Traffic at the Eisenhower Tunnel I-70 Colorado

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NYC DSA - Python
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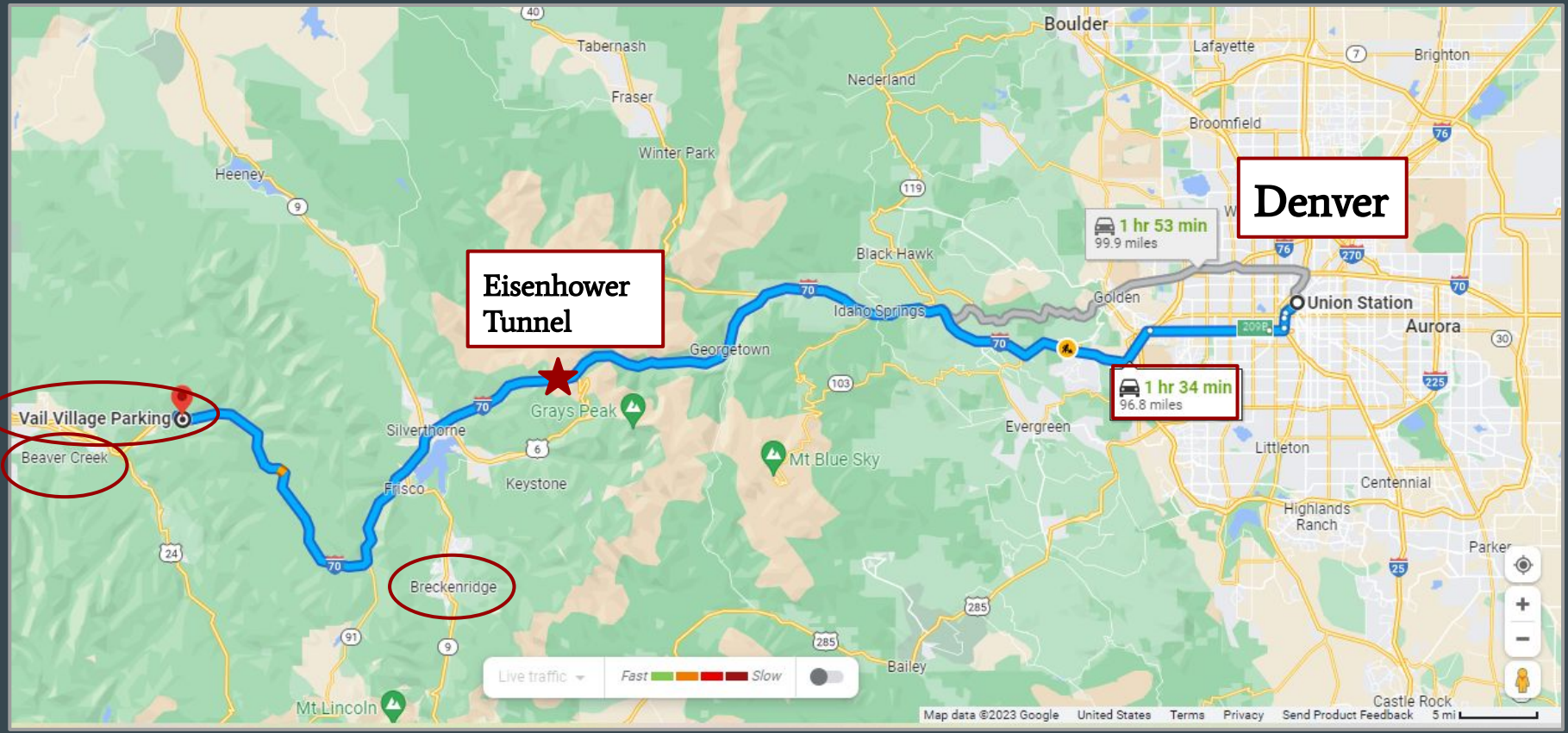
Background information:

Traffic is a constant issue on the I-70 corridor between Denver, CO and Vail, CO for both locals and tourists.

The driving conditions are also very unpredictable as you go over several mountain passes and weather can change dramatically.

Google maps is not always accurate in this area likely due to the number of variables.

I-70 Colorado corridor between Denver and Vail



https://www.google.com/maps/dir/Union+Station,+Denver,+CO/Vail+Village+Parking,+North+Frontage+Road+West,+Vail,+CO/@39.4459739,-106.1233407,9z/data=!3m1!4b1!4m14!4m13!1m5!1m1!1s0x876c78c309781fbb:0xfa51804416e57e70!2m2!1d-104.9988948!2d39.752156!1m5!1m1!1s0x876a705e08eeb627:0x27e3b116e6a460e4!2m2!1d-106.3716696!2d39.6422753!3e0?entry=ttu

Research Questions:

When are the best times to travel between Denver and Vail in order to avoid traffic?

- How does traffic vary going westbound vs. eastbound on different weekdays?
- What are the seasonal variations in traffic?
- Is there a statistical increase in traffic post-covid?

Knowing high-probability traffic times can help people save time. Additionally, it can show when the ideal times are to add more public transportation to and from Denver.

