

Data Transformation I

#### Introduction



- Read Chapter 3 (R4DS)
- Look at Chapter 3 (R4DS2)
- Goal: Their Data Your Data
- Covers:
  - Data Subsetting
  - Data Ordering
  - Variable Selecting
  - Variable Creating
- Help: dplyr Package in R

## NYC Flights Meta Data



- Requirements:
  - > install.packages(nycflights13)
  - > library(nycflights13)
- All 2013 Flights from NYC
  - US Bureau of Trans. Statistics
- To View all Data, Use > View(flights)
  - For more information, > ?flights

#### NYC Flights Meta Data



# Preview Data: > flights

```
> flights
# A tibble: 336.776 x 19
                 day dep_time sched_dep_time dep_delay arr_time sched_arr_time
    year month
                          <int>
                                                              <int>
                           517
                                           515
                                                               830
                                                                               819
    2013
    2013
                           533
                                           529
                                                                850
                                                                                830
    2013
                                           540
                                                               923
                                                                               850
    2013
                                           545
                                                              1004
                                                                              1022
    2013
                                           600
                                                               812
                                                                               837
    2013
                                           558
                                                               740
                                                                               728
                                                               913
    2013
                                           600
                                                                               854
    2013
                           557
                                           600
                                                                709
                                                                                723
    2013
                                           600
                                                               838
                                                                                846
                           558
                                                                               745
    2013
                                           600
                                                               753
  ... with 336,766 more rows, and 11 more variables: arr_delay <dbl>,
    carrier <chr>, flight <int>, tailnum <chr>, origin <chr>, dest <chr>,
    air_time <db7>, distance <db7>, hour <db7>, minute <db7>, time_hour <dttm>
```

- Four Different Types of Variables
  - int = integer
  - dbl = double
  - chr = character
  - dttm = date and times
- Other Types of Variables
  - Igl = logical (TRUE or FALSE)
  - fctr = factor
  - date = dates

### Basics of dplyr



- 5 Key Functions
  - filter() = Chooses Observations
     Based on Values
  - arrange() = Sorts Observations
  - select() = Chooses Variables
  - mutate() = Creates New Variables
  - summarize() = Generates
     Statistics From Data

#### Basics of dplyr



- Function Usage
  - First, Specify the Dataset
  - Next, Specify What to Do with the Data
  - Result is a New Dataset
- Powerful When Used With group\_by() Function

#### Comparisons



# Important Operators

- Less Than (<)</li>
- Greater Than (>)
- Not Equal (!=)
- Equal (==)

#### Returns TRUE or FALSE

#### Comparisons



#### Numerical Precision

#### Problem

```
> x=1/49
> y=49
> x*y==1
[1] FALSE
> near(x*y,1)
[1] TRUE
```

#### Solution

```
> x*y
[1] 1
> near(x*y,1)
[1] TRUE
```

# Logical Operators



# Boolean Logic

- And (&)
- Or (|)
- Not (!)

# Example

```
> X=T
> y=F
> #Basic
> x&y
[1] FALSE
> x | y
[1] TRUE
> !x
[1] FALSE
> #Combined
> |x|!y
[1] TRUE
> !(x&y)
[1] TRUE
> !x&!y
[1] FALSE
```

### Missing Values



- Represented by NA
  - Enduring Questions
    - To Impute or Not Impute
    - To Ignore or Not Ignore
  - Handling Should Be Explained
  - Be Careful When Performing Operations on Missing Data

#### Missing Values



```
> male.age=c(NA,20,21,35,22,NA)
> female.age=c(21,NA,23,33,22,NA)
  age.data=tibble(ma=male.age,fa=female.age)
  age.data
 A tibble: 6 x 2
           fa
     ma
  <db1> <db1>
     NA
           21
     20
           NA
           23
     21
     35
       33
     22
           22
     NA
           NA
> is.na(male.age)
    TRUE FALSE FALSE FALSE
> na.omit(age.data)
# A tibble: 3 x 2
           fa
     ma
  <db1> <db1>
     21 23
     35 33
     22
          22
> mean(male.age)
[1] NA
> mean(male.age,na.rm=T)
[1] 24.5
```

filter()



