                 | NA               | NA                           | 812 <NA> NA                |
| ## 3 | 72                  | 66               | 45                           | 230 8:38:00 AM 5           |
| ## 4 | 102                 | 101              | 62                           | 373 8:46:00 AM 3           |
| ## 5 | 95                  | 91               | 75                           | 388 8:31:00 AM 5           |
| ## 6 | 141                 | 116              | 105                          | 773 9:13:00 AM 2           |
| ##   | SCHEDULED_ARRIVAL   | ARRIVAL_TIME     | ARRIVAL_DELAY                | DIVERTED CANCELLED         |
| ## 1 | 8:33:00 AM          | 8:26:00 AM       | -7                           | 0 0                        |
| ## 2 | 7:45:00 AM          | <NA>             | NA                           | 0 1                        |
| ## 3 | 8:57:00 AM          | 8:43:00 AM       | -14                          | 0 0                        |
| ## 4 | 8:52:00 AM          | 8:49:00 AM       | -3                           | 0 0                        |
| ## 5 | 8:50:00 AM          | 8:36:00 AM       | -14                          | 0 0                        |
| ## 6 | 9:41:00 AM          | 9:15:00 AM       | -26                          | 0 0                        |
| ##   | CANCELLATION_REASON | AIR_SYSTEM_DELAY | SECURITY_DELAY               | AIRLINE_DELAY              |
| ## 1 | <NA>                | NA               | NA                           | NA                         |
| ## 2 | B                   | NA               | NA                           | NA                         |
| ## 3 | <NA>                | NA               | NA                           | NA                         |
| ## 4 | <NA>                | NA               | NA                           | NA                         |
| ## 5 | <NA>                | NA               | NA                           | NA                         |
| ## 6 | <NA>                | NA               | NA                           | NA                         |
| ##   | LATE_AIRCRAFT_DELAY | WEATHER_DELAY    | AIRLINE.y                    |                            |
| ## 1 | NA                  | NA               | American Eagle Airlines Inc. |                            |
| ## 2 | NA                  | NA               | American Eagle Airlines Inc. |                            |
| ## 3 | NA                  | NA               | Skywest Airlines Inc.        |                            |
| ## 4 | NA                  | NA               | Delta Air Lines Inc.         |                            |
| ## 5 | NA                  | NA               | Frontier Airlines Inc.       |                            |
| ## 6 | NA                  | NA               | Delta Air Lines Inc.         |                            |

```
total_dataframe <- left_join(first_dataframe,
                             airports,
                             by=c("ORIGIN_AIRPORT"="IATA_CODE"))
head(total_dataframe)
```

|      |                     |                |                 |                   |                     |
|------|---------------------|----------------|-----------------|-------------------|---------------------|
| ##   | FLIGHT_DATE         | AIRLINE        | FLIGHT_NUMBER   | ORIGIN_AIRPORT    | DESTINATION_AIRPORT |
| ## 1 | 1/1/2015            | MQ             | 3355            | CVG               | MIA                 |
| ## 2 | 1/1/2015            | MQ             | 3597            | CVG               | DFW                 |
| ## 3 | 1/1/2015            | OO             | 4811            | BNA               | CVG                 |
| ## 4 | 1/1/2015            | DL             | 2315            | CVG               | ATL                 |
| ## 5 | 1/1/2015            | F9             | 1308            | IAD               | CVG                 |
| ## 6 | 1/1/2015            | DL             | 1502            | CVG               | TPA                 |
| ##   | SCHEDULED_DEPARTURE | DEPARTURE_TIME | DEPARTURE_DELAY | TAXI_OUT          | WHEELS_OFF          |
| ## 1 | 6:00:00 AM          | 5:56:00 AM     | -4              | 15 6:11:00 AM     |                     |
| ## 2 | 6:00:00 AM          | <NA>           | NA              | NA <NA>           |                     |
| ## 3 | 6:45:00 AM          | 6:37:00 AM     | -8              | 16 6:53:00 AM     |                     |
| ## 4 | 7:10:00 AM          | 7:08:00 AM     | -2              | 36 7:44:00 AM     |                     |
| ## 5 | 7:15:00 AM          | 7:05:00 AM     | -10             | 11 7:16:00 AM     |                     |
| ## 6 | 7:20:00 AM          | 7:19:00 AM     | -1              | 9 7:28:00 AM      |                     |
| ##   | SCHEDULED_TIME      | ELAPSED_TIME   | AIR_TIME        | DISTANCE          | WHEELS_ON TAXI_IN   |
| ## 1 | 153                 | 150            | 123             | 948 8:14:00 AM 12 |                     |
| ## 2 | 165                 | NA             | NA              | 812 <NA> NA       |                     |
| ## 3 | 72                  | 66             | 45              | 230 8:38:00 AM 5  |                     |
| ## 4 | 102                 | 101            | 62              | 373 8:46:00 AM 3  |                     |

```

## 5          95          91          75          388 8:31:00 AM          5
## 6         141         116         105          773 9:13:00 AM          2
## SCHEDULED_ARRIVAL ARRIVAL_TIME ARRIVAL_DELAY DIVERTED CANCELLED
## 1      8:33:00 AM    8:26:00 AM          -7          0          0
## 2      7:45:00 AM          <NA>          NA          0          1
## 3      8:57:00 AM    8:43:00 AM         -14          0          0
## 4      8:52:00 AM    8:49:00 AM          -3          0          0
## 5      8:50:00 AM    8:36:00 AM         -14          0          0
## 6      9:41:00 AM    9:15:00 AM         -26          0          0
## CANCELLATION_REASON AIR_SYSTEM_DELAY SECURITY_DELAY AIRLINE_DELAY
## 1          <NA>          NA          NA          NA          NA
## 2           B          NA          NA          NA          NA
## 3          <NA>          NA          NA          NA          NA
## 4          <NA>          NA          NA          NA          NA
## 5          <NA>          NA          NA          NA          NA
## 6          <NA>          NA          NA          NA          NA
## LATE_AIRCRAFT_DELAY WEATHER_DELAY          AIRLINE.y
## 1           NA          NA American Eagle Airlines Inc.
## 2           NA          NA American Eagle Airlines Inc.
## 3           NA          NA    Skywest Airlines Inc.
## 4           NA          NA    Delta Air Lines Inc.
## 5           NA          NA    Frontier Airlines Inc.
## 6           NA          NA    Delta Air Lines Inc.
##          AIRPORT          CITY STATE COUNTRY
## 1 Cincinnati/Northern Kentucky International Airport Covington    KY    USA
## 2 Cincinnati/Northern Kentucky International Airport Covington    KY    USA
## 3              Nashville International Airport Nashville    TN    USA
## 4 Cincinnati/Northern Kentucky International Airport Covington    KY    USA
## 5      Washington Dulles International Airport Chantilly    VA    USA
## 6 Cincinnati/Northern Kentucky International Airport Covington    KY    USA
## LATITUDE LONGITUDE
## 1 39.04614 -84.66217
## 2 39.04614 -84.66217
## 3 36.12448 -86.67818
## 4 39.04614 -84.66217
## 5 38.94453 -77.45581
## 6 39.04614 -84.66217