Data: CDOT (Colorado Department of Transportation)
OTIS (Online Transportation Information System)

https://dtdapps.coloradodot.info/otis/TrafficData#ui/1/1/0/station/000106/criteria/070A/0/449.58

Six csv files of continuous hourly traffic counts at the Eis
January, 2018 to September, 2023

	COUNTSTATIONID	COUNTDATE	COUNTDIR	HOUR0	HOUR1	HOUR2	HOUR3	HOUR4	HOUR5	HOUR6	...	HOUR15	HOUR16	HOUR
0	106	20180101	P	91	82	69	89	128	210	473	...	2198	2032	16
1	106	20180101	S	64	95	86	78	73	113	304	...	1559	1380	8
2	106	20180102	P	130	91	92	98	229	373	691	...	1896	1887	13
3	106	20180102	S	8						477	...	1466	1289	9
4	106	20180103	P	10						452	...	1950	1666	13
...	...	...	...							...	...	...	...	
529	106	20230928	S							683	...	1419	1322	11
530	106	20230929	P	26						379	...	2050	1867	16
531	106	20230929	S							638	...	2131	2228	19
532	106	20230930	P	11						441	...	2315	2189	18
533	106	20230930	S	23						739	...	1868	1677	11

4074 rows × 28 columns

Date - 9/29/2023
Direction - S (West)

- - - - - - - - - - - - - - - - - -

Count - 2228
Hour - 16 (4 pm)
Month - September
Weekday - Friday
Season - Shoulder
Covid - Post- covid

1. Converted the COUNTDATE column to a pandas datetime
2. Changed the index to COUNTDATE
3. Used COUNTDATE to add a day of the week column called Weekday and a month column called Month
4. Split the dataframe into eastbound and westbound

Overall trends in traffic through the Eisenhower Tunnel:

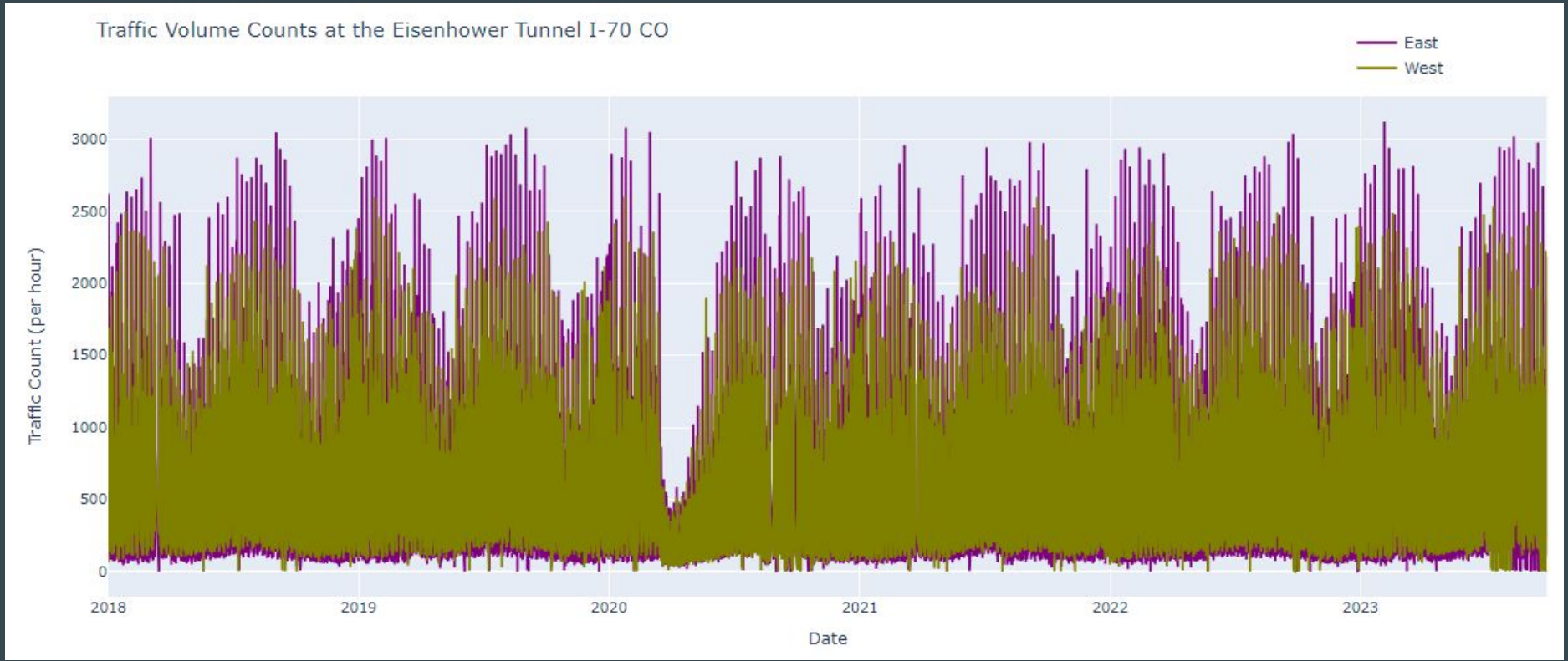
Included in this dataframe:

All traffic counts, both eastbound and westbound, from 12 am, 6 am, 10 am, 4 pm, and 8 pm.

COUNTDATE	Date	Time	Count_W	Count_E	Weekday	Month	Year
2018-01-01	1/1/2018	0	64	91	Monday	January	2018
2018-01-01	1/1/2018	6	304	473	Monday	January	2018
2018-01-01	1/1/2018	10	1371	2621	Monday	January	2018
2018-01-01	1/1/2018	16	1380	2032	Monday	January	2018
2018-01-01	1/1/2018	20	457	835	Monday	January	2018
...	...	...	...	...	...	...	...
2023-09-30	9/30/2023	0	231	112	Saturday	September	2023
2023-09-30	9/30/2023	6	739	441	Saturday	September	2023
2023-09-30	9/30/2023	10	1896	1558	Saturday	September	2023
2023-09-30	9/30/2023	16	1677	2189	Saturday	September	2023
2023-09-30	9/30/2023	20	561	909	Saturday	September	2023