- Used to Subset Observations Based on Their Values
  - Selects Row if TRUE
  - Removes Row if FALSE
- Examples:
  - All Flights from 9/13/2013 Out of LaGuardia Airport
- > filter(flights,month==9,day==13,origin =="LGA")
  - All Dec. or Nov. Flights
  - > filter(flights,month==11|month==12)
  - > filter(flights,month %in% c(11,12))

filter()



# Examples:

- Don't Want Flights with Unusual Delays (> 120 min.)
- > filter(flights, !(arr\_delay>120 | dep\_delay>120) )
- > filter(flights, arr\_delay <= 120, dep\_delay <= 120)</pre>
  - Want Flights with No Delays
- > filter(flights, dep\_delay==0, arr\_delay==0)
- > filter(flights, dep\_delay==0 & arr\_delay==0)

filter()



- Examples:
  - Want Flights Missing Air Time
    - > filter(flights, is.na(air\_time) )

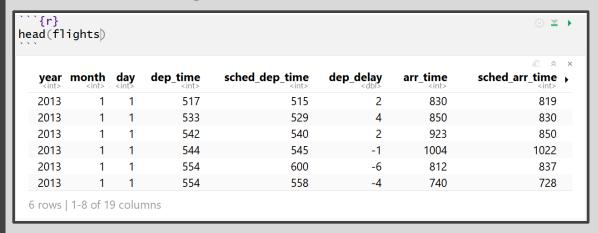
- Do not Want Flights Missing Air Time
  - > filter(flights, !is.na(air\_time) )

- Remove All Cases with Missing Values
  - > na.omit(flights)

arrange()



- Used to Sort Observations
- Raw Flight Data

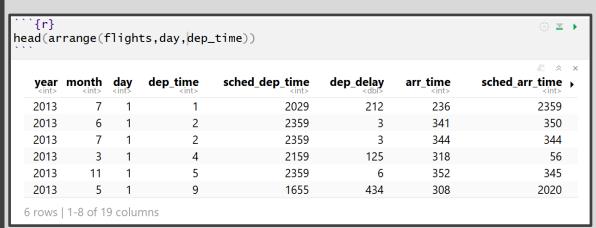


 Sorted by year, month, and day, in that order

# arrange()



# Sorting Experiment

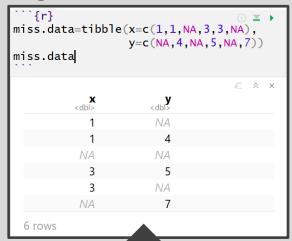


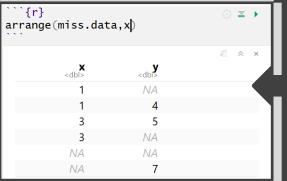
| `{r}<br>ad(arrange(flights,desc(day) ,dep_time))<br>` |                      |                    |                         |                |                          |          |                |
|---|----------------------|--------------------|-------------------------|----------------|--------------------------|----------|----------------|
| year<br><int></int>                                   | month<br><int></int> | day<br><int></int> | dep_time<br><int></int> | sched_dep_time | dep_delay<br><dbl></dbl> | arr_time | sched_arr_time |
| 2013  | 1                    | 31                 | 1                       | 2100           | 181                      | 124      | 2225           |
| 2013  | 1                    | 31                 | 4                       | 2359           | 5                        | 455      | 444            |
| 2013  | 1                    | 31                 | 7                       | 2359           | 8                        | 453      | 437            |
| 2013  | 7                    | 31                 | 10                      | 2359           | 11                       | 344      | 340            |
| 2013  | 1                    | 31                 | 12                      | 2250           | 82                       | 132      | 7              |
| 2013  | 12                   | 31                 | 13                      | 2359           | 14                       | 439      | 437            |

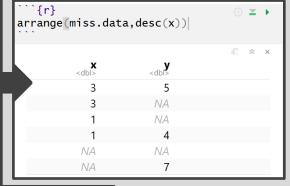
arrange()



# Handling NA







```
> order(miss.data$x)
[1] 1 2 4 5 3 6
> order(desc(miss.data$x))
[1] 4 5 1 2 3 6
> is.na(miss.data$x)
[1] FALSE FALSE TRUE FALSE FALSE
[6] TRUE
> order(is.na(miss.data$x))
[1] 1 2 4 5 3 6
> order(is.na(miss.data$x),
+ decreasing=T)
[1] 3 6 1 2 4 5
```