```

5. For this merged data set, print the first six rows and last six rows.

```
head(total_dataframe,6)
```

```

## FLIGHT_DATE AIRLINE FLIGHT_NUMBER ORIGIN_AIRPORT DESTINATION_AIRPORT
## 1 1/1/2015 MQ 3355 CVG MIA
## 2 1/1/2015 MQ 3597 CVG DFW
## 3 1/1/2015 OO 4811 BNA CVG
## 4 1/1/2015 DL 2315 CVG ATL
## 5 1/1/2015 F9 1308 IAD CVG
## 6 1/1/2015 DL 1502 CVG TPA
## SCHEDULED_DEPARTURE DEPARTURE_TIME DEPARTURE_DELAY TAXI_OUT WHEELS_OFF
## 1 6:00:00 AM 5:56:00 AM -4 15 6:11:00 AM
## 2 6:00:00 AM <NA> NA NA <NA>
## 3 6:45:00 AM 6:37:00 AM -8 16 6:53:00 AM

```

```

## 4      7:10:00 AM      7:08:00 AM      -2      36 7:44:00 AM
## 5      7:15:00 AM      7:05:00 AM      -10      11 7:16:00 AM
## 6      7:20:00 AM      7:19:00 AM      -1       9 7:28:00 AM
## SCHEDULED_TIME ELAPSED_TIME AIR_TIME DISTANCE WHEELS_ON TAXI_IN
## 1      153      150      123      948 8:14:00 AM      12
## 2      165      NA      NA      812      <NA>      NA
## 3      72      66      45      230 8:38:00 AM      5
## 4      102      101      62      373 8:46:00 AM      3
## 5      95      91      75      388 8:31:00 AM      5
## 6      141      116      105      773 9:13:00 AM      2
## SCHEDULED_ARRIVAL ARRIVAL_TIME ARRIVAL_DELAY DIVERTED CANCELLED
## 1      8:33:00 AM      8:26:00 AM      -7      0      0
## 2      7:45:00 AM      <NA>      NA      0      1
## 3      8:57:00 AM      8:43:00 AM      -14      0      0
## 4      8:52:00 AM      8:49:00 AM      -3      0      0
## 5      8:50:00 AM      8:36:00 AM      -14      0      0
## 6      9:41:00 AM      9:15:00 AM      -26      0      0
## CANCELLATION_REASON AIR_SYSTEM_DELAY SECURITY_DELAY AIRLINE_DELAY
## 1      <NA>      NA      NA      NA
## 2      B      NA      NA      NA
## 3      <NA>      NA      NA      NA
## 4      <NA>      NA      NA      NA
## 5      <NA>      NA      NA      NA
## 6      <NA>      NA      NA      NA
## LATE_AIRCRAFT_DELAY WEATHER_DELAY AIRLINE.y
## 1      NA      NA American Eagle Airlines Inc.
## 2      NA      NA American Eagle Airlines Inc.
## 3      NA      NA Skywest Airlines Inc.
## 4      NA      NA Delta Air Lines Inc.
## 5      NA      NA Frontier Airlines Inc.
## 6      NA      NA Delta Air Lines Inc.
## AIRPORT CITY STATE COUNTRY
## 1 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 2 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 3 Nashville International Airport Nashville TN USA
## 4 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 5 Washington Dulles International Airport Chantilly VA USA
## 6 Cincinnati/Northern Kentucky International Airport Covington KY USA
## LATITUDE LONGITUDE
## 1 39.04614 -84.66217
## 2 39.04614 -84.66217
## 3 36.12448 -86.67818
## 4 39.04614 -84.66217
## 5 38.94453 -77.45581
## 6 39.04614 -84.66217

```

```
tail(total_dataframe,6)
```

```

## FLIGHT_DATE AIRLINE FLIGHT_NUMBER ORIGIN_AIRPORT DESTINATION_AIRPORT
## 7758 3/10/2015 DL 803 CVG MCO
## 7759 3/10/2015 DL 2011 ATL CVG
## 7760 3/10/2015 EV 4638 EWR CVG
## 7761 3/10/2015 DL 1705 CVG LGA
## 7762 3/10/2015 F9 734 DEN CVG

