Data Transformation III

Data Transformation III Info

- Finish Reading Chapter 3 and Practice the Code in R4DS
- Covers
  - The Pipe
  - Statistical Summaries
  - Grouped Summaries
  - Helpful Functions
- Builds Off Tutorial 3

The Pipe

- Useful for Combining Multiple Steps of Operations
- Represented by %>%
- Reads as “Then”
- Works Like a Composite Function From Algebra

$$f(x) = 3x + 4$$
$$g(x) = 2x$$
$$h = 1$$

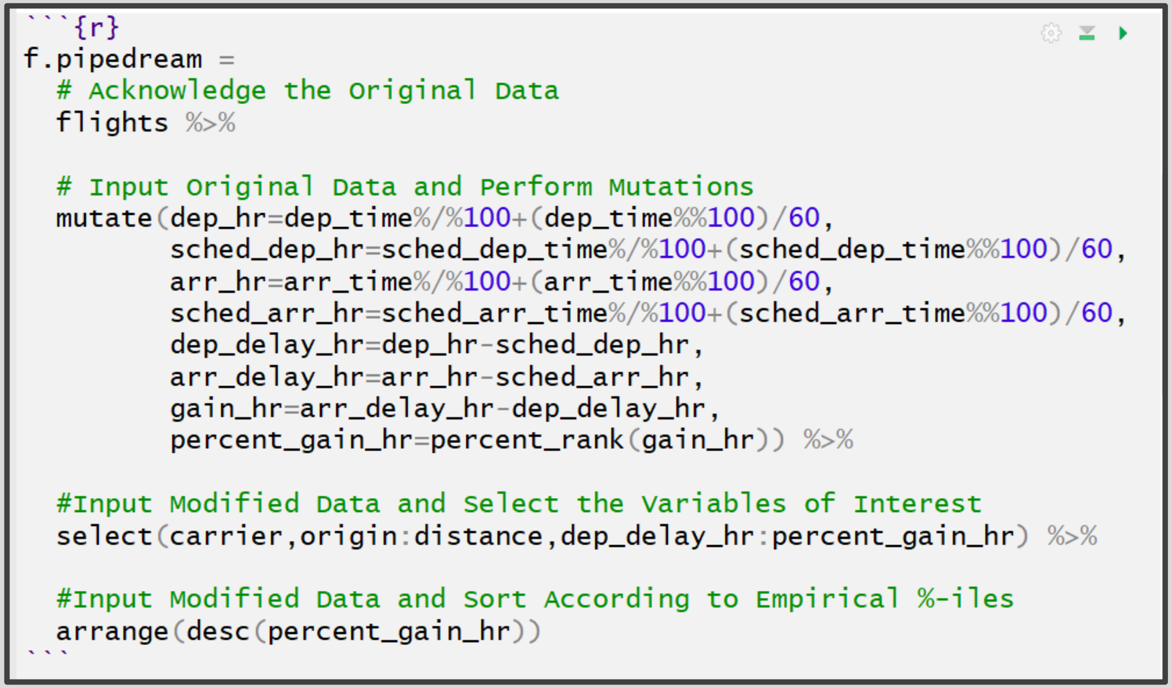
$$f\big(g(h)\big) = 3\big(2(1)\big) + 4 = 10$$

→

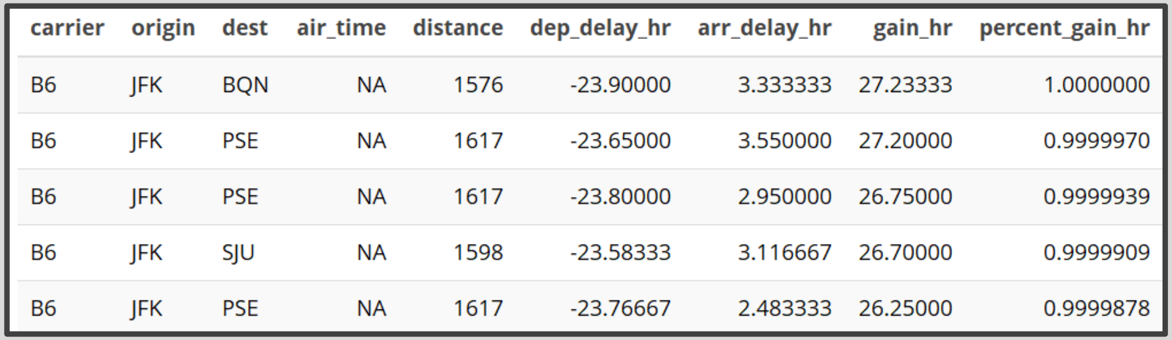
```
OUT = h %>%
          g() %>%
             f()

OUT = 10
```

The Pipe

- Chaining with the Pipe



~~~
```{r}
f.pipedream =
  # Acknowledge the Original Data
  flights %>%

  # Input Original Data and Perform Mutations
  mutate(dep_hr=dep_time%/%100+(dep_time%%100)/60,
         sched_dep_hr=sched_dep_time%/%100+(sched_dep_time%%100)/60,
         arr_hr=arr_time%/%100+(arr_time%%100)/60,
         sched_arr_hr=sched_arr_time%/%100+(sched_arr_time%%100)/60,
         dep_delay_hr=dep_hr-sched_dep_hr,
         arr_delay_hr=arr_hr-sched_arr_hr,
         gain_hr=arr_delay_hr-dep_delay_hr,
         percent_gain_hr=percent_rank(gain_hr)) %>%

  #Input Modified Data and Select the Variables of Interest
  select(carrier,origin:distance,dep_delay_hr:percent_gain_hr) %>%

  #Input Modified Data and Sort According to Empirical %-iles
  arrange(desc(percent_gain_hr))
```
~~~

