STOR 320 Data Transformation II

Lecture 4

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Data Transformation II Info

- Finish Reading Chapter 3 and Practice the Code in R4DS

- Covers
  - The Pipe
  - Statistical Summaries
  - Grouped Summaries
  - Helpful Functions

- Builds Off Last Tutorial

The Pipe

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

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

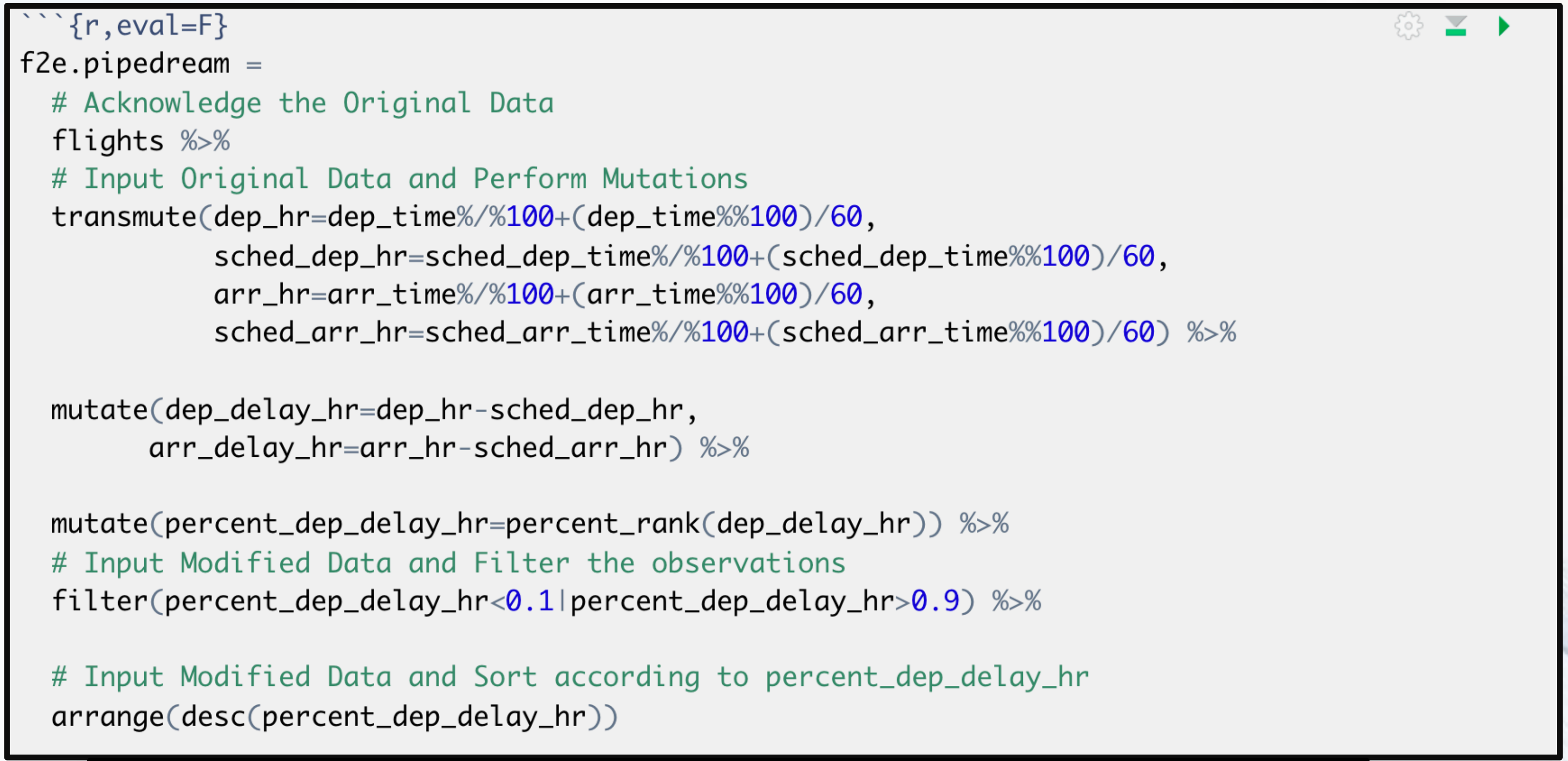
```
OUT = h %>%
          g() %>%
               f()
```

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

```
OUT = 10
```

The Pipe

- Chaining with the Pipe

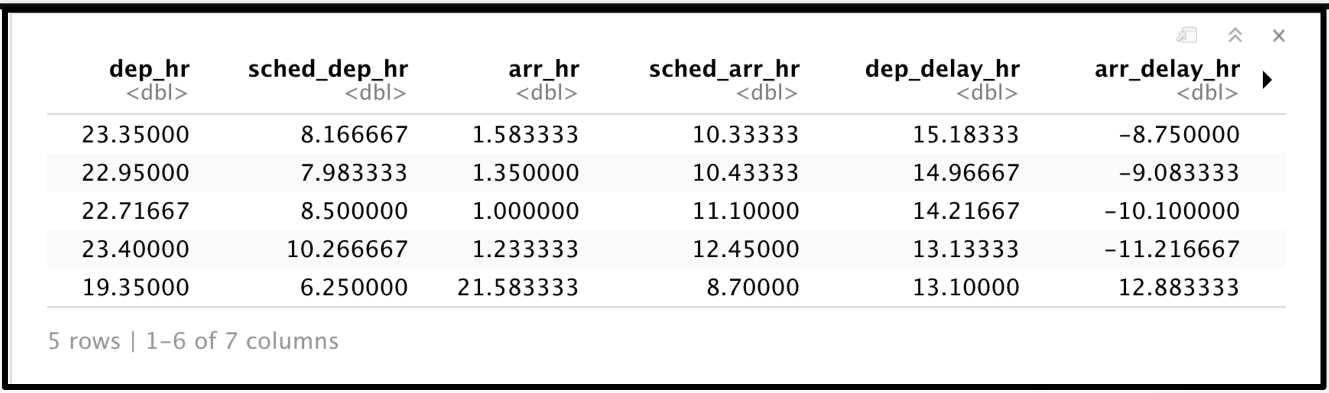


~~~
```{r,eval=F}
f2e.pipedream =
  # Acknowledge the Original Data
  flights %>%
  # Input Original Data and Perform Mutations
  transmute(dep_hr=dep_time%/%100+(dep_time%%100)/60,
            sched_dep_hr=sched_dep_time%/%100+(sched_dep_time%%100)/60,
            arr_hr=arr_time%/%100+(arr_time%%100)/60,
            sched_arr_hr=sched_arr_time%/%100+(sched_arr_time%%100)/60) %>%