```

|    |      |  |                  |                             |               |                   |
|----|------|--|------------------|-----------------------------|---------------|-------------------|
| ## | 7763 | 3/10/2015  | 00               | 5643                        | DEN           | CVG               |
| ## |      | SCHEDULED_DEPARTURE                                | DEPARTURE_TIME   | DEPARTURE_DELAY             | TAXI_OUT      | WHEELS_OFF        |
| ## | 7758 | 9:40:00 AM   | 9:36:00 AM       | -4                          | 12            | 9:48:00 AM        |
| ## | 7759 | 9:40:00 AM   | 9:48:00 AM       | 8                           | 10            | 9:58:00 AM        |
| ## | 7760 | 9:41:00 AM   | 9:31:00 AM       | -10                         | 15            | 9:46:00 AM        |
| ## | 7761 | 9:45:00 AM   | 9:45:00 AM       | 0                           | 13            | 9:58:00 AM        |
| ## | 7762 | 10:00:00 AM  | 10:09:00 AM      | 9                           | 16            | 10:25:00 AM       |
| ## | 7763 | 10:00:00 AM  | 10:02:00 AM      | 2                           | 16            | 10:18:00 AM       |
| ## |      | SCHEDULED_TIME                                     | ELAPSED_TIME     | AIR_TIME                    | DISTANCE      | WHEELS_ON TAXI_IN |
| ## | 7758 | 129  | 127              | 110                         | 757           | 1:38:00 AM 5      |
| ## | 7759 | 85   | 74               | 59                          | 373           | 1:57:00 AM 5      |
| ## | 7760 | 136  | 125              | 103                         | 569           | 1:29:00 AM 7      |
| ## | 7761 | 121  | 100              | 73                          | 585           | 1:11:00 AM 14     |
| ## | 7762 | 152  | 156              | 132                         | 1069          | 1:37:00 AM 8      |
| ## | 7763 | 159  | 159              | 134                         | 1069          | 1:32:00 AM 9      |
| ## |      | SCHEDULED_ARRIVAL                                  | ARRIVAL_TIME     | ARRIVAL_DELAY               | DIVERTED      | CANCELLED         |
| ## | 7758 | 11:49:00 AM  | 11:43:00 AM      | -6                          | 0             | 0                 |
| ## | 7759 | 11:05:00 AM  | 11:02:00 AM      | -3                          | 0             | 0                 |
| ## | 7760 | 11:57:00 AM  | 11:36:00 AM      | -21                         | 0             | 0                 |
| ## | 7761 | 11:46:00 AM  | 11:25:00 AM      | -21                         | 0             | 0                 |
| ## | 7762 | 2:32:00 PM   | 2:45:00 PM       | 13                          | 0             | 0                 |
| ## | 7763 | 2:39:00 PM   | 2:41:00 PM       | 2                           | 0             | 0                 |
| ## |      | CANCELLATION_REASON                                | AIR_SYSTEM_DELAY | SECURITY_DELAY              | AIRLINE_DELAY |                   |
| ## | 7758 | <NA>   | NA               | NA                          | NA            |                   |
| ## | 7759 | <NA>   | NA               | NA                          | NA            |                   |
| ## | 7760 | <NA>   | NA               | NA                          | NA            |                   |
| ## | 7761 | <NA>   | NA               | NA                          | NA            |                   |
| ## | 7762 | <NA>   | NA               | NA                          | NA            |                   |
| ## | 7763 | <NA>   | NA               | NA                          | NA            |                   |
| ## |      | LATE_AIRCRAFT_DELAY                                | WEATHER_DELAY    |                             | AIRLINE.y     |                   |
| ## | 7758 | NA   | NA               | Delta Air Lines Inc.        |               |                   |
| ## | 7759 | NA   | NA               | Delta Air Lines Inc.        |               |                   |
| ## | 7760 | NA   | NA               | Atlantic Southeast Airlines |               |                   |
| ## | 7761 | NA   | NA               | Delta Air Lines Inc.        |               |                   |
| ## | 7762 | NA   | NA               | Frontier Airlines Inc.      |               |                   |
| ## | 7763 | NA   | NA               | Skywest Airlines Inc.       |               |                   |
| ## |      |  |                  | AIRPORT                     | CITY          | STATE COUNTRY     |
| ## | 7758 | Cincinnati/Northern Kentucky International Airport | Covington        | KY                          | USA           |                   |
| ## | 7759 | Hartsfield-Jackson Atlanta International Airport   | Atlanta          | GA                          | USA           |                   |
| ## | 7760 | Newark Liberty International Airport               | Newark           | NJ                          | USA           |                   |
| ## | 7761 | Cincinnati/Northern Kentucky International Airport | Covington        | KY                          | USA           |                   |
| ## | 7762 | Denver International Airport                       | Denver           | CO                          | USA           |                   |
| ## | 7763 | Denver International Airport                       | Denver           | CO                          | USA           |                   |
| ## |      | LATITUDE   | LONGITUDE        |                             |               |                   |
| ## | 7758 | 39.04614   | -84.66217        |                             |               |                   |
| ## | 7759 | 33.64044   | -84.42694        |                             |               |                   |
| ## | 7760 | 40.69250   | -74.16866        |                             |               |                   |
| ## | 7761 | 39.04614   | -84.66217        |                             |               |                   |
| ## | 7762 | 39.85841   | -104.66700       |                             |               |                   |
| ## | 7763 | 39.85841   | -104.66700       |                             |               |                   |

6. For this merged data set, are there any missing values? In what variables are these missing values?

```
na.vals <- apply(is.na(total_dataframe), 2, which)
```

```
# Columns containing NA values
```

```
na.vals <- na.vals[lapply(na.vals,length)>0]
```

```
# Columns containing NA values
```

```
names(na.vals)
```

```
## [1] "DEPARTURE_TIME"      "DEPARTURE_DELAY"    "TAXI_OUT"
## [4] "WHEELS_OFF"          "ELAPSED_TIME"       "AIR_TIME"
## [7] "WHEELS_ON"           "TAXI_IN"            "ARRIVAL_TIME"
## [10] "ARRIVAL_DELAY"       "CANCELLATION_REASON" "AIR_SYSTEM_DELAY"
## [13] "SECURITY_DELAY"      "AIRLINE_DELAY"      "LATE_AIRCRAFT_DELAY"
## [16] "WEATHER_DELAY"
```

7. What is the proportion of canceled flights (to all flights)? How many different cancellation reasons are there?

```
# Proportion of canceled flights (
(total_dataframe %>%
  subset(CANCELLED == 1) %>%
  nrow()) / nrow(total_dataframe)
```

```
## [1] 0.04869252
```

```
# Cancellation reason
```

```
total_dataframe %>%
  select(CANCELLATION_REASON) %>%
  drop_na() %>%
  unique()
```

```
## CANCELLATION_REASON
## 1 B
## 4 A
## 10 C
```

```
# Three different reasons
```

8. For DEPARTURE\_TIME, are there missing values? Do we know why these values are missing?

```
# 8 Missing departure times
```

```
na.vals$DEPARTURE_TIME
```

```
## [1] 2 7 11 27 29 34 147 325 361 388 417 422 427 435 438
## [16] 444 448 451 459 461 462 467 485 492 494 515 520 549 564 570
## [31] 578 579 589 596 610 611 632 726 782 801 805 892 894 905 918
## [46] 920 924 927 935 947 949 954 960 962 1013 1041 1094 1106 1207 1211
## [61] 1232 1234 1248 1253 1254 1268 1276 1281 1299 1309 1487 1946 1950 2111 2228
## [76] 2229 2259 2571 2774 2801 2802 2810 2819 2821 2827 2829 2832 2837 2853 2855
## [91] 2862 2868 2876 2878 2896 2897 2923 2924 2931 2940 2942 2948 2949 2952 2957
```

```
## [106] 2969 2974 2981 2996 3012 3414 3426 3431 3433 3441 3442 3447 3448 3454 3459
## [121] 3466 3468 3471 3472 3475 3479 3483 3485 3490 3494 3500 3502 3510 3513 3517
## [136] 3519 3520 3521 3533 3538 3540 3542 3548 3554 3556 3557 3562 3566 3568 3571
## [151] 3573 3574 3576 3579 3583 3592 3596 3599 3600 3602 3615 3633 3641 3656 3686
## [166] 3693 3699 3706 3710 3721 3728 3736 3794 3811 3814 3839 3866 3881 3888 3901
## [181] 3904 3929 3938 4231 4234 4275 4293 4297 4324 4325 4333 4344 4352 4372 4650
## [196] 4940 4950 4981 4999 5001 5010 5022 5028 5045 5052 5066 5092 5093 5127 5158
## [211] 5159 5180 5193 5199 5213 5341 5407 5452 5557 5657 5680 5686 5747 5749 5761
## [226] 5768 5785 5788 5791 5801 5804 5840 5854 5885 5899 5911 5920 5949 5975 5989
## [241] 6002 6020 6025 6032 6033 6042 6048 6053 6055 6066 6081 6130 6145 6146 6155
## [256] 6167 6205 6264 6269 6280 6282 6300 6328 6334 6355 6403 6492 6505 6519 6535
## [271] 6536 6549 6555 6561 6563 6575 6577 6589 6595 6602 6603 6610 6614 6621 6623
## [286] 6628 6630 6636 6648 6649 6653 6655 6657 6661 6677 6683 6694 6711 6714 6720
## [301] 6733 6745 6750 6778 6781 6889 6892 6900 6914 6918 6927 6941 6942 6949 6959
## [316] 6962 6972 6975 6979 6984 6988 6999 7005 7072 7081 7086 7088 7092 7096 7100
## [331] 7101 7108 7114 7118 7121 7129 7131 7133 7135 7136 7139 7141 7148 7150 7157
## [346] 7165 7170 7180 7186 7190 7192 7195 7201 7202 7208 7214 7216 7227 7241 7243
## [361] 7247 7253 7268 7270 7271 7290 7291 7320 7387 7422
```

```
# occurs when flight is canceled
```