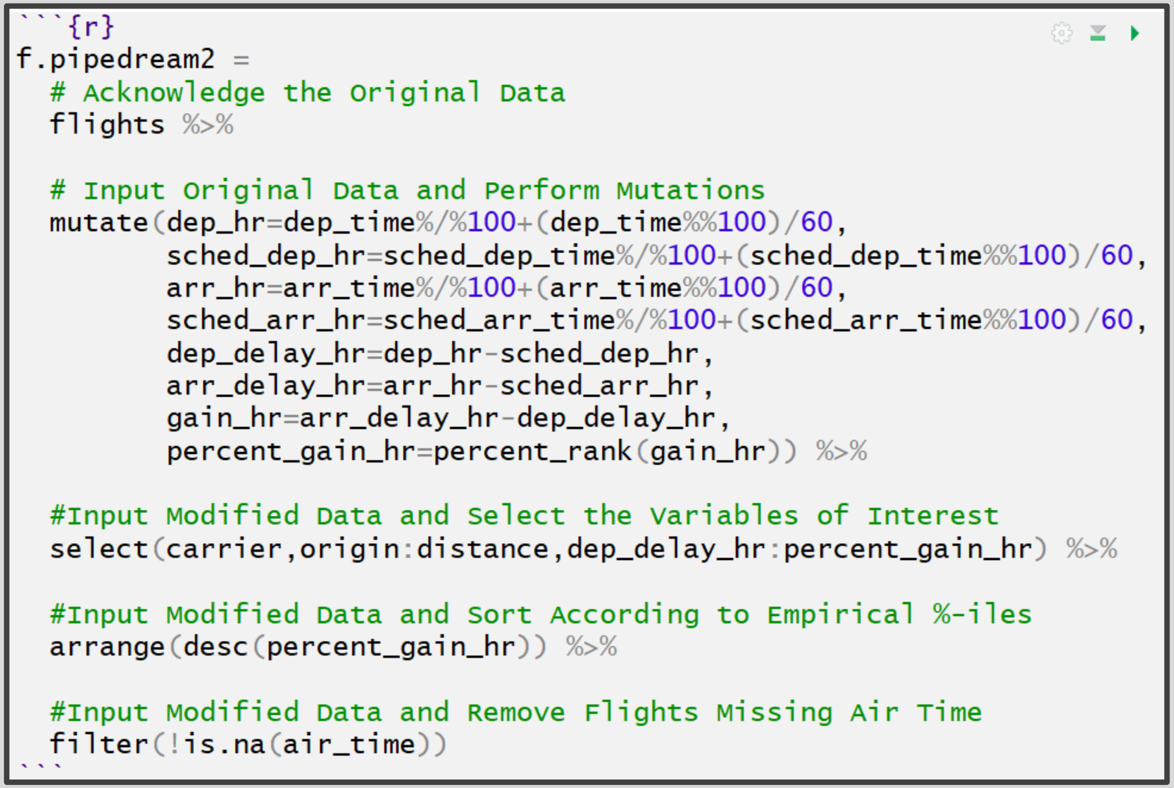


carrier	origin	dest	air_time	distance	dep_delay_hr	arr_delay_hr	gain_hr	percent_gain_hr
B6	JFK	BQN	NA	1576	-23.90000	3.333333	27.23333	1.0000000
B6	JFK	PSE	NA	1617	-23.65000	3.550000	27.20000	0.9999970
B6	JFK	PSE	NA	1617	-23.80000	2.950000	26.75000	0.9999939
B6	JFK	SJU	NA	1598	-23.58333	3.116667	26.70000	0.9999909
B6	JFK	PSE	NA	1617	-23.76667	2.483333	26.25000	0.9999878

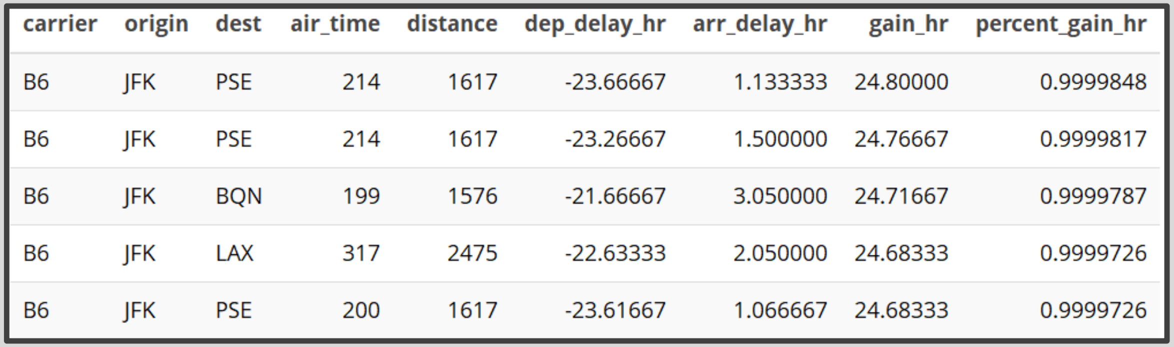
HTML Table: knitr and kableExtra

The Pipe

- Chaining with the Pipe



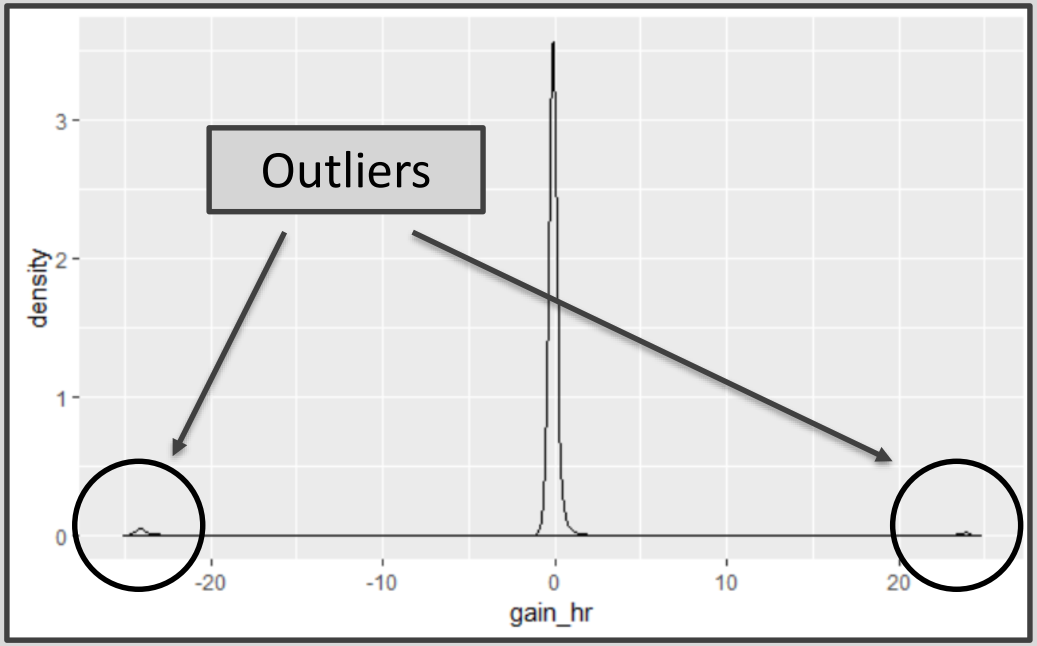
~~~
```{r}
f.pipedream2 =
  # Acknowledge the Original Data
  flights %>%

  # Input Original Data and Perform Mutations
  mutate(dep_hr=dep_time%/%100+(dep_time%%100)/60,
         sched_dep_hr=sched_dep_time%/%100+(sched_dep_time%%100)/60,
         arr_hr=arr_time%/%100+(arr_time%%100)/60,
         sched_arr_hr=sched_arr_time%/%100+(sched_arr_time%%100)/60,
         dep_delay_hr=dep_hr-sched_dep_hr,
         arr_delay_hr=arr_hr-sched_arr_hr,
         gain_hr=arr_delay_hr-dep_delay_hr,
         percent_gain_hr=percent_rank(gain_hr)) %>%