  mutate(dep_delay_hr=dep_hr-sched_dep_hr,
         arr_delay_hr=arr_hr-sched_arr_hr) %>%

  mutate(percent_dep_delay_hr=percent_rank(dep_delay_hr)) %>%
  # Input Modified Data and Filter the observations
  filter(percent_dep_delay_hr<0.1|percent_dep_delay_hr>0.9) %>%

  # Input Modified Data and Sort according to percent_dep_delay_hr
  arrange(desc(percent_dep_delay_hr))
~~~



dep_hr	sched_dep_hr	arr_hr	sched_arr_hr	dep_delay_hr	arr_delay_hr
<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
23.35000	8.166667	1.583333	10.33333	15.18333	-8.750000
22.95000	7.983333	1.350000	10.43333	14.96667	-9.083333
22.71667	8.500000	1.000000	11.10000	14.21667	-10.100000
23.40000	10.266667	1.233333	12.45000	13.13333	-11.216667
19.35000	6.250000	21.583333	8.70000	13.10000	12.883333

5 rows | 1-6 of 7 columns

The Pipe

Why use

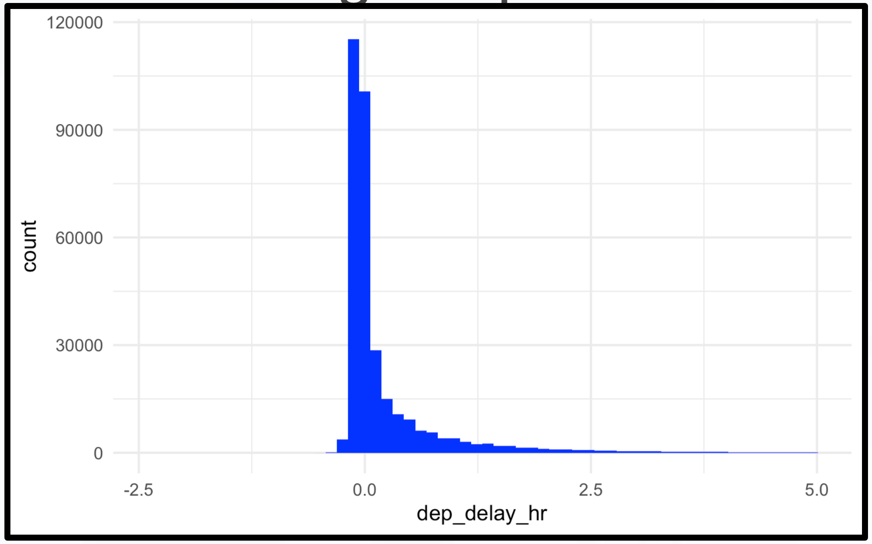
- Avoid nested functions
- Minimize number of local variables
- Easier to add steps in the sequence

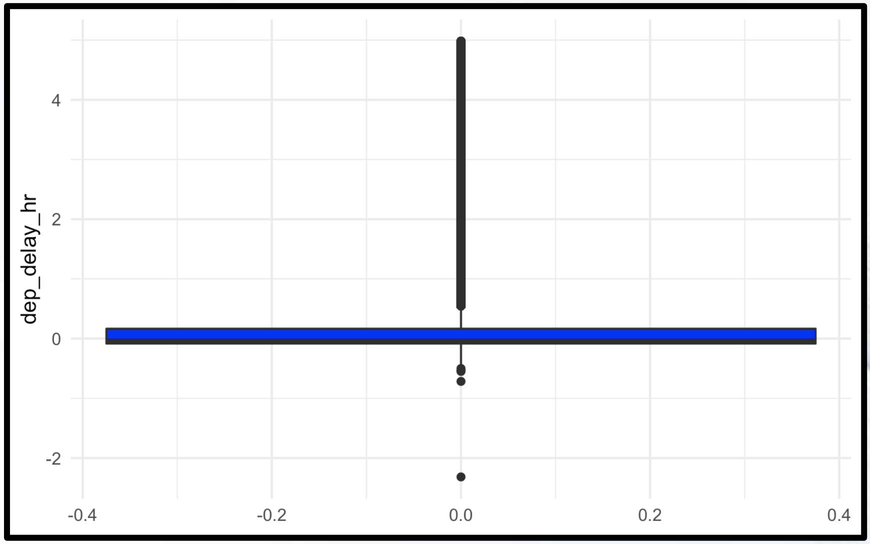
Why not to use

- Debug
- Can’t handle multiple inputs
- Can’t handle complex code structure

summarize()

- Summarizing All Data
  - Using Graphics



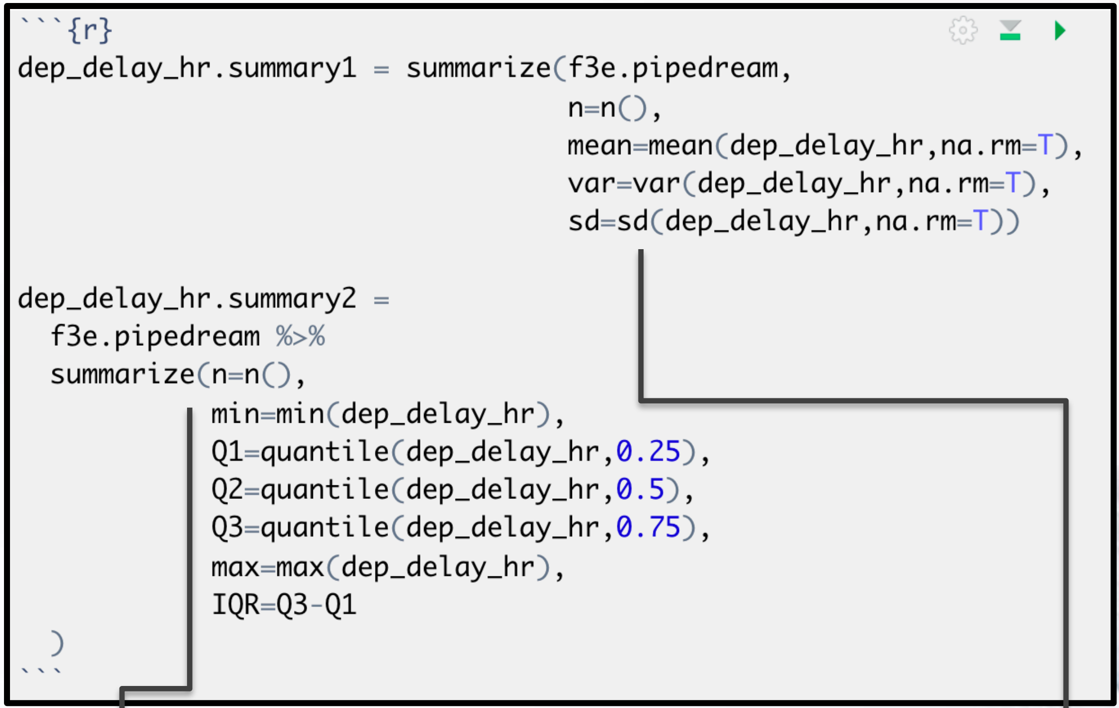


Both the histogram and the boxplot are made from summary statistics.

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

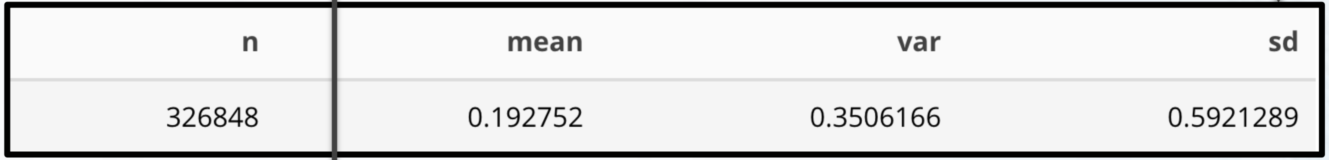
summarize()

- Summarizing All Data

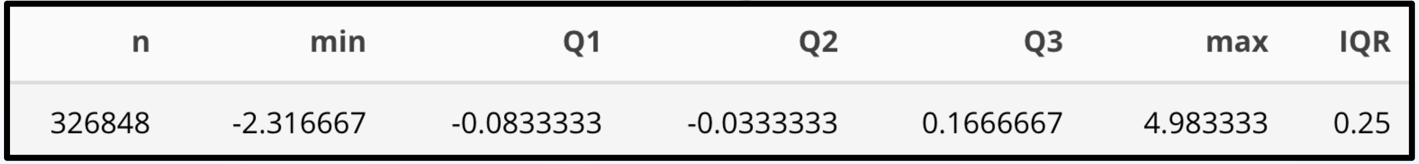