9. In the merged data frame, create a new variable (i.e., new column) as the time difference between the SCHEDULED\_TIME and the ELAPSED\_TIME, i.e., SCHEDULED\_TIME - ELAPSED\_TIME. Print the first and last six rows of the revised data frame.

```
total_dataframe$TOTAL_TIME <-
  total_dataframe$SCHEDULED_TIME - total_dataframe$ELAPSED_TIME

head(total_dataframe, 6)
```

```
## FLIGHT_DATE AIRLINE FLIGHT_NUMBER ORIGIN_AIRPORT DESTINATION_AIRPORT
## 1 1/1/2015 MQ 3355 CVG MIA
## 2 1/1/2015 MQ 3597 CVG DFW
## 3 1/1/2015 OO 4811 BNA CVG
## 4 1/1/2015 DL 2315 CVG ATL
## 5 1/1/2015 F9 1308 IAD CVG
## 6 1/1/2015 DL 1502 CVG TPA
## SCHEDULED_DEPARTURE DEPARTURE_TIME DEPARTURE_DELAY TAXI_OUT WHEELS_OFF
## 1 6:00:00 AM 5:56:00 AM -4 15 6:11:00 AM
## 2 6:00:00 AM <NA> NA NA <NA>
## 3 6:45:00 AM 6:37:00 AM -8 16 6:53:00 AM
## 4 7:10:00 AM 7:08:00 AM -2 36 7:44:00 AM
## 5 7:15:00 AM 7:05:00 AM -10 11 7:16:00 AM
## 6 7:20:00 AM 7:19:00 AM -1 9 7:28:00 AM
## SCHEDULED_TIME ELAPSED_TIME AIR_TIME DISTANCE WHEELS_ON TAXI_IN
## 1 153 150 123 948 8:14:00 AM 12
## 2 165 NA NA 812 <NA> NA
## 3 72 66 45 230 8:38:00 AM 5
## 4 102 101 62 373 8:46:00 AM 3
## 5 95 91 75 388 8:31:00 AM 5
## 6 141 116 105 773 9:13:00 AM 2
## SCHEDULED_ARRIVAL ARRIVAL_TIME ARRIVAL_DELAY DIVERTED CANCELLED
## 1 8:33:00 AM 8:26:00 AM -7 0 0
```



```

## 2      7:45:00 AM      <NA>      NA      0      1
## 3      8:57:00 AM      8:43:00 AM      -14      0      0
## 4      8:52:00 AM      8:49:00 AM      -3      0      0
## 5      8:50:00 AM      8:36:00 AM      -14      0      0
## 6      9:41:00 AM      9:15:00 AM      -26      0      0
## CANCELLATION_REASON AIR_SYSTEM_DELAY SECURITY_DELAY AIRLINE_DELAY
## 1      <NA>      NA      NA      NA
## 2      B      NA      NA      NA
## 3      <NA>      NA      NA      NA
## 4      <NA>      NA      NA      NA
## 5      <NA>      NA      NA      NA
## 6      <NA>      NA      NA      NA
## LATE_AIRCRAFT_DELAY WEATHER_DELAY      AIRLINE.y
## 1      NA      NA American Eagle Airlines Inc.
## 2      NA      NA American Eagle Airlines Inc.
## 3      NA      NA Skywest Airlines Inc.
## 4      NA      NA Delta Air Lines Inc.
## 5      NA      NA Frontier Airlines Inc.
## 6      NA      NA Delta Air Lines Inc.
##      AIRPORT      CITY STATE COUNTRY
## 1 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 2 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 3      Nashville International Airport Nashville TN USA
## 4 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 5      Washington Dulles International Airport Chantilly VA USA
## 6 Cincinnati/Northern Kentucky International Airport Covington KY USA
## LATITUDE LONGITUDE TOTAL_TIME
## 1 39.04614 -84.66217      3
## 2 39.04614 -84.66217      NA
## 3 36.12448 -86.67818      6
## 4 39.04614 -84.66217      1
## 5 38.94453 -77.45581      4
## 6 39.04614 -84.66217      25

```

```
tail(total_dataframe, 6)
```

```

## FLIGHT_DATE AIRLINE FLIGHT_NUMBER ORIGIN_AIRPORT DESTINATION_AIRPORT
## 7758 3/10/2015 DL      803      CVG      MCO
## 7759 3/10/2015 DL      2011      ATL      CVG
## 7760 3/10/2015 EV      4638      EWR      CVG
## 7761 3/10/2015 DL      1705      CVG      LGA
## 7762 3/10/2015 F9      734      DEN      CVG
## 7763 3/10/2015 OO      5643      DEN      CVG
## SCHEDULED_DEPARTURE DEPARTURE_TIME DEPARTURE_DELAY TAXI_OUT WHEELS_OFF
## 7758 9:40:00 AM 9:36:00 AM      -4      12 9:48:00 AM
## 7759 9:40:00 AM 9:48:00 AM      8      10 9:58:00 AM
## 7760 9:41:00 AM 9:31:00 AM     -10      15 9:46:00 AM
## 7761 9:45:00 AM 9:45:00 AM      0      13 9:58:00 AM
## 7762 10:00:00 AM 10:09:00 AM      9      16 10:25:00 AM
## 7763 10:00:00 AM 10:02:00 AM      2      16 10:18:00 AM
## SCHEDULED_TIME ELAPSED_TIME AIR_TIME DISTANCE WHEELS_ON TAXI_IN
## 7758 129      127      110      757 1:38:00 AM      5
## 7759 85      74      59      373 1:57:00 AM      5
## 7760 136      125      103      569 1:29:00 AM      7