  #Input Modified Data and Select the Variables of Interest
  select(carrier,origin:distance,dep_delay_hr:percent_gain_hr) %>%

  #Input Modified Data and Sort According to Empirical %-iles
  arrange(desc(percent_gain_hr)) %>%

  #Input Modified Data and Remove Flights Missing Air Time
  filter(!is.na(air_time))
```
~~~



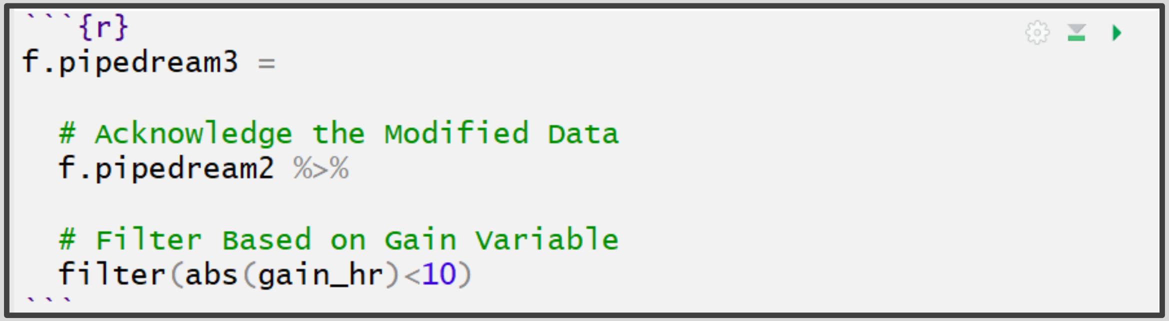
carrier	origin	dest	air_time	distance	dep_delay_hr	arr_delay_hr	gain_hr	percent_gain_hr
B6	JFK	PSE	214	1617	-23.66667	1.133333	24.80000	0.9999848
B6	JFK	PSE	214	1617	-23.26667	1.500000	24.76667	0.9999817
B6	JFK	BQN	199	1576	-21.66667	3.050000	24.71667	0.9999787
B6	JFK	LAX	317	2475	-22.63333	2.050000	24.68333	0.9999726
B6	JFK	PSE	200	1617	-23.61667	1.066667	24.68333	0.9999726

The Pipe

- Chaining with the Pipe



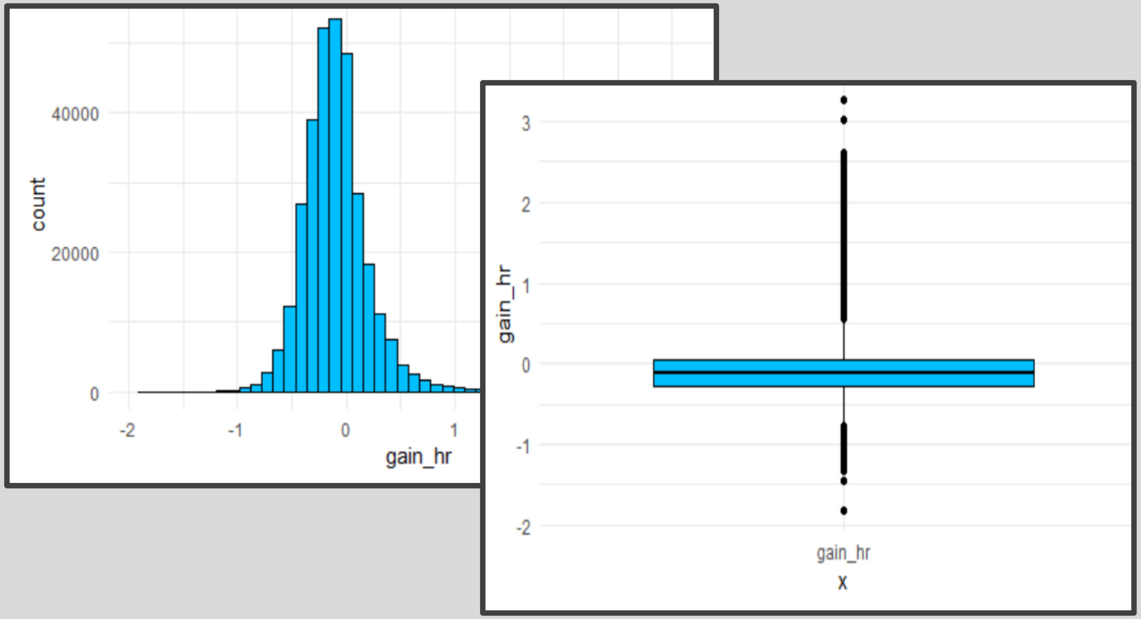
Outliers



~~~
```{r}
f.pipedream3 =

  # Acknowledge the Modified Data
  f.pipedream2 %>%

  # Filter Based on Gain Variable
  filter(abs(gain_hr)<10)
```
~~~

summarize()