~~~
```{r}
dep_delay_hr.summary1 = summarize(f3e.pipedream,
                                  n=n(),
                                  mean=mean(dep_delay_hr,na.rm=T),
                                  var=var(dep_delay_hr,na.rm=T),
                                  sd=sd(dep_delay_hr,na.rm=T))

dep_delay_hr.summary2 =
  f3e.pipedream %>%
  summarize(n=n(),
            min=min(dep_delay_hr),
            Q1=quantile(dep_delay_hr,0.25),
            Q2=quantile(dep_delay_hr,0.5),
            Q3=quantile(dep_delay_hr,0.75),
            max=max(dep_delay_hr),
            IQR=Q3-Q1
  )
```
~~~



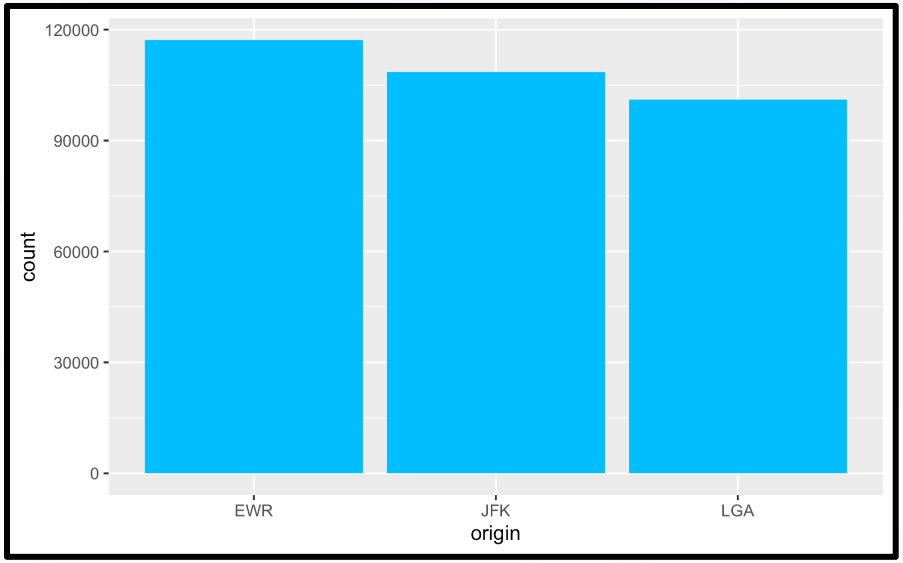
n	mean	var	sd
326848	0.192752	0.3506166	0.5921289

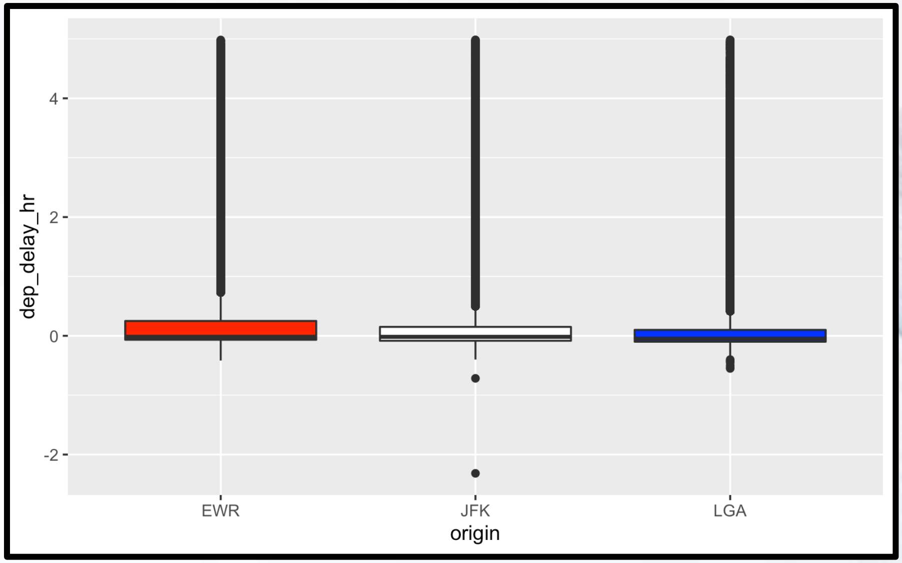


n	min	Q1	Q2	Q3	max	IQR
326848	-2.316667	-0.0833333	-0.0333333	0.1666667	4.983333	0.25

summarize() with group_by()

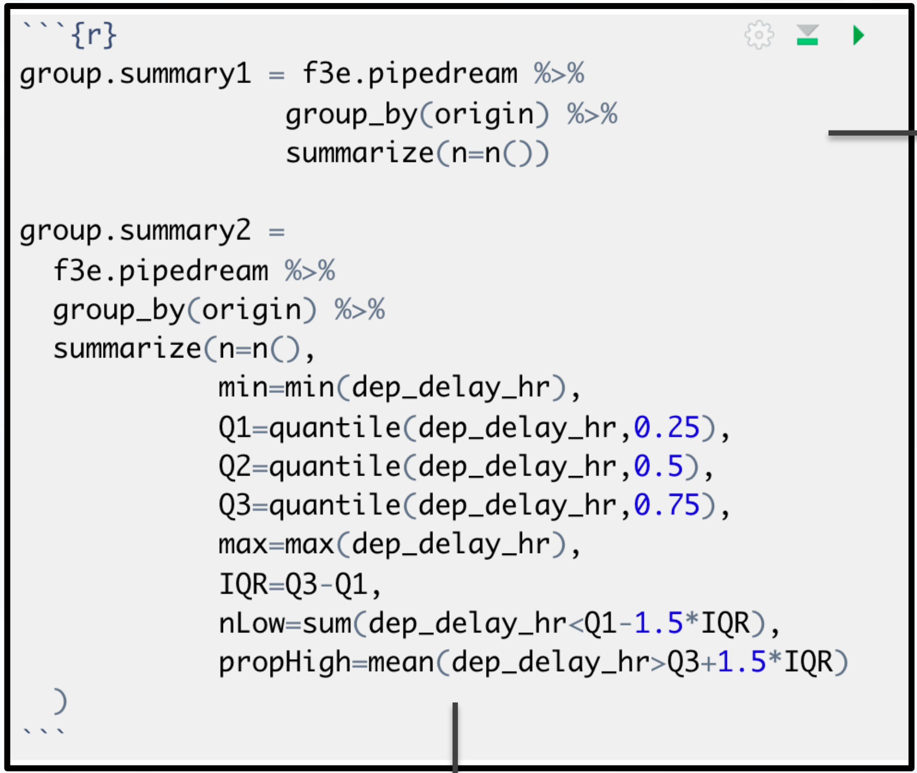
- Summarizing Data by Groups
  - Using Graphics





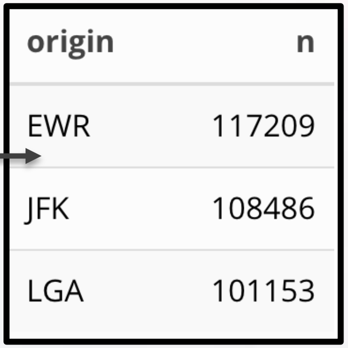
summarize() with group_by()

- Summarizing Data by Groups
  - Using Tables

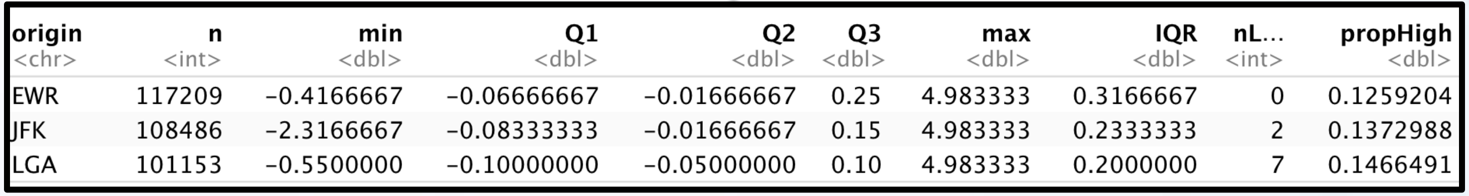