```

|    |      |  |                  |                |                             |            |         |
|----|------|--|------------------|----------------|-----------------------------|------------|---------|
| ## | 7761 | 121  | 100              | 73             | 585                         | 1:11:00 AM | 14      |
| ## | 7762 | 152  | 156              | 132            | 1069                        | 1:37:00 AM | 8       |
| ## | 7763 | 159  | 159              | 134            | 1069                        | 1:32:00 AM | 9       |
| ## |      | SCHEDULED_ARRIVAL                                  | ARRIVAL_TIME     | ARRIVAL_DELAY  | DIVERTED                    | CANCELLED  |         |
| ## | 7758 | 11:49:00 AM  | 11:43:00 AM      | -6             | 0                           | 0          |         |
| ## | 7759 | 11:05:00 AM  | 11:02:00 AM      | -3             | 0                           | 0          |         |
| ## | 7760 | 11:57:00 AM  | 11:36:00 AM      | -21            | 0                           | 0          |         |
| ## | 7761 | 11:46:00 AM  | 11:25:00 AM      | -21            | 0                           | 0          |         |
| ## | 7762 | 2:32:00 PM   | 2:45:00 PM       | 13             | 0                           | 0          |         |
| ## | 7763 | 2:39:00 PM   | 2:41:00 PM       | 2              | 0                           | 0          |         |
| ## |      | CANCELLATION_REASON                                | AIR_SYSTEM_DELAY | SECURITY_DELAY | AIRLINE_DELAY               |            |         |
| ## | 7758 | <NA>   | NA               | NA             | NA                          | NA         |         |
| ## | 7759 | <NA>   | NA               | NA             | NA                          | NA         |         |
| ## | 7760 | <NA>   | NA               | NA             | NA                          | NA         |         |
| ## | 7761 | <NA>   | NA               | NA             | NA                          | NA         |         |
| ## | 7762 | <NA>   | NA               | NA             | NA                          | NA         |         |
| ## | 7763 | <NA>   | NA               | NA             | NA                          | NA         |         |
| ## |      | LATE_AIRCRAFT_DELAY                                | WEATHER_DELAY    |                | AIRLINE.y                   |            |         |
| ## | 7758 | NA   | NA               |                | Delta Air Lines Inc.        |            |         |
| ## | 7759 | NA   | NA               |                | Delta Air Lines Inc.        |            |         |
| ## | 7760 | NA   | NA               |                | Atlantic Southeast Airlines |            |         |
| ## | 7761 | NA   | NA               |                | Delta Air Lines Inc.        |            |         |
| ## | 7762 | NA   | NA               |                | Frontier Airlines Inc.      |            |         |
| ## | 7763 | NA   | NA               |                | Skywest Airlines Inc.       |            |         |
| ## |      |  |                  | AIRPORT        | CITY                        | STATE      | COUNTRY |
| ## | 7758 | Cincinnati/Northern Kentucky International Airport | Covington        |                | KY                          | USA        |         |
| ## | 7759 | Hartsfield-Jackson Atlanta International Airport   | Atlanta          |                | GA                          | USA        |         |
| ## | 7760 | Newark Liberty International Airport               | Newark           |                | NJ                          | USA        |         |
| ## | 7761 | Cincinnati/Northern Kentucky International Airport | Covington        |                | KY                          | USA        |         |
| ## | 7762 | Denver International Airport                       | Denver           |                | CO                          | USA        |         |
| ## | 7763 | Denver International Airport                       | Denver           |                | CO                          | USA        |         |
| ## |      | LATITUDE   | LONGITUDE        | TOTAL_TIME     |                             |            |         |
| ## | 7758 | 39.04614   | -84.66217        | 2              |                             |            |         |
| ## | 7759 | 33.64044   | -84.42694        | 11             |                             |            |         |
| ## | 7760 | 40.69250   | -74.16866        | 11             |                             |            |         |
| ## | 7761 | 39.04614   | -84.66217        | 21             |                             |            |         |
| ## | 7762 | 39.85841   | -104.66700       | -4             |                             |            |         |
| ## | 7763 | 39.85841   | -104.66700       | 0              |                             |            |         |

10. Extract the observations (i.e., rows) with AIRLINE of Delta and ORIGIN\_AIRPORT of Cincinnati/Northern Kentucky International Airport, and put these observations into a new data frame. Print the first and last six rows of the new data frame.

```

cvgDelta <- total_dataframe %>%
  subset(AIRLINE.y == "Delta Air Lines Inc." &
         ORIGIN_AIRPORT == "CVG")

head(cvgDelta, 6)

```

|    |   |             |         |               |                |                     |
|----|---|-------------|---------|---------------|----------------|---------------------|
| ## |   | FLIGHT_DATE | AIRLINE | FLIGHT_NUMBER | ORIGIN_AIRPORT | DESTINATION_AIRPORT |
| ## | 4 | 1/1/2015    | DL      | 2315          | CVG            | ATL                 |
| ## | 6 | 1/1/2015    | DL      | 1502          | CVG            | TPA                 |
| ## | 9 | 1/1/2015    | DL      | 2359          | CVG            | RSW                 |