- Summarizing All Data
  - Using Graphics

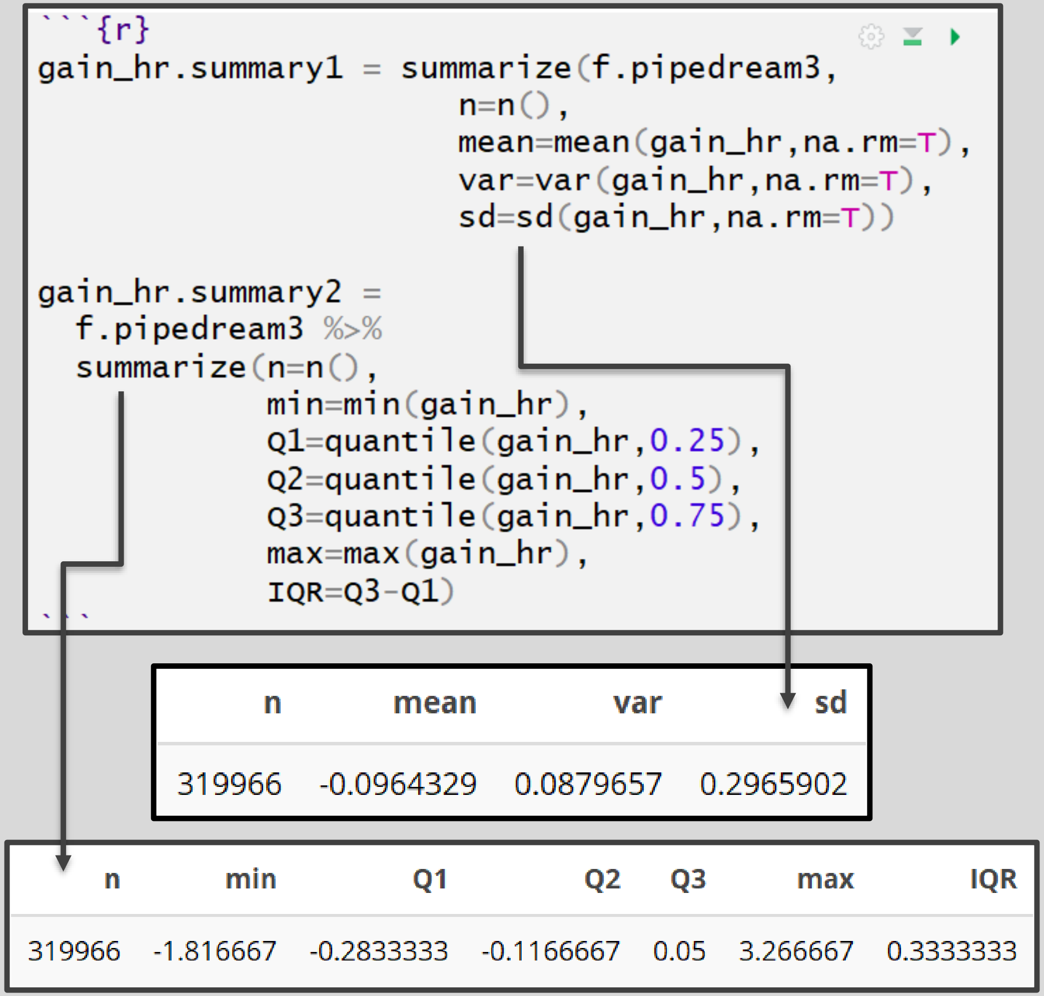


Both the histogram and the boxplot are made from summary statistics.

(**Statistical Transformations** in Ch. 3)

summarize()

- Summarizing All Data
  - Using Tables



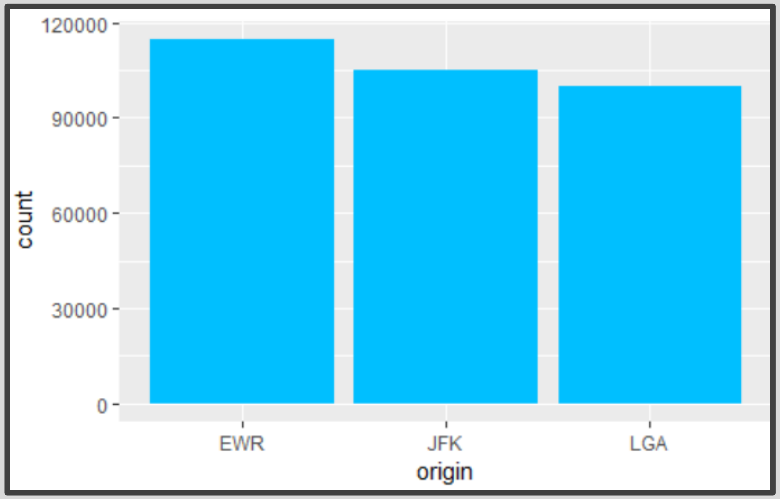
~~~
```{r}
gain_hr.summary1 = summarize(f.pipedream3,
                      n=n(),
                      mean=mean(gain_hr,na.rm=T),
                      var=var(gain_hr,na.rm=T),
                      sd=sd(gain_hr,na.rm=T))

gain_hr.summary2 =
  f.pipedream3 %>%
  summarize(n=n(),
            min=min(gain_hr),
            Q1=quantile(gain_hr,0.25),
            Q2=quantile(gain_hr,0.5),
            Q3=quantile(gain_hr,0.75),
            max=max(gain_hr),
            IQR=Q3-Q1)
```
~~~

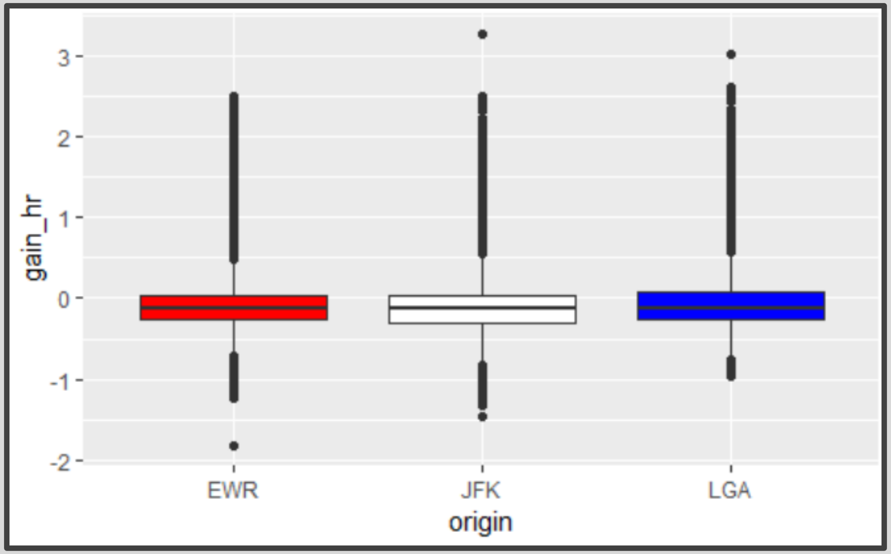
n	mean	var	sd
319966	-0.0964329	0.0879657	0.2965902

n	min	Q1	Q2	Q3	max	IQR
319966	-1.816667	-0.2833333	-0.1166667	0.05	3.266667	0.3333333

summarize()
with
group_by()

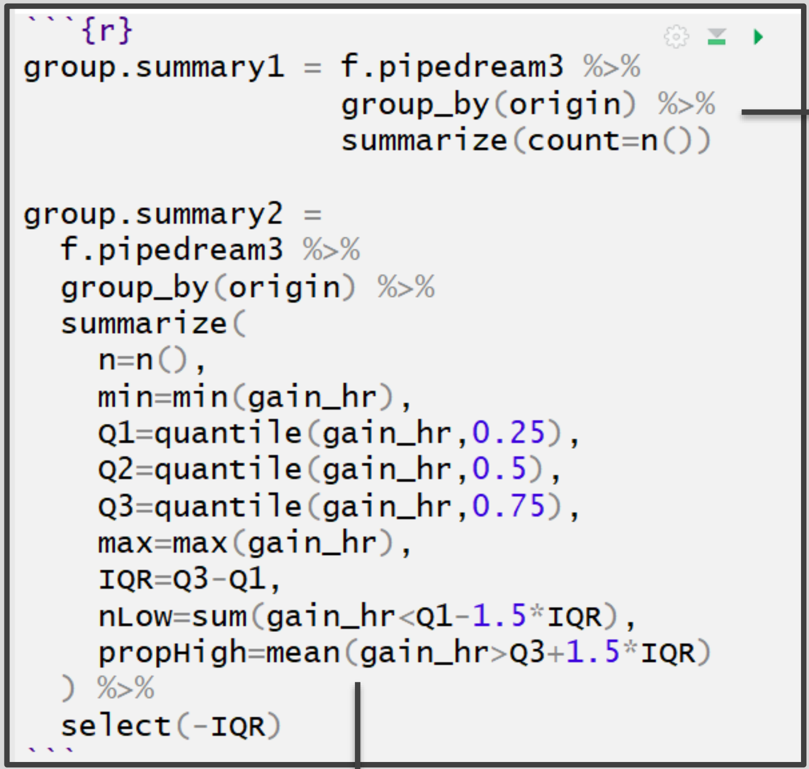
- Summarizing Data by Groups
  - Using Graphics