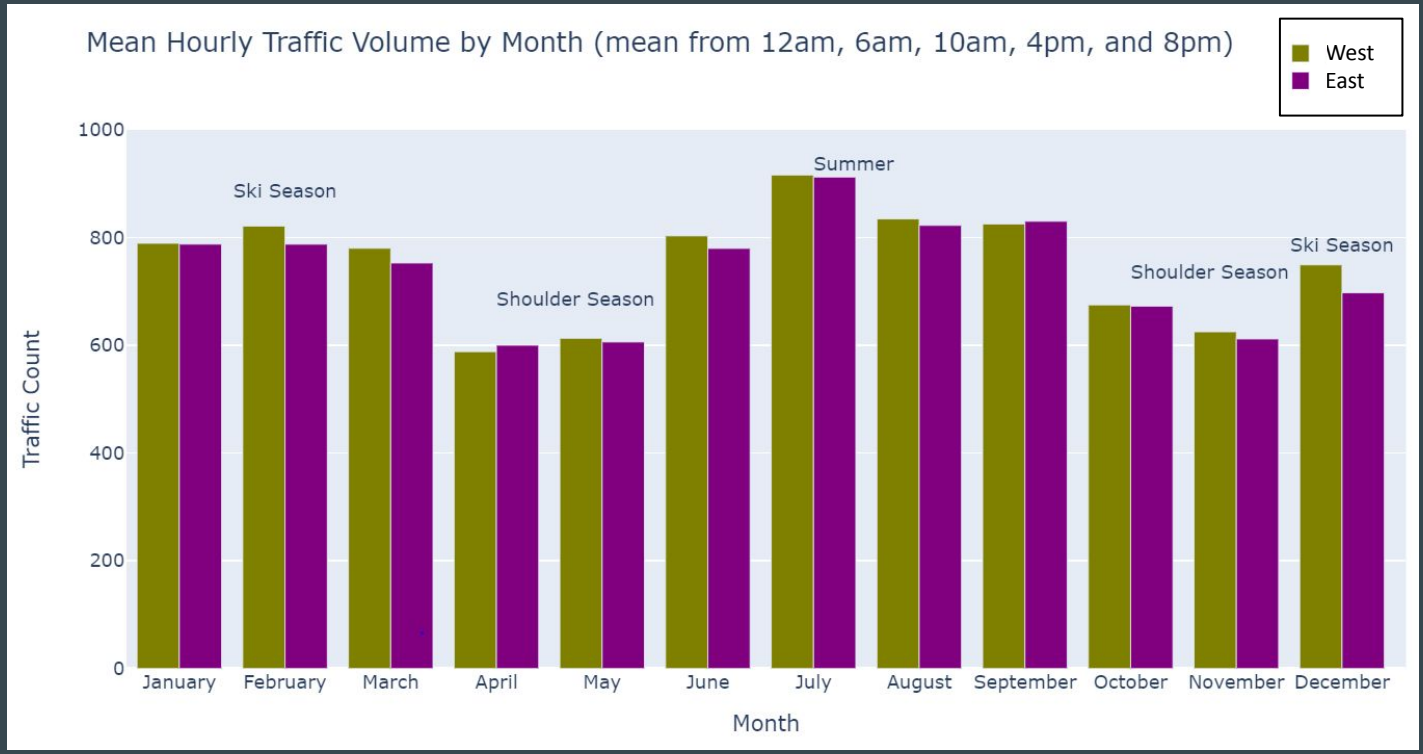
10185 rows × 7 columns

Overall trends in traffic through the Eisenhower Tunnel:



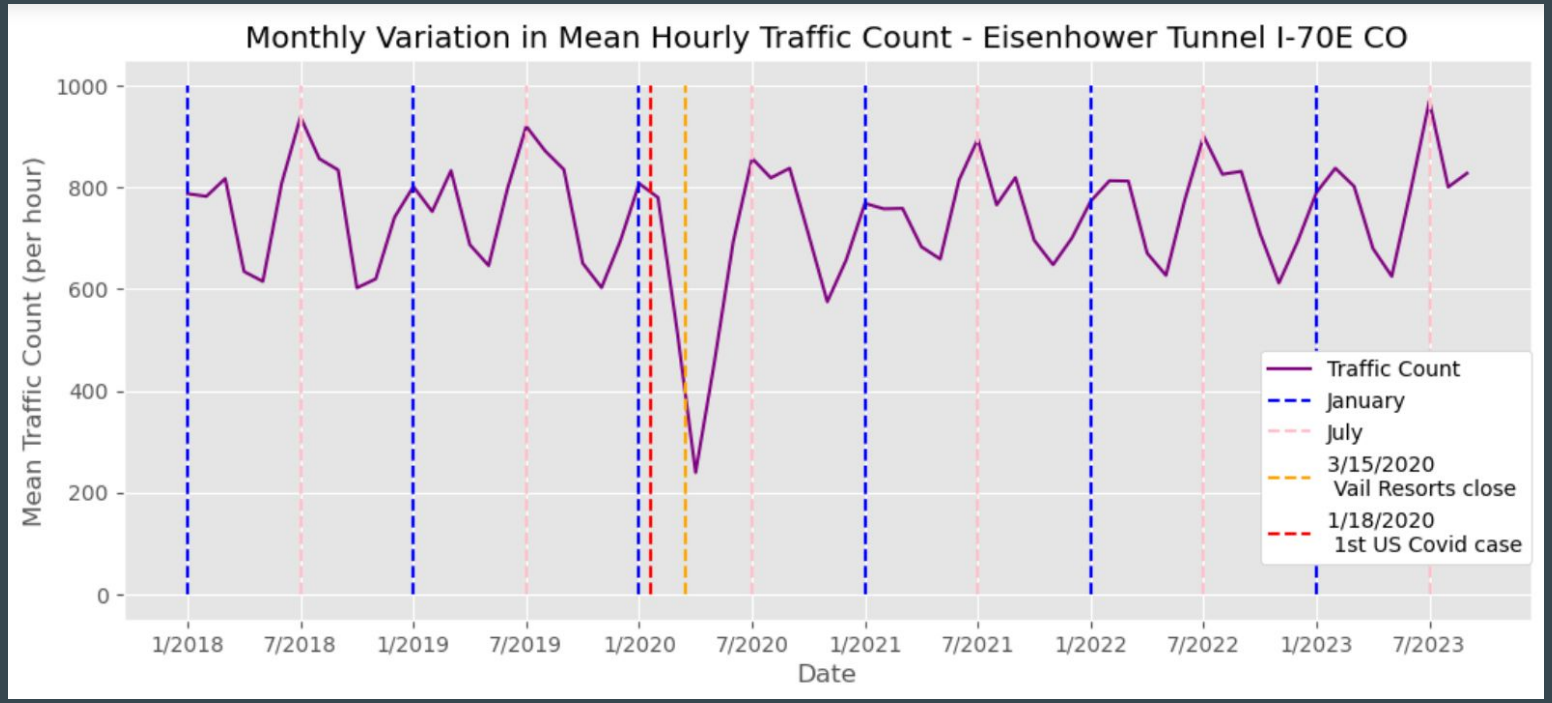
Monthly mean hourly traffic through the Eisenhower Tunnel:

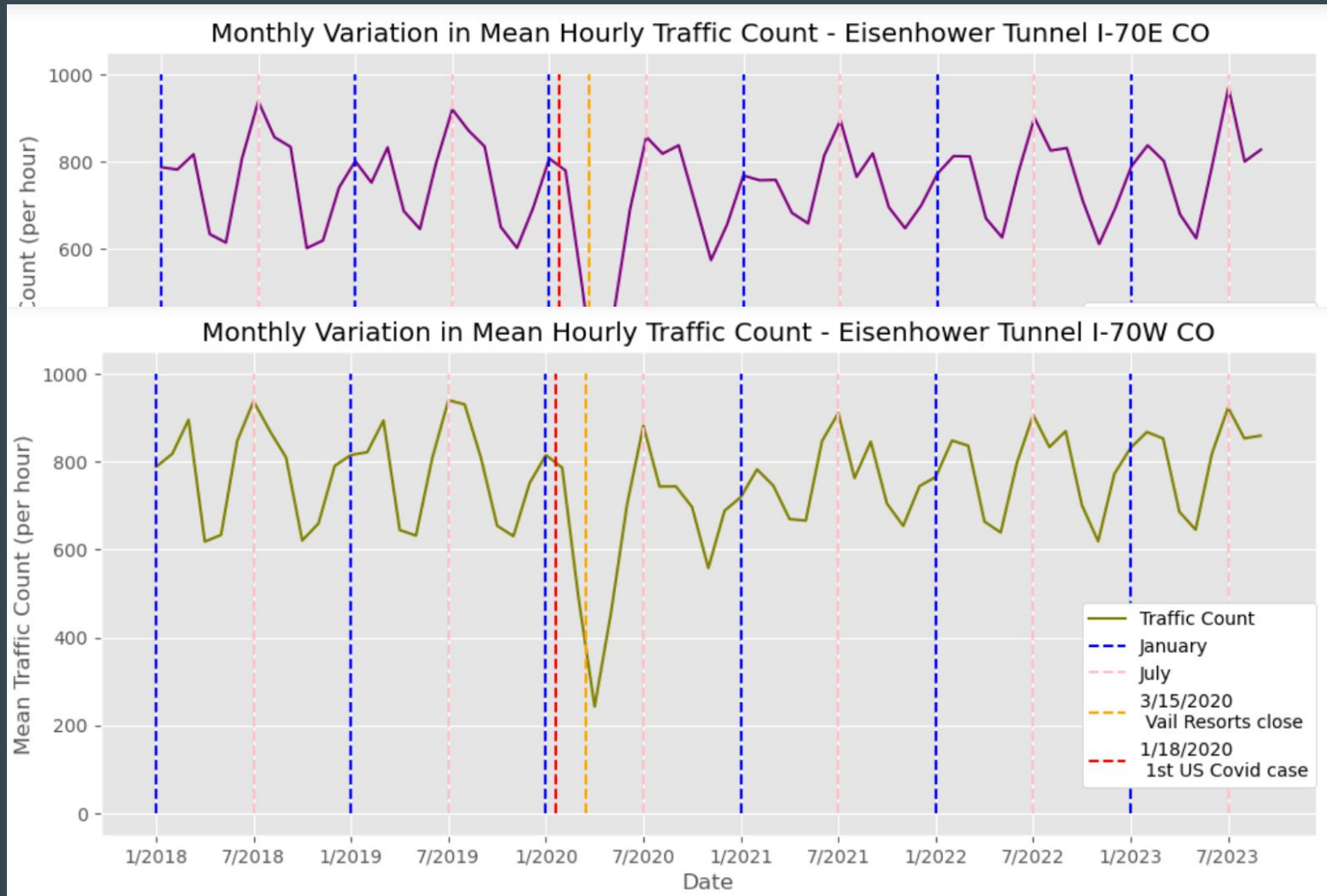
Monthly variation is a result of the number of people recreating. Ski season and the summer are very busy while what is called the shoulder season (April, May, Oct. and Nov.) is not a busy.



Trend in mean hourly traffic data grouped by year and month

Having just one point for each month illustrates the cyclical changes in traffic based on the seasons and the dramatic pandemic dip followed by a quick recovery.