~~~
```{r}
group.summary1 = f3e.pipedream %>%
                group_by(origin) %>%
                summarize(n=n())

group.summary2 =
  f3e.pipedream %>%
  group_by(origin) %>%
  summarize(n=n(),
           min=min(dep_delay_hr),
           Q1=quantile(dep_delay_hr,0.25),
           Q2=quantile(dep_delay_hr,0.5),
           Q3=quantile(dep_delay_hr,0.75),
           max=max(dep_delay_hr),
           IQR=Q3-Q1,
           nLow=sum(dep_delay_hr<Q1-1.5*IQR),
           propHigh=mean(dep_delay_hr>Q3+1.5*IQR)
  )
```
~~~



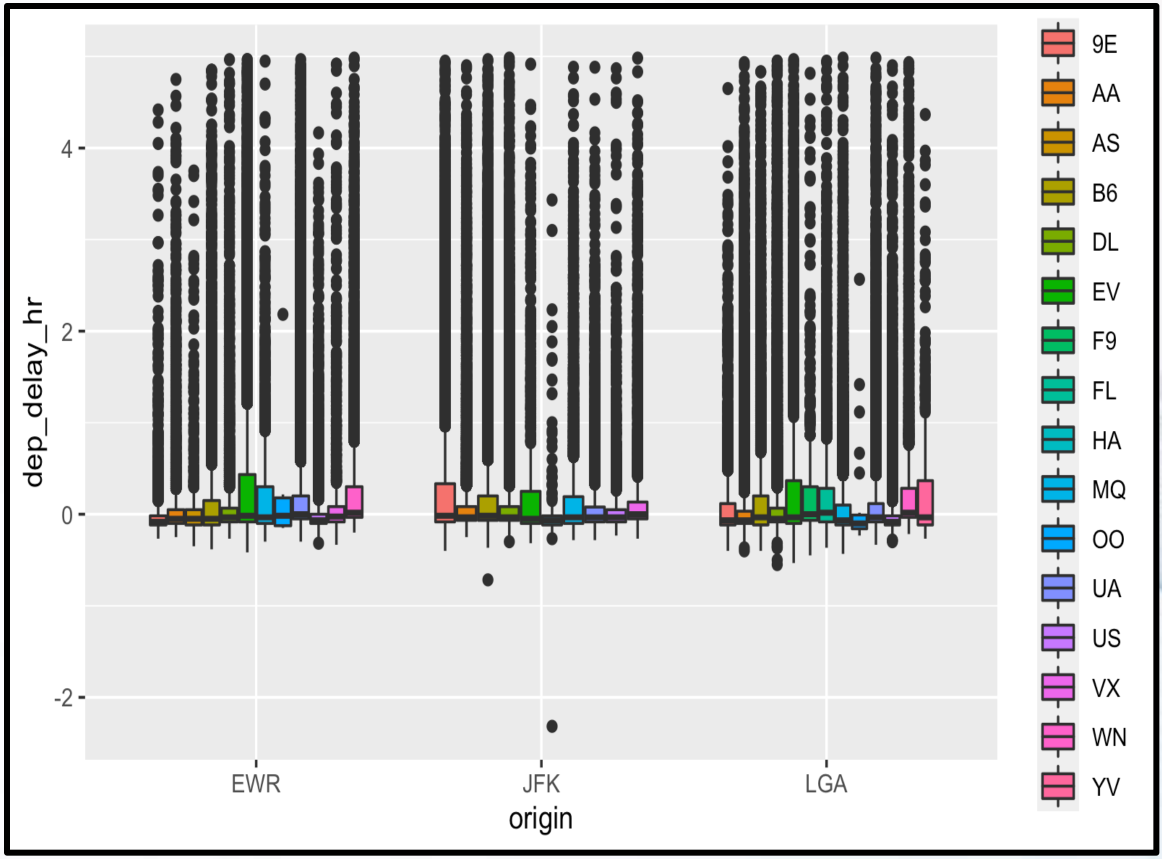
origin	n
EWR	117209
JFK	108486
LGA	101153



origin	n	min	Q1	Q2	Q3	max	IQR	nL...	propHigh
<chr>	<int>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>	<int>	<dbl>
EWR	117209	-0.4166667	-0.06666667	-0.01666667	0.25	4.983333	0.3166667	0	0.1259204
JFK	108486	-2.3166667	-0.08333333	-0.01666667	0.15	4.983333	0.2333333	2	0.1372988
LGA	101153	-0.5500000	-0.10000000	-0.05000000	0.10	4.983333	0.2000000	7	0.1466491

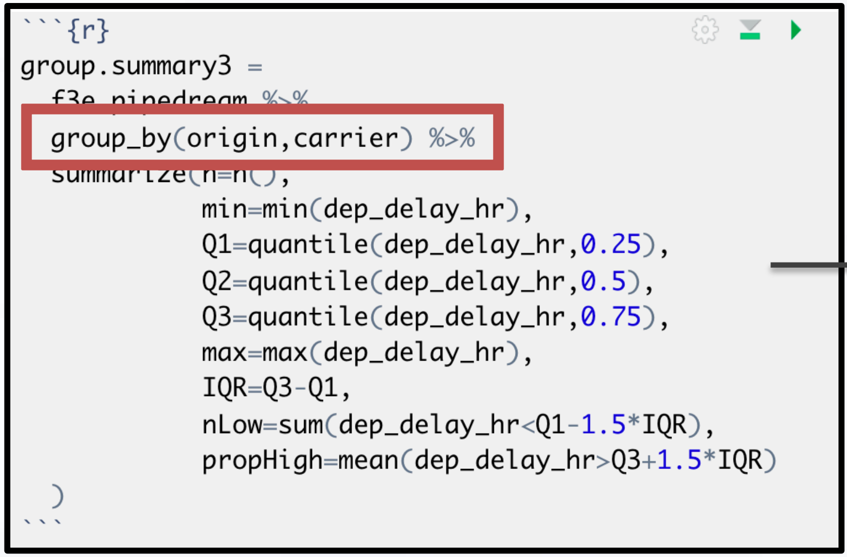
summarize() with group_by()

- Multiple Groups
  - Using Graphics

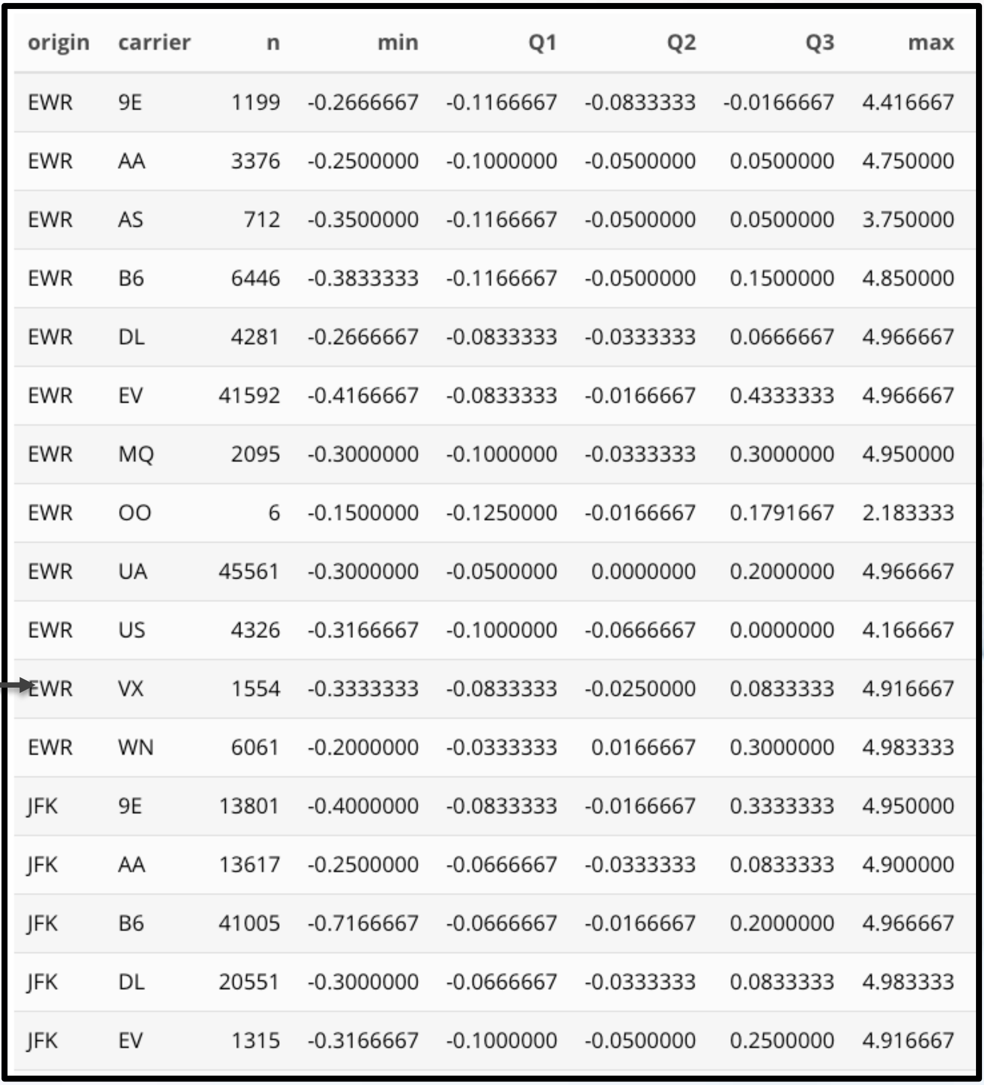


summarize() with group_by()

- Multiple Groups
  - Using Tables