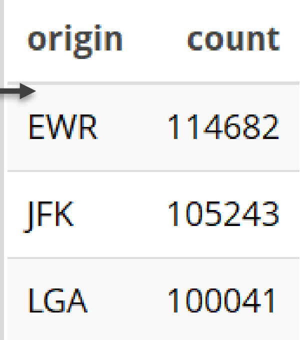


summarize() with group_by()

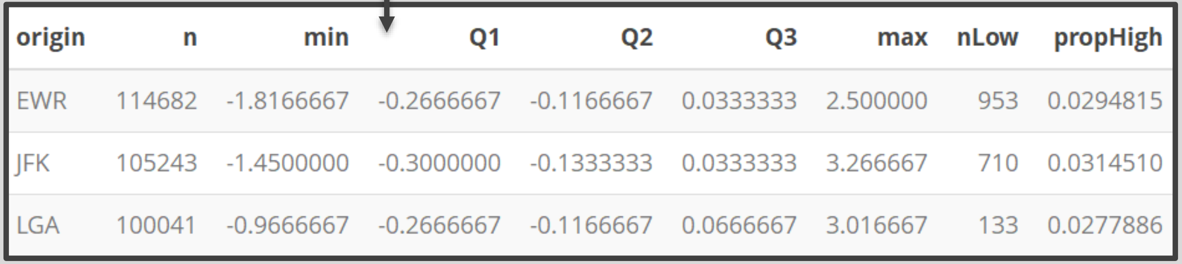
- Summarizing Data by Groups
  - Using Tables



```{r}
group.summary1 = f.pipedream3 %>%
                 group_by(origin) %>%
                 summarize(count=n())

group.summary2 =
  f.pipedream3 %>%
  group_by(origin) %>%
  summarize(
    n=n(),
    min=min(gain_hr),
    Q1=quantile(gain_hr,0.25),
    Q2=quantile(gain_hr,0.5),
    Q3=quantile(gain_hr,0.75),
    max=max(gain_hr),
    IQR=Q3-Q1,
    nLow=sum(gain_hr<Q1-1.5*IQR),
    propHigh=mean(gain_hr>Q3+1.5*IQR)
  ) %>%
  select(-IQR)
```



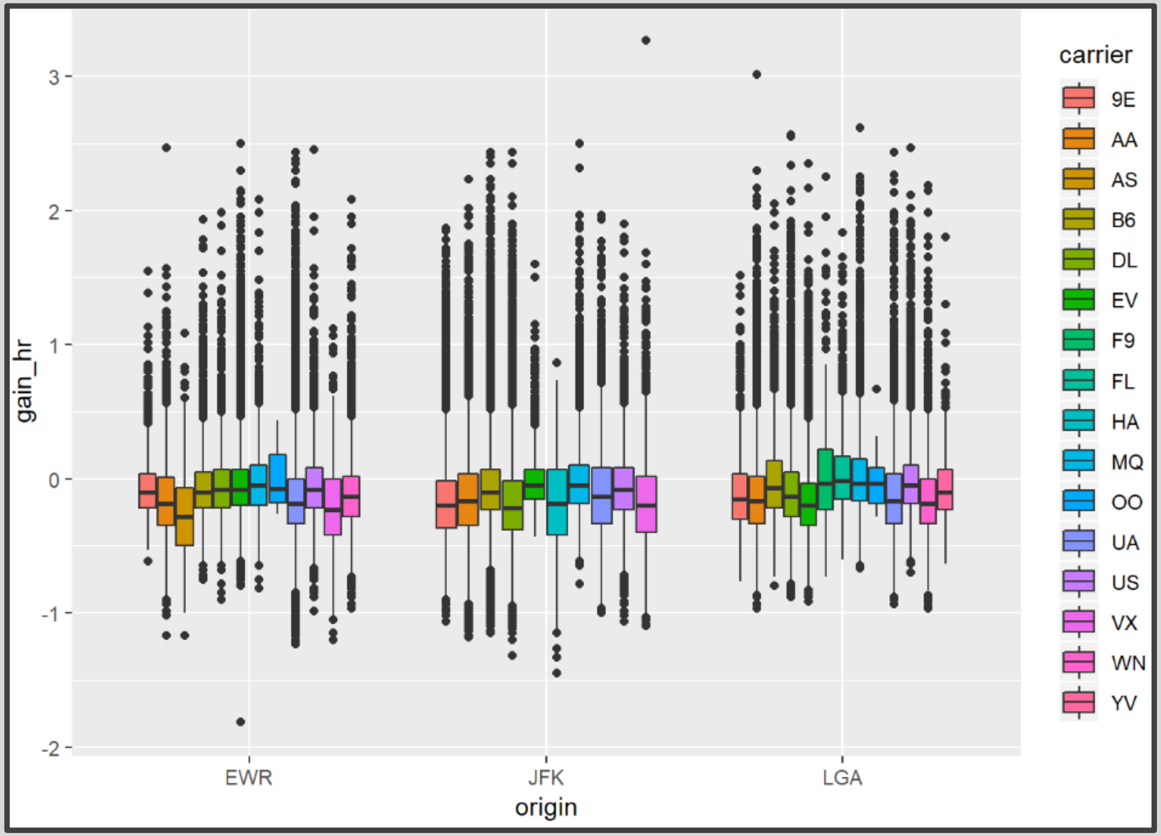
origin	count
EWR	114682
JFK	105243
LGA	100041



origin	n	min	Q1	Q2	Q3	max	nLow	propHigh
EWR	114682	-1.8166667	-0.2666667	-0.1166667	0.0333333	2.500000	953	0.0294815
JFK	105243	-1.4500000	-0.3000000	-0.1333333	0.0333333	3.266667	710	0.0314510
LGA	100041	-0.9666667	-0.2666667	-0.1166667	0.0666667	3.016667	133	0.0277886