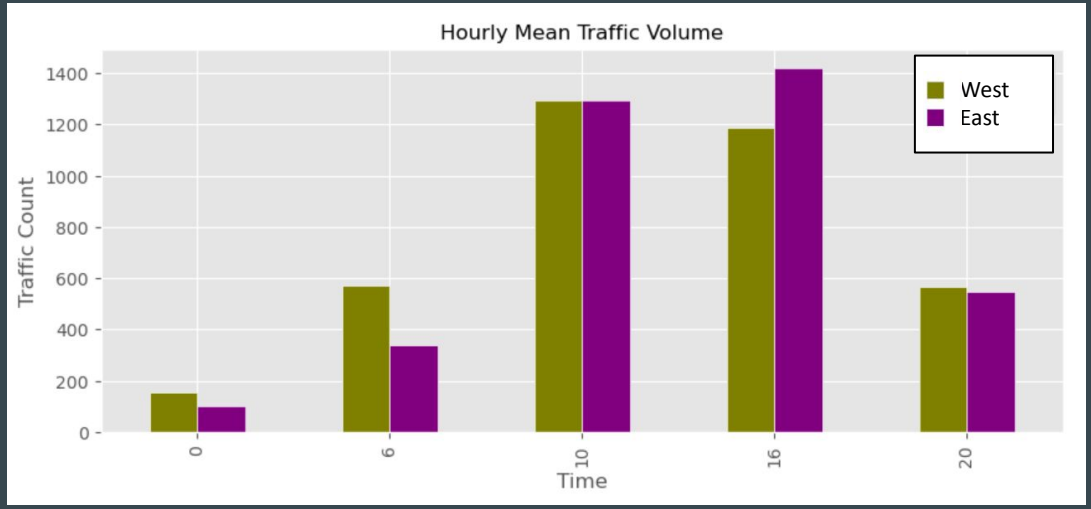


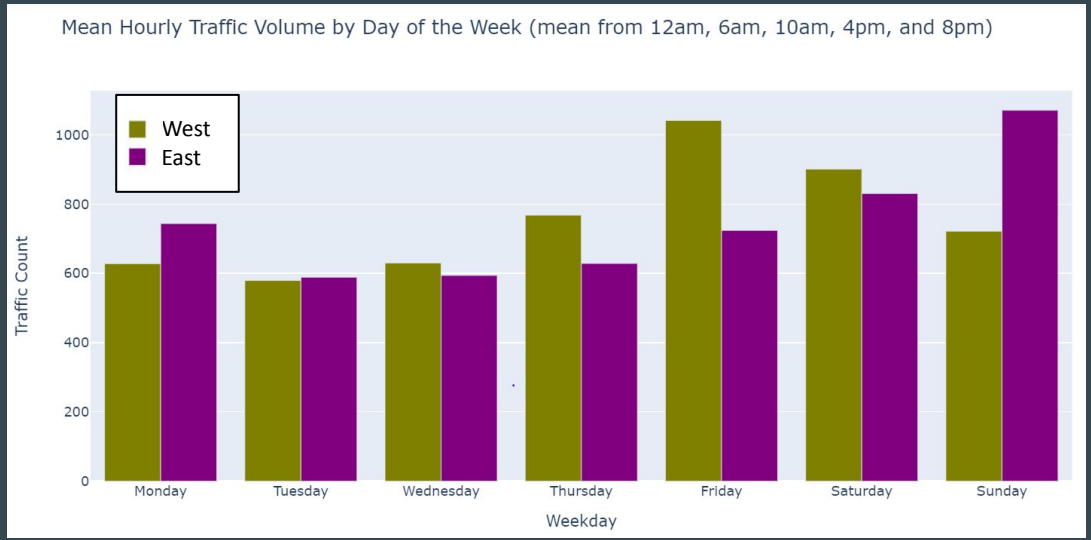

Monthly Variation in Mean Hourly Traffic Count - Eisenhower Tunnel I-70E CO
1000
800
600
Monthly Variation in Mean Hourly Traffic Count - Eisenhower Tunnel I-70W CO
Mean Traffic Count (per hour)
1000
800
600
400
200
0
Traffic Count
January
July
3/15/2020
Vail Resorts close
1/18/2020
1st US Covid case
1/2018
7/2018
1/2019
7/2019
1/2020
7/2020
1/2021
7/2021
1/2022
7/2022
1/2023
7/2023
Date

Weekly and hourly traffic through the Eisenhower Tunnel:

Higher volume going west on Thursdays, Fridays, and Saturdays particularly in the morning.

Higher volume going east on Sundays and Mondays particularly in the afternoon.





Traffic pattern changes relating to the Covid-19 pandemic:

Dataframe shows the average hourly traffic count for each hour of each weekday from February to April of 2018, 2020, and 2023.

So there are 24 counts for each weekday of each month.