|       |  |                  |                      |               |                   |
|-------|--|------------------|----------------------|---------------|-------------------|
| ## 12 | 1/1/2015   | DL               | 1741                 | CVG           | SLC               |
| ## 14 | 1/1/2015   | DL               | 1221                 | CVG           | SEA               |
| ## 18 | 1/1/2015   | DL               | 2367                 | CVG           | FLL               |
| ##    | SCHEDULED_DEPARTURE                                | DEPARTURE_TIME   | DEPARTURE_DELAY      | TAXI_OUT      | WHEELS_OFF        |
| ## 4  | 7:10:00 AM   | 7:08:00 AM       | -2                   | 36            | 7:44:00 AM        |
| ## 6  | 7:20:00 AM   | 7:19:00 AM       | -1                   | 9             | 7:28:00 AM        |
| ## 9  | 7:31:00 AM   | 7:22:00 AM       | -9                   | 27            | 7:49:00 AM        |
| ## 12 | 8:25:00 AM   | 8:20:00 AM       | -5                   | 20            | 8:40:00 AM        |
| ## 14 | 8:40:00 AM   | 8:39:00 AM       | -1                   | 10            | 8:49:00 AM        |
| ## 18 | 9:30:00 AM   | 9:27:00 AM       | -3                   | 19            | 9:46:00 AM        |
| ##    | SCHEDULED_TIME                                     | ELAPSED_TIME     | AIR_TIME             | DISTANCE      | WHEELS_ON TAXI_IN |
| ## 4  | 102  | 101              | 62                   | 373           | 8:46:00 AM 3      |
| ## 6  | 141  | 116              | 105                  | 773           | 9:13:00 AM 2      |
| ## 9  | 153  | 150              | 117                  | 879           | 9:46:00 AM 6      |
| ## 12 | 244  | 238              | 214                  | 1450          | 1:14:00 AM 4      |
| ## 14 | 306  | 289              | 270                  | 1965          | 1:19:00 AM 9      |
| ## 18 | 165  | 144              | 122                  | 932           | 1:48:00 AM 3      |
| ##    | SCHEDULED_ARRIVAL                                  | ARRIVAL_TIME     | ARRIVAL_DELAY        | DIVERTED      | CANCELLED         |
| ## 4  | 8:52:00 AM   | 8:49:00 AM       | -3                   | 0             | 0                 |
| ## 6  | 9:41:00 AM   | 9:15:00 AM       | -26                  | 0             | 0                 |
| ## 9  | 10:04:00 AM  | 9:52:00 AM       | -12                  | 0             | 0                 |
| ## 12 | 10:29:00 AM  | 10:18:00 AM      | -11                  | 0             | 0                 |
| ## 14 | 10:46:00 AM  | 10:28:00 AM      | -18                  | 0             | 0                 |
| ## 18 | 12:15:00 PM  | 11:51:00 AM      | -24                  | 0             | 0                 |
| ##    | CANCELLATION_REASON                                | AIR_SYSTEM_DELAY | SECURITY_DELAY       | AIRLINE_DELAY |                   |
| ## 4  | <NA>   | NA               | NA                   | NA            |                   |
| ## 6  | <NA>   | NA               | NA                   | NA            |                   |
| ## 9  | <NA>   | NA               | NA                   | NA            |                   |
| ## 12 | <NA>   | NA               | NA                   | NA            |                   |
| ## 14 | <NA>   | NA               | NA                   | NA            |                   |
| ## 18 | <NA>   | NA               | NA                   | NA            |                   |
| ##    | LATE_AIRCRAFT_DELAY                                | WEATHER_DELAY    | AIRLINE.y            |               |                   |
| ## 4  | NA   | NA               | Delta Air Lines Inc. |               |                   |
| ## 6  | NA   | NA               | Delta Air Lines Inc. |               |                   |
| ## 9  | NA   | NA               | Delta Air Lines Inc. |               |                   |
| ## 12 | NA   | NA               | Delta Air Lines Inc. |               |                   |
| ## 14 | NA   | NA               | Delta Air Lines Inc. |               |                   |
| ## 18 | NA   | NA               | Delta Air Lines Inc. |               |                   |
| ##    |  | AIRPORT          | CITY                 | STATE         | COUNTRY           |
| ## 4  | Cincinnati/Northern Kentucky International Airport | Covington        | KY                   | USA           |                   |
| ## 6  | Cincinnati/Northern Kentucky International Airport | Covington        | KY                   | USA           |                   |
| ## 9  | Cincinnati/Northern Kentucky International Airport | Covington        | KY                   | USA           |                   |
| ## 12 | Cincinnati/Northern Kentucky International Airport | Covington        | KY                   | USA           |                   |
| ## 14 | Cincinnati/Northern Kentucky International Airport | Covington        | KY                   | USA           |                   |
| ## 18 | Cincinnati/Northern Kentucky International Airport | Covington        | KY                   | USA           |                   |
| ##    | LATITUDE   | LONGITUDE        | TOTAL_TIME           |               |                   |
| ## 4  | 39.04614   | -84.66217        | 1                    |               |                   |
| ## 6  | 39.04614   | -84.66217        | 25                   |               |                   |
| ## 9  | 39.04614   | -84.66217        | 3                    |               |                   |
| ## 12 | 39.04614   | -84.66217        | 6                    |               |                   |
| ## 14 | 39.04614   | -84.66217        | 17                   |               |                   |
| ## 18 | 39.04614   | -84.66217        | 21                   |               |                   |

```
tail(cvgDelta, 6)
```

| ## | FLIGHT_DATE   | AIRLINE            | FLIGHT_NUMBER           | ORIGIN_AIRPORT | DESTINATION_AIRPORT |         |
|----|---|--------------------|-------------------------|----------------|---------------------|---------|
| ## | 7751  | 3/10/2015          | DL                      | 2498           | CVG                 | ATL     |
| ## | 7752  | 3/10/2015          | DL                      | 2527           | CVG                 | FLL     |
| ## | 7753  | 3/10/2015          | DL                      | 1502           | CVG                 | TPA     |
| ## | 7754  | 3/10/2015          | DL                      | 1933           | CVG                 | LAX     |
| ## | 7758  | 3/10/2015          | DL                      | 803            | CVG                 | MCO     |
| ## | 7761  | 3/10/2015          | DL                      | 1705           | CVG                 | LGA     |
| ## | SCHEDULED_DEPARTURE                                     | DEPARTURE_TIME     | DEPARTURE_DELAY         | TAXI_OUT       | WHEELS_OFF          |         |
| ## | 7751  | 9:30:00 AM         | 9:28:00 AM              | -2             | 9 9:37:00 AM        |         |
| ## | 7752  | 9:30:00 AM         | 9:33:00 AM              | 3              | 10 9:43:00 AM       |         |
| ## | 7753  | 9:30:00 AM         | 9:28:00 AM              | -2             | 13 9:41:00 AM       |         |
| ## | 7754  | 9:30:00 AM         | 9:27:00 AM              | -3             | 12 9:39:00 AM       |         |
| ## | 7758  | 9:40:00 AM         | 9:36:00 AM              | -4             | 12 9:48:00 AM       |         |
| ## | 7761  | 9:45:00 AM         | 9:45:00 AM              | 0              | 13 9:58:00 AM       |         |
| ## | SCHEDULED_TIME  | ELAPSED_TIME       | AIR_TIME                | DISTANCE       | WHEELS_ON           | TAXI_IN |
| ## | 7751  | 90                 | 80                      | 64             | 373 1:41:00 AM      | 7       |
| ## | 7752  | 151                | 145                     | 131            | 932 1:54:00 AM      | 4       |
| ## | 7753  | 125                | 127                     | 111            | 773 1:32:00 AM      | 3       |
| ## | 7754  | 305                | 278                     | 256            | 1900 1:55:00 AM     | 10      |
| ## | 7758  | 129                | 127                     | 110            | 757 1:38:00 AM      | 5       |
| ## | 7761  | 121                | 100                     | 73             | 585 1:11:00 AM      | 14      |
| ## | SCHEDULED_ARRIVAL                                       | ARRIVAL_TIME       | ARRIVAL_DELAY           | DIVERTED       | CANCELLED           |         |
| ## | 7751  | 11:00:00 AM        | 10:48:00 AM             | -12            | 0 0                 |         |
| ## | 7752  | 12:01:00 PM        | 11:58:00 AM             | -3             | 0 0                 |         |
| ## | 7753  | 11:35:00 AM        | 11:35:00 AM             | 0              | 0 0                 |         |
| ## | 7754  | 11:35:00 AM        | 11:05:00 AM             | -30            | 0 0                 |         |
| ## | 7758  | 11:49:00 AM        | 11:43:00 AM             | -6             | 0 0                 |         |
| ## | 7761  | 11:46:00 AM        | 11:25:00 AM             | -21            | 0 0                 |         |
| ## | CANCELLATION_REASON                                     | AIR_SYSTEM_DELAY   | SECURITY_DELAY          | AIRLINE_DELAY  |                     |         |
| ## | 7751  | <NA>               | NA                      | NA NA          |                     |         |
| ## | 7752  | <NA>               | NA                      | NA NA          |                     |         |
| ## | 7753  | <NA>               | NA                      | NA NA          |                     |         |
| ## | 7754  | <NA>               | NA                      | NA NA          |                     |         |
| ## | 7758  | <NA>               | NA                      | NA NA          |                     |         |
| ## | 7761  | <NA>               | NA                      | NA NA          |                     |         |
| ## | LATE_AIRCRAFT_DELAY                                     | WEATHER_DELAY      | AIRLINE.y               |                |                     |         |
| ## | 7751  | NA                 | NA Delta Air Lines Inc. |                |                     |         |
| ## | 7752  | NA                 | NA Delta Air Lines Inc. |                |                     |         |
| ## | 7753  | NA                 | NA Delta Air Lines Inc. |                |                     |         |
| ## | 7754  | NA                 | NA Delta Air Lines Inc. |                |                     |         |
| ## | 7758  | NA                 | NA Delta Air Lines Inc. |                |                     |         |
| ## | 7761  | NA                 | NA Delta Air Lines Inc. |                |                     |         |
| ## | AIRPORT   | CITY               | STATE                   | COUNTRY        |                     |         |
| ## | 7751 Cincinnati/Northern Kentucky International Airport | Covington          | KY                      | USA            |                     |         |
| ## | 7752 Cincinnati/Northern Kentucky International Airport | Covington          | KY                      | USA            |                     |         |
| ## | 7753 Cincinnati/Northern Kentucky International Airport | Covington          | KY                      | USA            |                     |         |
| ## | 7754 Cincinnati/Northern Kentucky International Airport | Covington          | KY                      | USA            |                     |         |
| ## | 7758 Cincinnati/Northern Kentucky International Airport | Covington          | KY                      | USA            |                     |         |
| ## | 7761 Cincinnati/Northern Kentucky International Airport | Covington          | KY                      | USA            |                     |         |
| ## | LATITUDE  | LONGITUDE          | TOTAL_TIME              |                |                     |         |
| ## | 7751  | 39.04614 -84.66217 | 10                      |                |                     |         |

```
## 7752 39.04614 -84.66217      6
## 7753 39.04614 -84.66217     -2
## 7754 39.04614 -84.66217     27
## 7758 39.04614 -84.66217      2
## 7761 39.04614 -84.66217     21
```