~~~
```{r}
group.summary3 =
  f3e.pipedream %>%
  group_by(origin,carrier) %>%
  summarize(n=n(),
            min=min(dep_delay_hr),
            Q1=quantile(dep_delay_hr,0.25),
            Q2=quantile(dep_delay_hr,0.5),
            Q3=quantile(dep_delay_hr,0.75),
            max=max(dep_delay_hr),
            IQR=Q3-Q1,
            nLow=sum(dep_delay_hr<Q1-1.5*IQR),
            propHigh=mean(dep_delay_hr>Q3+1.5*IQR)
  )
```
~~~



origin	carrier	n	min	Q1	Q2	Q3	max
EWR	9E	1199	-0.2666667	-0.1166667	-0.0833333	-0.0166667	4.416667
EWR	AA	3376	-0.2500000	-0.1000000	-0.0500000	0.0500000	4.750000
EWR	AS	712	-0.3500000	-0.1166667	-0.0500000	0.0500000	3.750000
EWR	B6	6446	-0.3833333	-0.1166667	-0.0500000	0.1500000	4.850000
EWR	DL	4281	-0.2666667	-0.0833333	-0.0333333	0.0666667	4.966667
EWR	EV	41592	-0.4166667	-0.0833333	-0.0166667	0.4333333	4.966667
EWR	MQ	2095	-0.3000000	-0.1000000	-0.0333333	0.3000000	4.950000
EWR	OO	6	-0.1500000	-0.1250000	-0.0166667	0.1791667	2.183333
EWR	UA	45561	-0.3000000	-0.0500000	0.0000000	0.2000000	4.966667
EWR	US	4326	-0.3166667	-0.1000000	-0.0666667	0.0000000	4.166667
EWR	VX	1554	-0.3333333	-0.0833333	-0.0250000	0.0833333	4.916667
EWR	WN	6061	-0.2000000	-0.0333333	0.0166667	0.3000000	4.983333
JFK	9E	13801	-0.4000000	-0.0833333	-0.0166667	0.3333333	4.950000
JFK	AA	13617	-0.2500000	-0.0666667	-0.0333333	0.0833333	4.900000
JFK	B6	41005	-0.7166667	-0.0666667	-0.0166667	0.2000000	4.966667
JFK	DL	20551	-0.3000000	-0.0666667	-0.0333333	0.0833333	4.983333
JFK	EV	1315	-0.3166667	-0.1000000	-0.0500000	0.2500000	4.916667

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

$$Accuracy = delay_{dep} + delay_{arr}$$

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

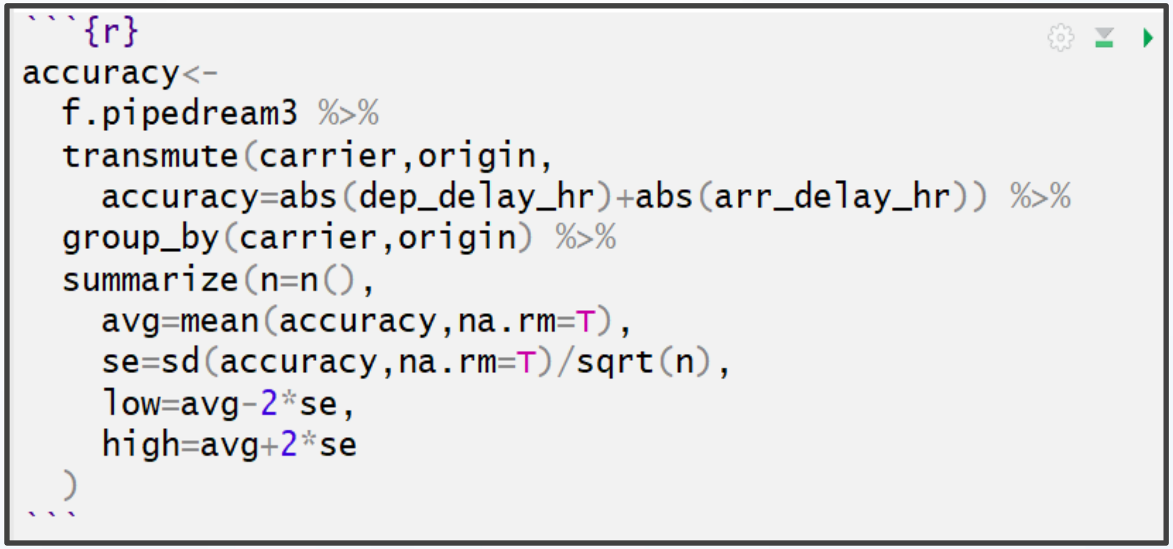
  - Good Metrics

$$Accuracy = |delay_{dep}| + |delay_{arr}|$$

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

Case Study

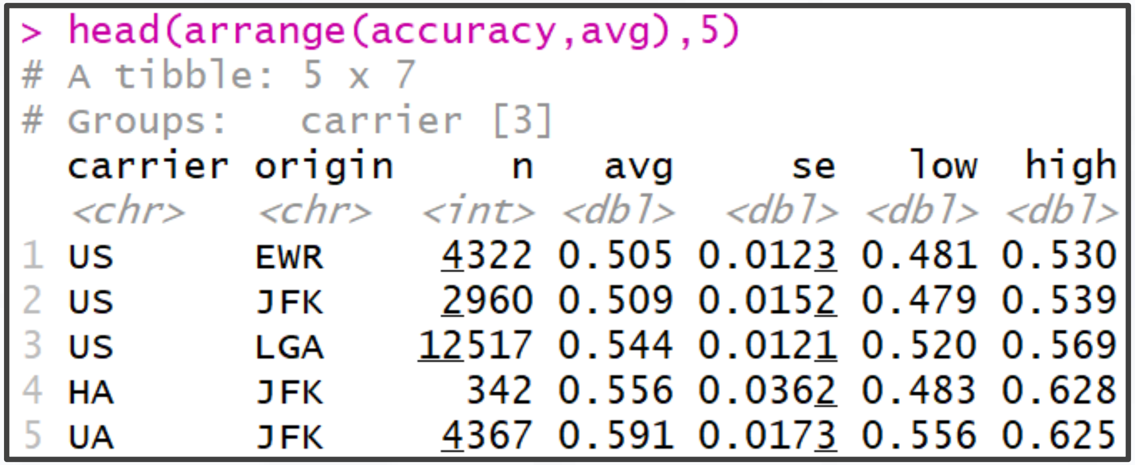
- Summary Table
  - Step 1: Accuracy Variable
  - Step 2: Grouping
  - Step 3: Summarize Info
    - Mean
    - Standard Error
    - Lower Bound (95% CI)
    - Upper Bound (95% CI)