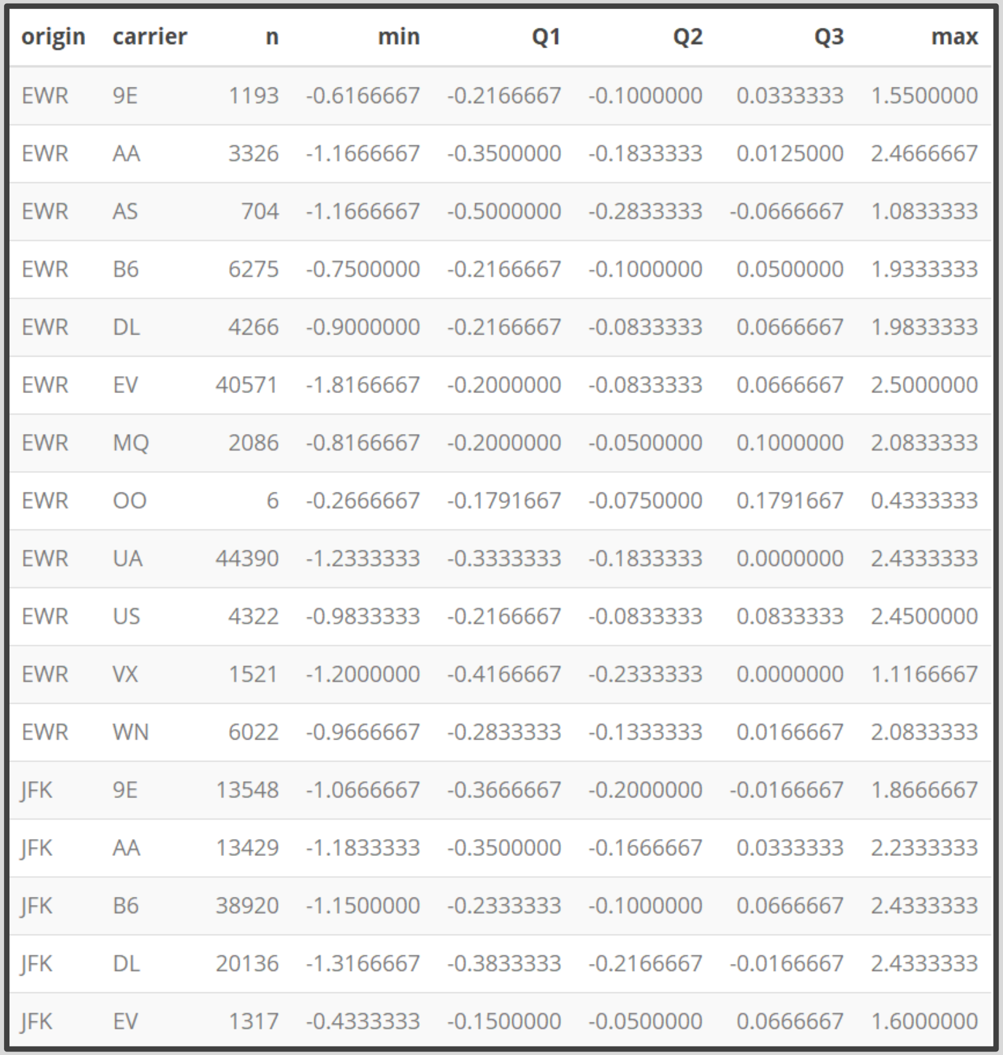
summarize() with group_by()

- Multiple Groups
  - Using Graphics



summarize() with group_by()

- Multiple Groups
  - Using Tables



origin	carrier	n	min	Q1	Q2	Q3	max
EWR	9E	1193	-0.6166667	-0.2166667	-0.1000000	0.0333333	1.5500000
EWR	AA	3326	-1.1666667	-0.3500000	-0.1833333	0.0125000	2.4666667
EWR	AS	704	-1.1666667	-0.5000000	-0.2833333	-0.0666667	1.0833333
EWR	B6	6275	-0.7500000	-0.2166667	-0.1000000	0.0500000	1.9333333
EWR	DL	4266	-0.9000000	-0.2166667	-0.0833333	0.0666667	1.9833333
EWR	EV	40571	-1.8166667	-0.2000000	-0.0833333	0.0666667	2.5000000
EWR	MQ	2086	-0.8166667	-0.2000000	-0.0500000	0.1000000	2.0833333
EWR	OO	6	-0.2666667	-0.1791667	-0.0750000	0.1791667	0.4333333
EWR	UA	44390	-1.2333333	-0.3333333	-0.1833333	0.0000000	2.4333333
EWR	US	4322	-0.9833333	-0.2166667	-0.0833333	0.0833333	2.4500000
EWR	VX	1521	-1.2000000	-0.4166667	-0.2333333	0.0000000	1.1166667
EWR	WN	6022	-0.9666667	-0.2833333	-0.1333333	0.0166667	2.0833333
JFK	9E	13548	-1.0666667	-0.3666667	-0.2000000	-0.0166667	1.8666667
JFK	AA	13429	-1.1833333	-0.3500000	-0.1666667	0.0333333	2.2333333
JFK	B6	38920	-1.1500000	-0.2333333	-0.1000000	0.0666667	2.4333333
JFK	DL	20136	-1.3166667	-0.3833333	-0.2166667	-0.0166667	2.4333333
JFK	EV	1317	-0.4333333	-0.1500000	-0.0500000	0.0666667	1.6000000

Useful Summary Functions

- Measures of Center
  - mean()
  - median()
  - mode()

- Measures of Spread
  - var()
  - sd()
  - IQR()
  - mad()

- Measures of Rank
  - min()
  - max()
  - quantile()

Useful Summary Functions

- Measures of Position
  - Order Matters
  - first() = x[1]
  - last() = x[length(x)]
  - nth(,k) = x[k]

- Counts
  - n()
  - n_distinct()

- Counts/Proportions for Logical
  - sum()
  - mean()
  - Example
    - sum(x>10)
    - mean(x>10)

Case Study

- Flight Accuracy
  - Accurate Flight Means
    - Departure Delay = 0
    - Arrival Delay = 0
  - Bad Metric

$$Accuracy = delay_{dep} + delay_{arr}$$
$$Accuracy = (delay_{dep} + delay_{arr})/2$$

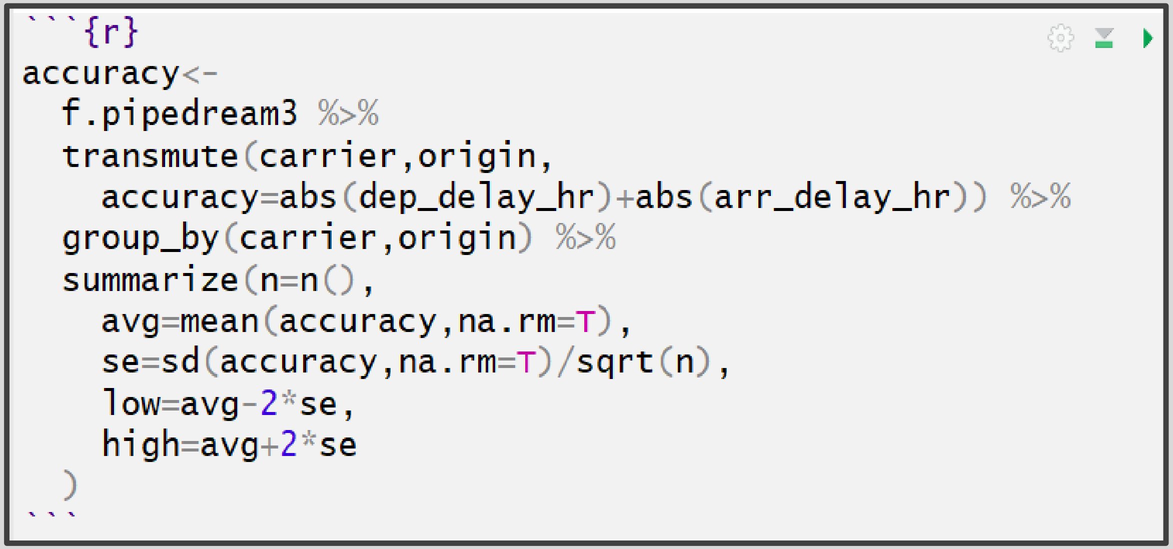
  - Good Metrics

$$Accuracy = |delay_{dep}| + |delay_{arr}|$$
$$Accuracy = \sqrt{delay_{dep}^2 + delay_{arr}^2}$$