24 hours x 7 days x 3month x 4 years

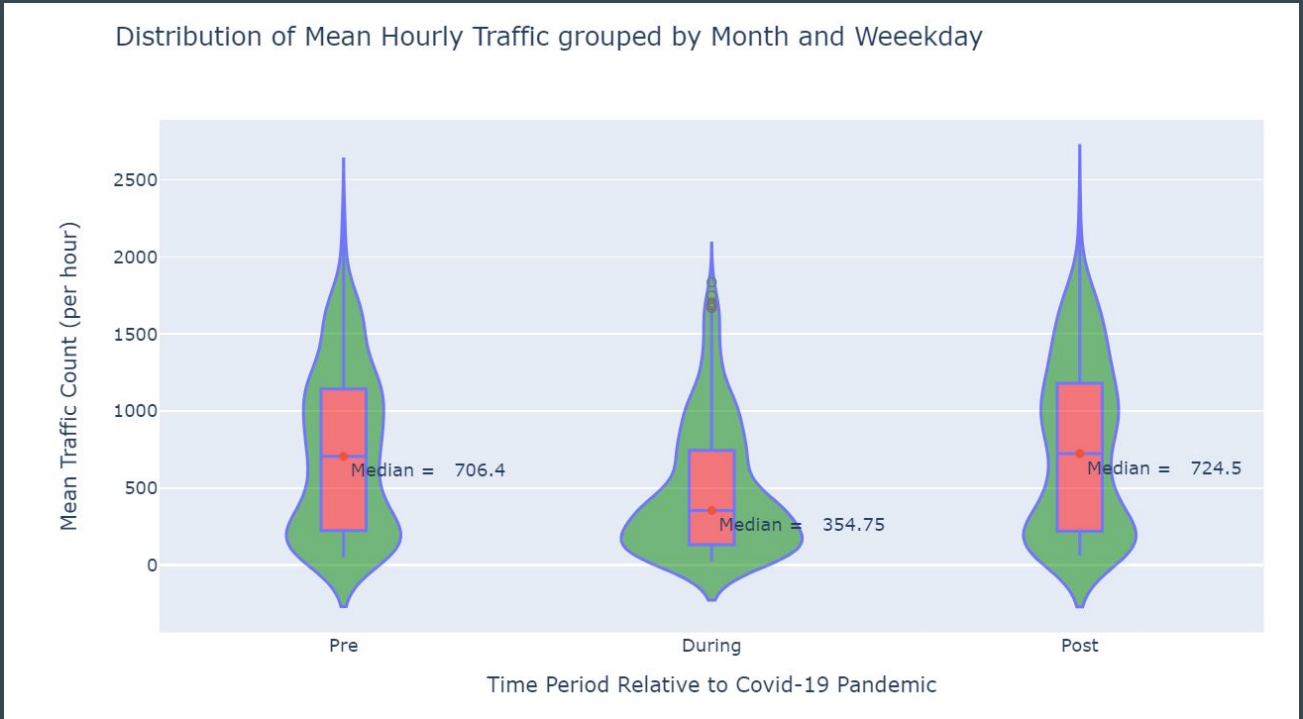
= 1512 traffic counts

	Month	Weekday	Hour	Time	Count
0	February	Monday	0	Pre	128.25
1	February	Tuesday	0	Pre	115.25
2	February	Wednesday	0	Pre	130.50
3	February	Thursday	0	Pre	231.00
4	February	Friday	0	Pre	306.75
...	...	...	...	...	...
499	April	Wednesday	23	Post	210.00
500	April	Thursday	23	Post	245.00
501	April	Friday	23	Post	220.75
502	April	Saturday	23	Post	204.20
503	April	Sunday	23	Post	192.20

1512 rows × 5 columns

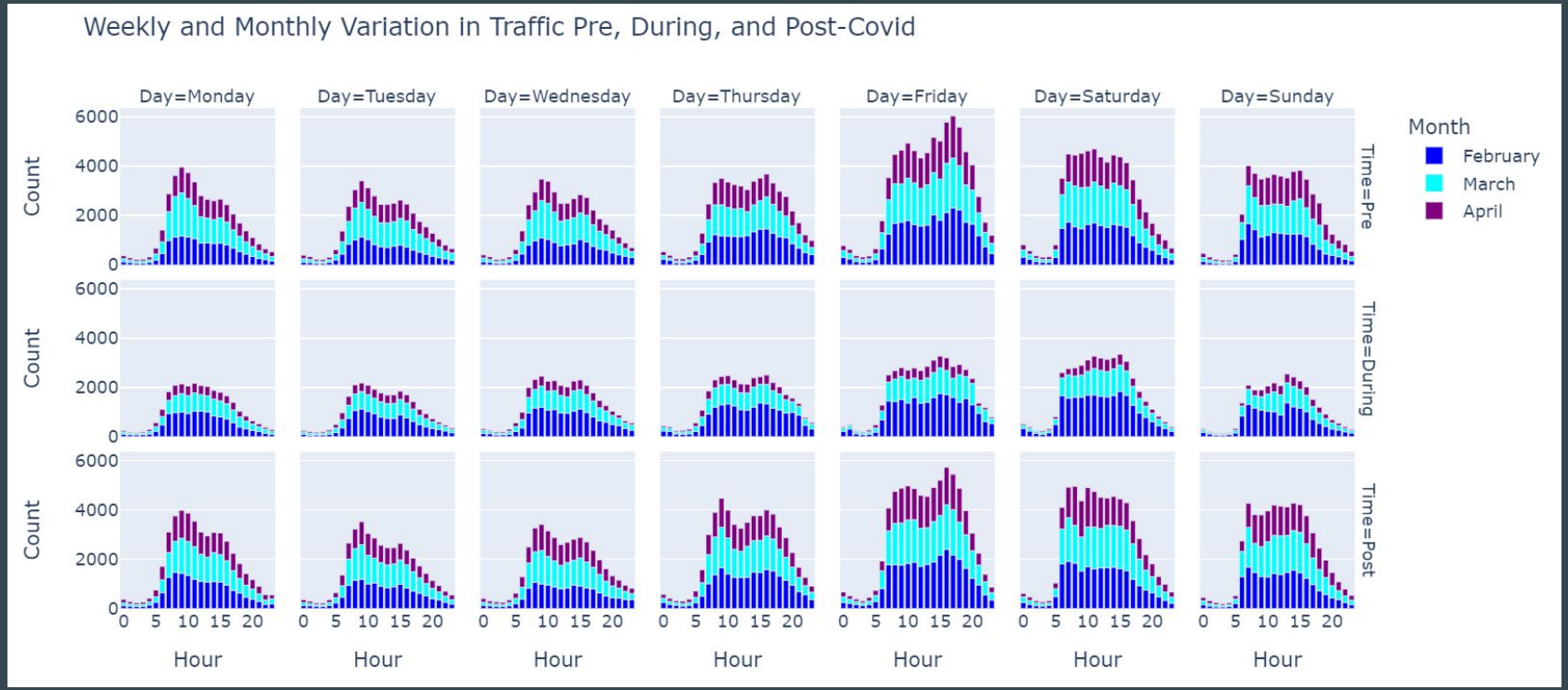
Traffic pattern changes relating to the Covid-19 pandemic:

Very clear difference in the distribution of hourly traffic count going westbound from February to April of 2020.