- Used to Select Variables
- Why? Not All Variables are Created Equal
- Need to Know Variable Names

```
> names(flights)
                       "month"
                                         "day"
     "year"
                       "sched_dep_time" "dep_delay"
     "dep_time"
                       "sched_arr_time" "arr_delay"
     "arr_time"
                                         "tailnum"
[10]
     "carrier"
                       "flight"
     "origin"
                       "dest"
                                         "air_time"
[13]
     "distance"
                       "hour"
                                         "minute"
[16]
    "time_hour"
```



- Basic Examples
  - Select Only Year, Month, Day

```
> data1=select(flights,year,month,day)
> names(data1)
[1] "year" "month" "day"
```

 Select All Variables Between dep\_time to arr\_delay

Deselect All Previous Variables



#### Select Based on Column Index

```
> length(names(flights))
[1] 19
> data4=select(flights,c(1,3,8,12))
> names(data4)
[1] "year"
[2] "day"
[3] "sched_arr_time"
[4] "tailnum"
```

#### Deselect Based on Column Index

```
> length(names(flights))
Γ1 19
> data5=select(flights,-c(1,3,8,12))
> names(data5)
 [1] "month"
 [2] "dep_time"
    "sched_dep_time"
     "dep_delay"
    "arr_time"
     "arr_delay"
     "carrier"
     "flight"
 [8]
 [9]
     "origin"
[10]
     "dest"
     "air_time"
[11]
     "distance"
Γ127
     "hour"
[13]
     "minute"
[14]
[15]
     "time_hour"
```



- Select Based on Text
  - starts\_with("TEXT")

```
> data6=select(flights,starts_with("dep"))
> names(data6)
[1] "dep_time" "dep_delay"
```

ends\_with("TEXT")

```
> data7=select(flights,ends_with("delay"))
> names(data7)
[1] "dep_delay" "arr_delay"
```

contains("TEXT")

```
> data8=select(flights,contains("ar"))
> names(data8)
[1] "year" "arr_time"
[3] "sched_arr_time" "arr_delay"
[5] "carrier"
```

Etc. AKA Others Exist



# Renaming Variables

- Can Use select()
- > data9=select(flights,yr=year)
  > names(data9)
  [1] "yr"
  - But Use rename()

```
> data10=rename(flights,yr=year)
> names(data10)
 [1] "yr"
                       "month"
     "day"
                       "dep_time"
     "sched_dep_time" "dep_delay"
     "arr_time"
                       "sched_arr_time"
     "arr_delay"
                       "carrier"
     "flight"
                       "tailnum"
     "origin"
                       "dest"
     "air_time"
                       "distance"
     "hour"
                       "minute"
Γ197
     "time_hour"
```



## Reordering Variables

```
> head(flights)
# A tibble: 6 x 19
   year month
                day dep_time sched_dep_time
  <int> <int> <int>
                        <int>
                                       <int>
   2013
            1
                          517
                                         515
   2013
                          533
                                         529
   2013
                          542
                                         540
   2013
                  1
                                         545
                          544
   2013
                          554
                                         600
   2013
                          554
                                         558
  ... with 14 more variables: dep_delay <db1>,
    arr_time <int>, sched_arr_time <int>,
  arr_delay <dbl>, carrier <chr>,
  flight <int>, tailnum <chr>, origin <chr>,
    dest <chr>, air_time <db1>, distance <db1>,
    hour <db1>, minute <db1>, time_hour <dttm>
> data11=select(flights,dep_time,arr_time,
                air_time.everything())
> head(data11)
# A tibble: 6 x 19
  dep_time arr_time air_time year month
                        <db1> <int> <int> <int>
     <int>
              <int>
       517
                830
                          227 2013
                                        1
       533
                850
                          227 2013
       542
                923
                          160 2013
       544
               1004
                          183 2013
       554
                812
                          116 2013
                                              1
       554
                740
                          150 2013
  ... with 13 more variables:
    sched_dep_time <int>, dep_delay <dbl>,
    sched_arr_time <int>, arr_delay <dbl>,
    carrier <chr>, flight <int>, tailnum <chr>,
    origin <chr>, dest <chr>, distance <db1>,
    hour <db1>, minute <db1>, time_hour <dttm>
```

Closing



# Disperse and Make Reasonable Decisions