  - Table First, Graphics Second

Case Study

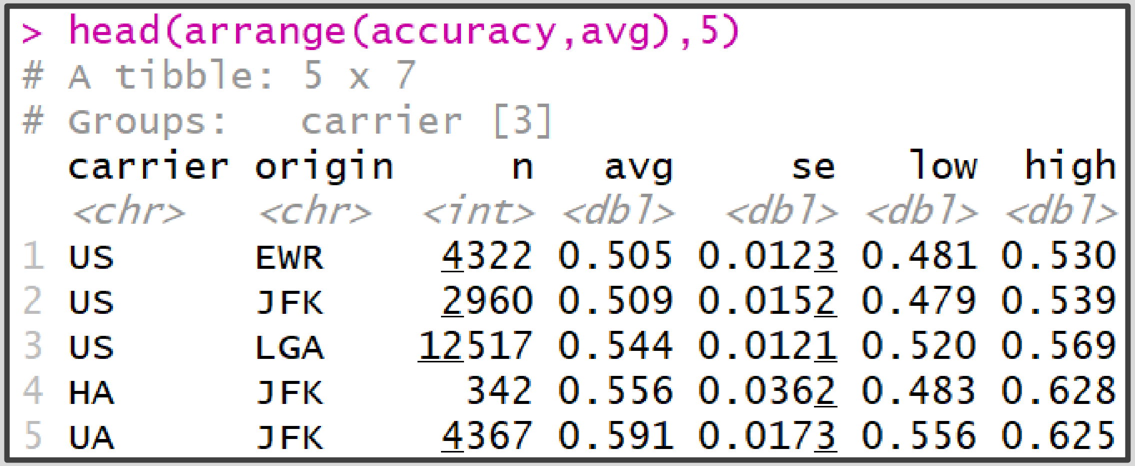
- Summary Table
  - Step 1: Accuracy Variable
  - Step 2: Grouping
  - Step 3: Summarize Info
    - Mean
    - Standard Error
    - Lower Bound (95% CI)
    - Upper Bound (95% CI)



~~~
```{r}
accuracy<-
  f.pipedream3 %>%
  transmute(carrier,origin,
    accuracy=abs(dep_delay_hr)+abs(arr_delay_hr)) %>%
  group_by(carrier,origin) %>%
  summarize(n=n(),
    avg=mean(accuracy,na.rm=T),
    se=sd(accuracy,na.rm=T)/sqrt(n),
    low=avg-2*se,
    high=avg+2*se
  )
```
~~~

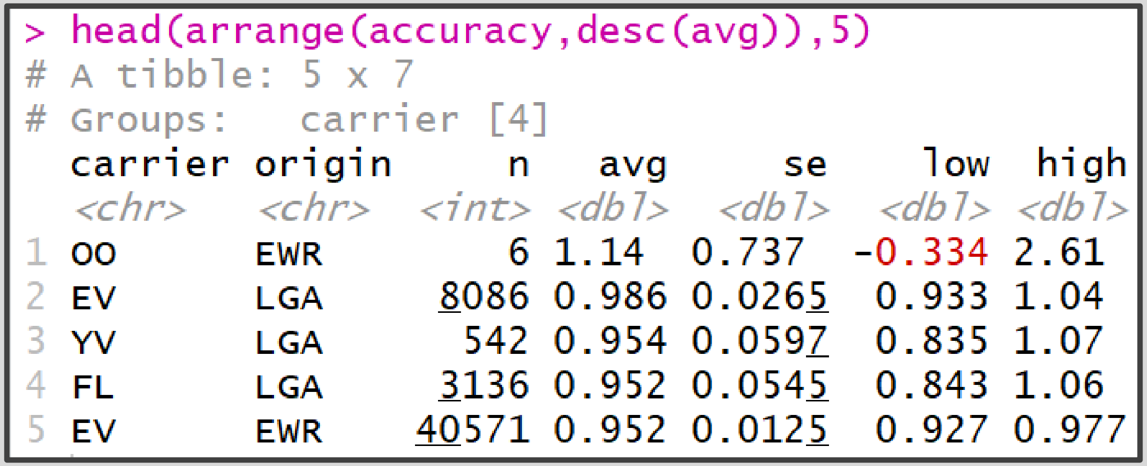
Case Study

- Sorted by Average Accuracy
  - Best Carriers/Origin



```
> head(arrange(accuracy,avg),5)
# A tibble: 5 x 7
# Groups:   carrier [3]
  carrier origin     n   avg     se   low  high
  <chr>   <chr>  <int> <dbl>  <dbl> <dbl> <dbl>
1 US      EWR     4322 0.505 0.0123 0.481 0.530
2 US      JFK     2960 0.509 0.0152 0.479 0.539
3 US      LGA    12517 0.544 0.0121 0.520 0.569
4 HA      JFK      342 0.556 0.0362 0.483 0.628
5 UA      JFK     4367 0.591 0.0173 0.556 0.625
```