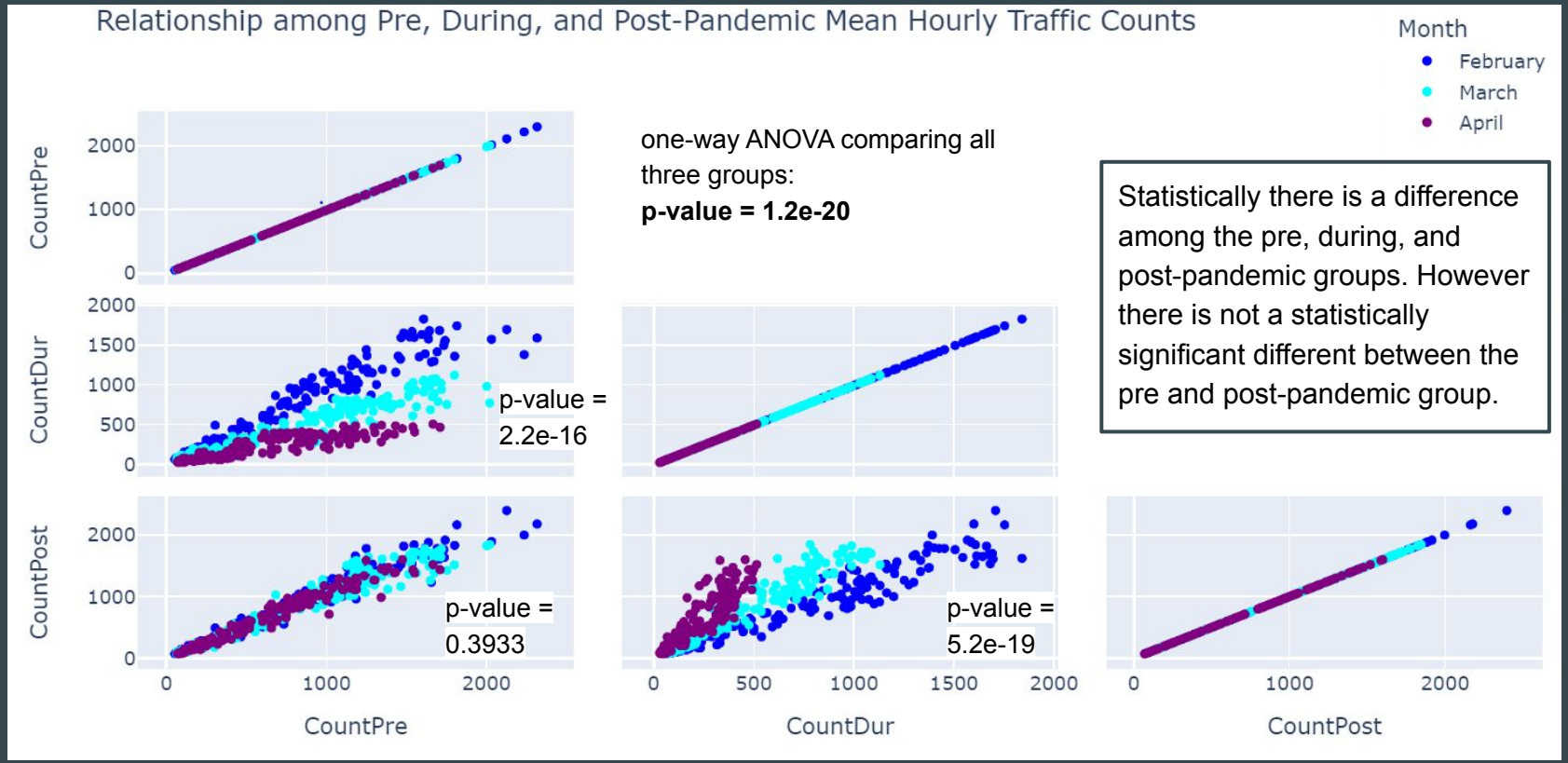


Traffic pattern changes relating to the Covid-19 pandemic:

Very little observable difference pre and post-pandemic, but clear decrease in traffic particularly during March and April of 2020 (During).



Traffic pattern changes relating to the Covid-19 pandemic:



one-way ANOVA comparing all three groups:
p-value = 1.2e-20

Statistically there is a difference among the pre, during, and post-pandemic groups. However there is not a statistically significant different between the pre and post-pandemic group.

Daily and seasonal trends in traffic through the Eisenhower Tunnel:

Dataframe shows mean hourly traffic for each weekday during each season going both eastbound and westbound.

7 days x 24 hours = 168 traffic counts for each season

Ski season- (Dec., Jan., Feb., March)

Summer - (June, July, Aug., Sept.)

Shoulder season - (April, May, Oct., Nov.)