~~~
```{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
  )
```
~~~

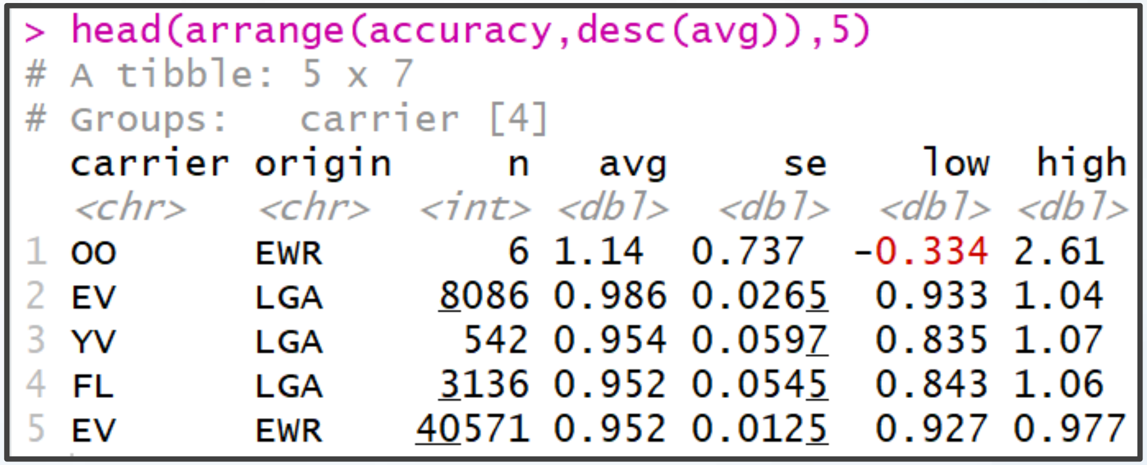
Case Study

- 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
```