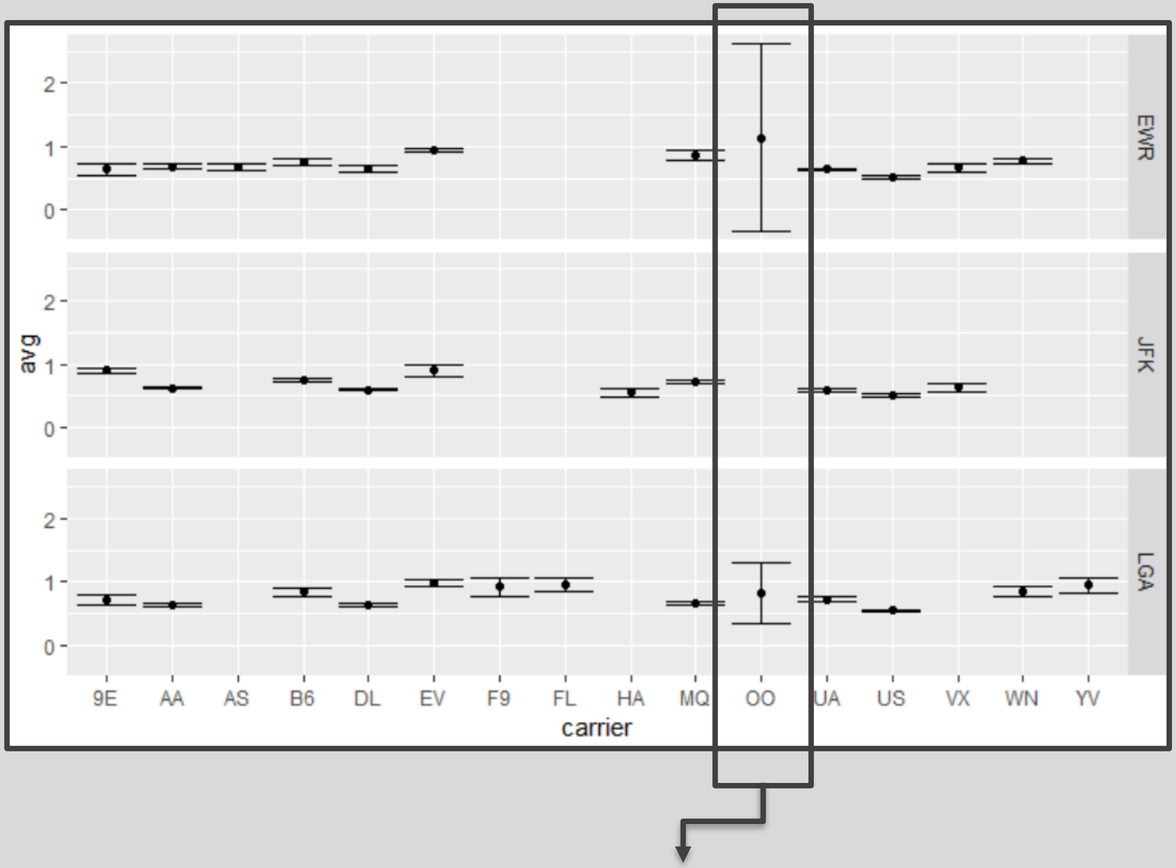
- Worst Carriers/Origin



```
> head(arrange(accuracy,desc(avg)),5)
# A tibble: 5 x 7
# Groups:   carrier [4]
  carrier origin     n   avg     se    low  high
  <chr>   <chr>  <int> <dbl>  <dbl>  <dbl> <dbl>
1 OO      EWR        6 1.14  0.737  -0.334 2.61
2 EV      LGA     8086 0.986 0.0265  0.933 1.04
3 YV      LGA      542 0.954 0.0597  0.835 1.07
4 FL      LGA     3136 0.952 0.0545  0.843 1.06
5 EV      EWR    40571 0.952 0.0125  0.927 0.977
```

Case Study

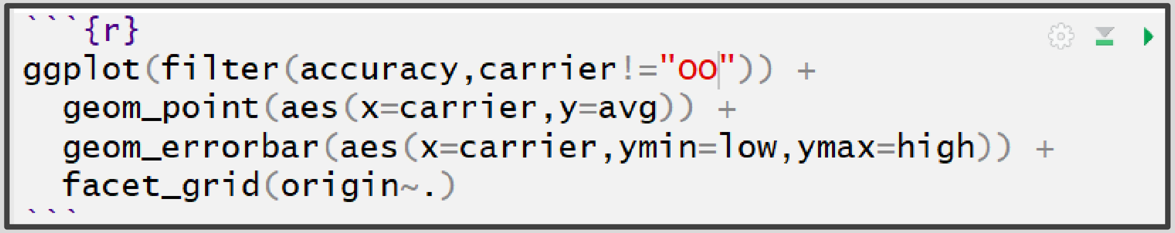
- 95% Confidence Intervals



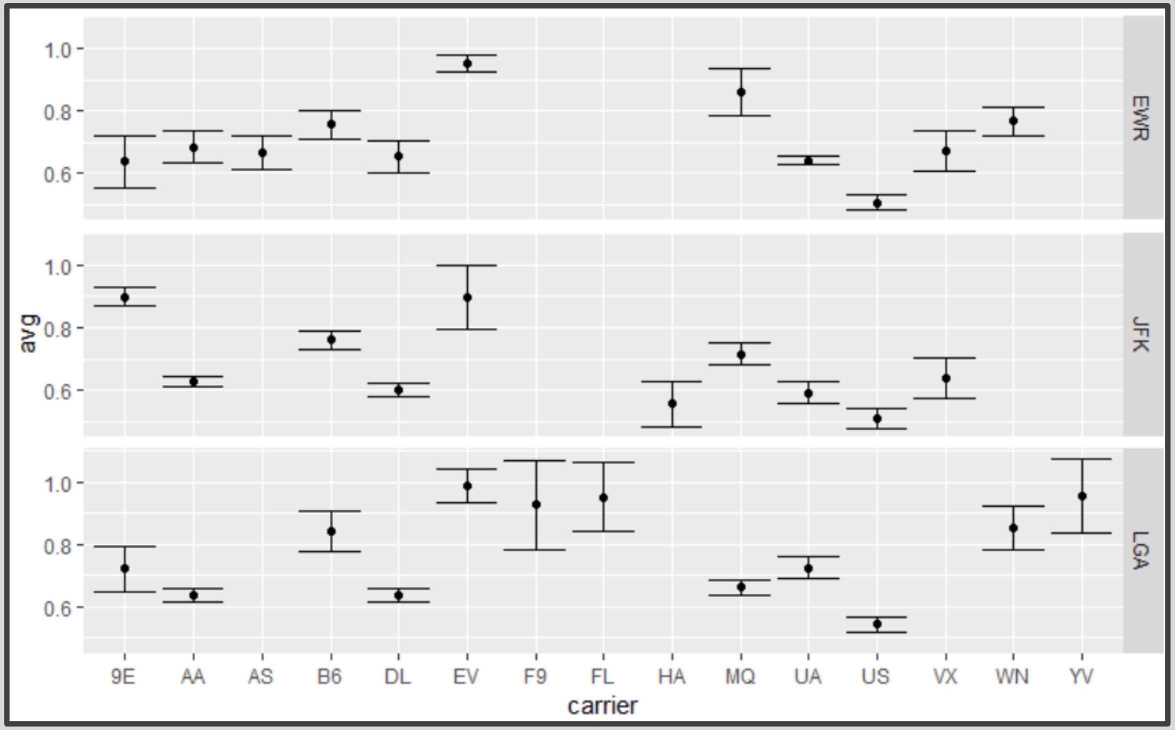
Carrier “OO” Creates a Visual Problem Due to Small Sample Size

Case Study

- 95% Confidence Intervals



~~~
```{r}
ggplot(filter(accuracy,carrier!="OO")) +
  geom_point(aes(x=carrier,y=avg)) +
  geom_errorbar(aes(x=carrier,ymin=low,ymax=high)) +
  facet_grid(origin~.)
```
~~~



Closing?

Disperse and Make Reasonable Decisions