11. Extract the observations (i.e., rows) with AIRLINE of Delta, ORIGIN\_AIRPORT of Cincinnati/Northern Kentucky International Airport, and DEPARTURE\_DELAY time larger than 30 minutes, and put these observations into a new data frame. Print the first and last six rows of the new data frame.

```
cvgDeltaLongDelay <- total_dataframe %>%
  subset(AIRLINE.y == "Delta Air Lines Inc." &
         ORIGIN_AIRPORT == "CVG" &
         DEPARTURE_DELAY > 30)

head(cvgDeltaLongDelay, 6)
```

```
##      FLIGHT_DATE AIRLINE FLIGHT_NUMBER ORIGIN_AIRPORT DESTINATION_AIRPORT
## 245      1/3/2015      DL          1741          CVG          SLC
## 304      1/3/2015      DL          1833          CVG          LAX
## 374      1/4/2015      DL          1854          CVG          RSW
## 1002     1/9/2015      DL          1503          CVG          MCO
## 1020     1/9/2015      DL           63          CVG          BOS
## 1103     1/10/2015     DL          1934          CVG          ATL
##      SCHEDULED_DEPARTURE DEPARTURE_TIME DEPARTURE_DELAY TAXI_OUT  WHEELS_OFF
## 245           8:25:00 AM    11:41:00 AM           196      11 11:52:00 AM
## 304           4:46:00 PM     5:43:00 PM            57       7  5:50:00 PM
## 374           9:35:00 AM    10:20:00 AM            45      15 10:35:00 AM
## 1002          1:55:00 PM     2:39:00 PM            44      15  2:54:00 PM
## 1020          4:15:00 PM     5:32:00 PM            77       9  5:41:00 PM
## 1103          2:19:00 PM     3:58:00 PM            99       8  4:06:00 PM
##      SCHEDULED_TIME ELAPSED_TIME AIR_TIME DISTANCE  WHEELS_ON TAXI_IN
## 245           245          222      208      1450 1:20:00 AM      3
## 304           294          269      250      1900 1:00:00 AM     12
## 374           153          156      139       879 1:54:00 AM      2
## 1002           134          131      109       757 1:43:00 AM      7
## 1020           121          104       90       752 1:11:00 AM      5
## 1103           99           74       60       373 1:06:00 AM      6
##      SCHEDULED_ARRIVAL ARRIVAL_TIME ARRIVAL_DELAY DIVERTED CANCELLED
## 245          10:30:00 AM    1:23:00 PM          173       0       0
## 304           6:40:00 PM     7:12:00 PM           32       0       0
## 374          12:08:00 PM    12:56:00 PM           48       0       0
## 1002          4:09:00 PM     4:50:00 PM           41       0       0
## 1020          6:16:00 PM     7:16:00 PM           60       0       0
## 1103          3:58:00 PM     5:12:00 PM           74       0       0
##      CANCELLATION_REASON AIR_SYSTEM_DELAY SECURITY_DELAY AIRLINE_DELAY
## 245              <NA>           0           0           173
## 304              <NA>           0           0           9
## 374              <NA>          48           0           0
## 1002             <NA>           0           0          41
## 1020             <NA>           0           0           0
## 1103             <NA>           0           0          74
```

| ##      | LATE_AIRCRAFT_DELAY                                | WEATHER_DELAY | AIRLINE.y            |         |
|---------|--|---------------|----------------------|---------|
| ## 245  | 0  | 0             | Delta Air Lines Inc. |         |
| ## 304  | 23   | 0             | Delta Air Lines Inc. |         |
| ## 374  | 0  | 0             | Delta Air Lines Inc. |         |
| ## 1002 | 0  | 0             | Delta Air Lines Inc. |         |
| ## 1020 | 60   | 0             | Delta Air Lines Inc. |         |
| ## 1103 | 0  | 0             | Delta Air Lines Inc. |         |
| ##      | AIRPORT  | CITY          | STATE                | COUNTRY |
| ## 245  | Cincinnati/Northern Kentucky International Airport | Covington     | KY                   | USA     |
| ## 304  | Cincinnati/Northern Kentucky International Airport | Covington     | KY                   | USA     |
| ## 374  | Cincinnati/Northern Kentucky International Airport | Covington     | KY                   | USA     |
| ## 1002 | Cincinnati/Northern Kentucky International Airport | Covington     | KY                   | USA     |
| ## 1020 | Cincinnati/Northern Kentucky International Airport | Covington     | KY                   | USA     |
| ## 1103 | Cincinnati/Northern Kentucky International Airport | Covington     | KY                   | USA     |
| ##      | LATITUDE   | LONGITUDE     | TOTAL_TIME           |         |
| ## 245  | 39.04614   | -84.66217     | 23                   |         |
| ## 304  | 39.04614   | -84.66217     | 25                   |         |
| ## 374  | 39.04614   | -84.66217     | -3                   |         |
| ## 1002 | 39.04614   | -84.66217     | 3                    |         |
| ## 1020 | 39.04614   | -84.66217     | 17                   |         |
| ## 1103 | 39.04614   | -84.66217     | 25                   |         |

```
tail(cvgDeltaLongDelay, 6)
```