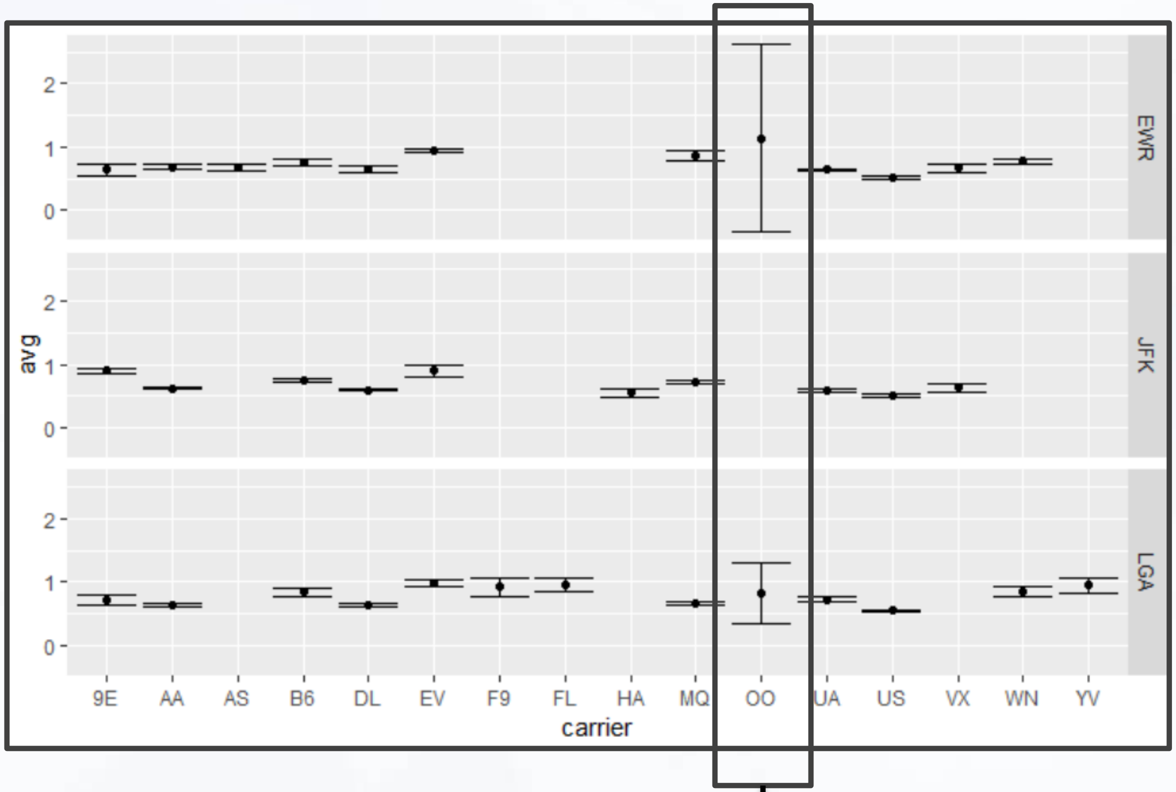
  - Worst Carriers/Origin



```
> 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
```

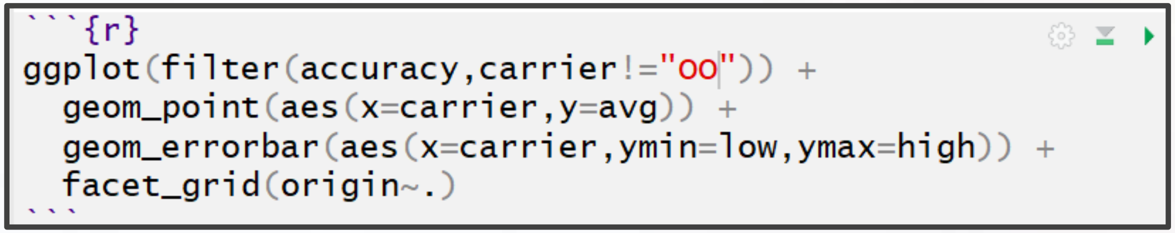
Case Study

- 95% Confidence Intervals



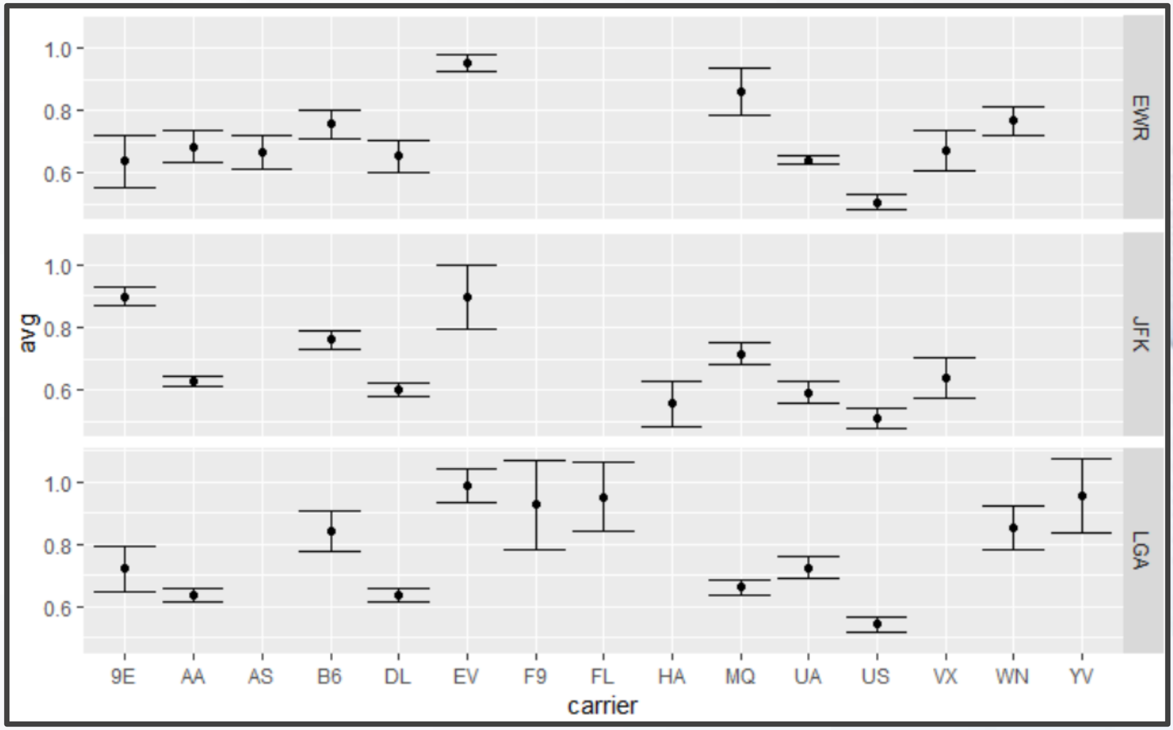
Carrier “OO” Creates a Visual Problem Due to Small Sample Size

Case Study



```{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~.)
```

- 95% Confidence Intervals


avg
EWR
JFK
LGA
9E
AA
AS
B6
DL
EV
F9
FL
HA
MQ
UA
US
VX
WN
YV
carrier