| ##      | FLIGHT_DATE         | AIRLINE          | FLIGHT_NUMBER   | ORIGIN_AIRPORT | DESTINATION_AIRPORT |         |
|---------|---------------------|------------------|-----------------|----------------|---------------------|---------|
| ## 7238 | 3/5/2015            | DL               | 1259            | CVG            | ATL                 |         |
| ## 7293 | 3/6/2015            | DL               | 2494            | CVG            | ATL                 |         |
| ## 7319 | 3/6/2015            | DL               | 1281            | CVG            | ATL                 |         |
| ## 7356 | 3/6/2015            | DL               | 1896            | CVG            | MCO                 |         |
| ## 7381 | 3/6/2015            | DL               | 2270            | CVG            | SLC                 |         |
| ## 7391 | 3/6/2015            | DL               | 2631            | CVG            | PHX                 |         |
| ##      | SCHEDULED_DEPARTURE | DEPARTURE_TIME   | DEPARTURE_DELAY | TAXI_OUT       | WHEELS_OFF          |         |
| ## 7238 | 6:21:00 PM          | 7:15:00 PM       | 54              | 19             | 7:34:00 PM          |         |
| ## 7293 | 9:30:00 AM          | 10:40:00 AM      | 70              | 11             | 10:51:00 AM         |         |
| ## 7319 | 11:45:00 AM         | 1:02:00 PM       | 77              | 13             | 1:15:00 PM          |         |
| ## 7356 | 4:15:00 PM          | 5:20:00 PM       | 65              | 14             | 5:34:00 PM          |         |
| ## 7381 | 7:18:00 PM          | 7:49:00 PM       | 31              | 7              | 7:56:00 PM          |         |
| ## 7391 | 8:15:00 PM          | 8:46:00 PM       | 31              | 13             | 8:59:00 PM          |         |
| ##      | SCHEDULED_TIME      | ELAPSED_TIME     | AIR_TIME        | DISTANCE       | WHEELS_ON           | TAXI_IN |
| ## 7238 | 99                  | 93               | 66              | 373            | 2:40:00 AM          | 8       |
| ## 7293 | 90                  | 87               | 70              | 373            | 1:01:00 AM          | 6       |
| ## 7319 | 94                  | 87               | 67              | 373            | 1:22:00 AM          | 7       |
| ## 7356 | 126                 | 133              | 111             | 757            | 1:25:00 AM          | 8       |
| ## 7381 | 232                 | 208              | 196             | 1450           | 2:12:00 AM          | 5       |
| ## 7391 | 243                 | 232              | 217             | 1569           | 2:36:00 AM          | 2       |
| ##      | SCHEDULED_ARRIVAL   | ARRIVAL_TIME     | ARRIVAL_DELAY   | DIVERTED       | CANCELLED           |         |
| ## 7238 | 8:00:00 PM          | 8:48:00 PM       | 48              | 0              | 0                   |         |
| ## 7293 | 11:00:00 AM         | 12:07:00 PM      | 67              | 0              | 0                   |         |
| ## 7319 | 1:19:00 PM          | 2:29:00 PM       | 70              | 0              | 0                   |         |
| ## 7356 | 6:21:00 PM          | 7:33:00 PM       | 72              | 0              | 0                   |         |
| ## 7381 | 9:10:00 PM          | 9:17:00 PM       | 7               | 0              | 0                   |         |
| ## 7391 | 10:18:00 PM         | 10:38:00 PM      | 20              | 0              | 0                   |         |
| ##      | CANCELLATION_REASON | AIR_SYSTEM_DELAY | SECURITY_DELAY  | AIRLINE_DELAY  |                     |         |
| ## 7238 | <NA>                | 0                | 0               | 4              |                     |         |

```
## 7293          <NA>          0          0          3
## 7319          <NA>          0          0          5
## 7356          <NA>          7          0          0
## 7381          <NA>         NA         NA         NA
## 7391          <NA>          0          0          9
##      LATE_AIRCRAFT_DELAY WEATHER_DELAY      AIRLINE.y
## 7238          44          0 Delta Air Lines Inc.
## 7293          64          0 Delta Air Lines Inc.
## 7319          65          0 Delta Air Lines Inc.
## 7356          65          0 Delta Air Lines Inc.
## 7381          NA         NA Delta Air Lines Inc.
## 7391          11          0 Delta Air Lines Inc.
##      AIRPORT      CITY STATE COUNTRY
## 7238 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 7293 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 7319 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 7356 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 7381 Cincinnati/Northern Kentucky International Airport Covington KY USA
## 7391 Cincinnati/Northern Kentucky International Airport Covington KY USA
##      LATITUDE LONGITUDE TOTAL_TIME
## 7238 39.04614 -84.66217          6
## 7293 39.04614 -84.66217          3
## 7319 39.04614 -84.66217          7
## 7356 39.04614 -84.66217         -7
## 7381 39.04614 -84.66217         24
## 7391 39.04614 -84.66217         11
```

12. Use `group_by()` and `summarize()` to compute the average delay time for different airlines.

```
total_dataframe %>%
  group_by(AIRLINE) %>%
  summarise(mean = mean(DEPARTURE_DELAY, na.rm = T))
```

```
## # A tibble: 5 x 2
##   AIRLINE mean
## * <chr>   <dbl>
## 1 DL      6.09
## 2 EV     10.4
## 3 F9     23.9
## 4 MQ     19.1
## 5 00     11.1
```

13. Use `group_by()` and `summarize()` to compute the average delay time for different `ORIGIN_AIRPORT`.

```
total_dataframe %>%
  group_by(ORIGIN_AIRPORT) %>%
  summarise(mean = mean(DEPARTURE_DELAY, na.rm = T))
```

```
## # A tibble: 38 x 2
##   ORIGIN_AIRPORT mean
## * <chr>         <dbl>
## 1 ATL           7.12
```

```
## 2 BDL          -4
## 3 BNA          13.3
## 4 BOS          21.1
## 5 CLT          10.0
## 6 CVG          11.6
## 7 DEN          15.1
## 8 DFW          16.9
## 9 DTW          21.3
## 10 EWR          7.29
## # ... with 28 more rows
```