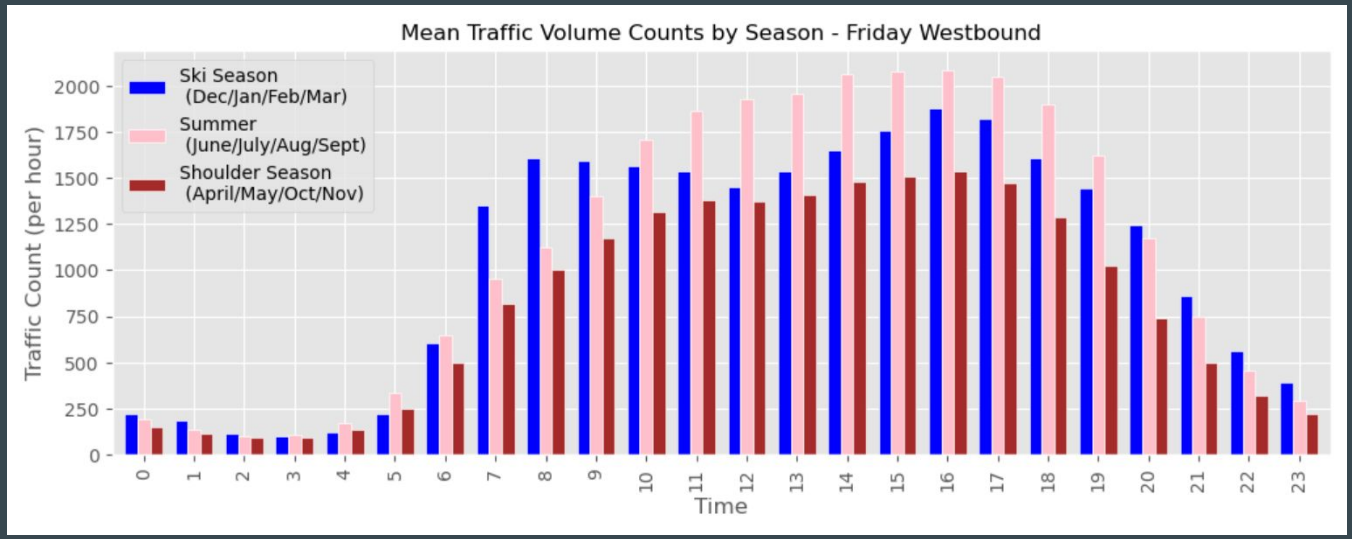
	Weekday	Hour	Count_ESki	Count_WSki	Count_ESummer	Count_WSummer	Count_EShoulder	Count_WShoulder
0	Monday	0	98.393617	112.861702	141.000000	157.190000	97.864583	120.229167
1	Tuesday	0	73.829787	112.648936	106.610000	146.740000	87.250000	119.760870
2	Wednesday	0	83.821053	122.231579	108.792079	152.405941	85.861702	121.553191
3	Thursday	0	82.263736	168.307692	119.163462	174.750000	84.626374	142.241758
4	Friday	0	86.645833	221.656250	125.184466	190.902913	84.872340	148.606383
...	...	...	...	...	...	...	...	...
163	Wednesday	23	113.705263	225.778947	170.831683	221.831683	127.265957	171.542553
164	Thursday	23	126.329670	303.604396	185.528846	253.211538	127.439560	199.142857
165	Friday	23	145.250000	391.322917	208.776699	293.417476	138.446809	223.489362
166	Saturday	23	158.212121	195.101010	254.596154	244.259615	148.468750	185.010417
167	Sunday	23	146.956989	155.118280	227.471154	214.663462	146.854167	159.114583

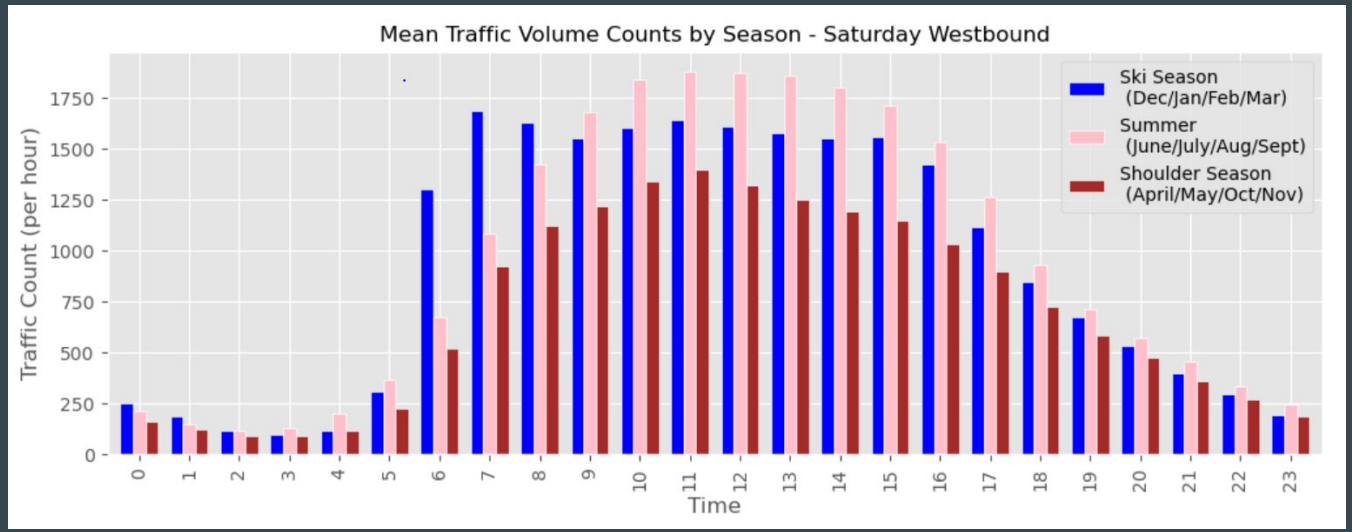
168 rows × 8 columns

Daily and seasonal trends in westbound traffic through the Eisenhower Tunnel:

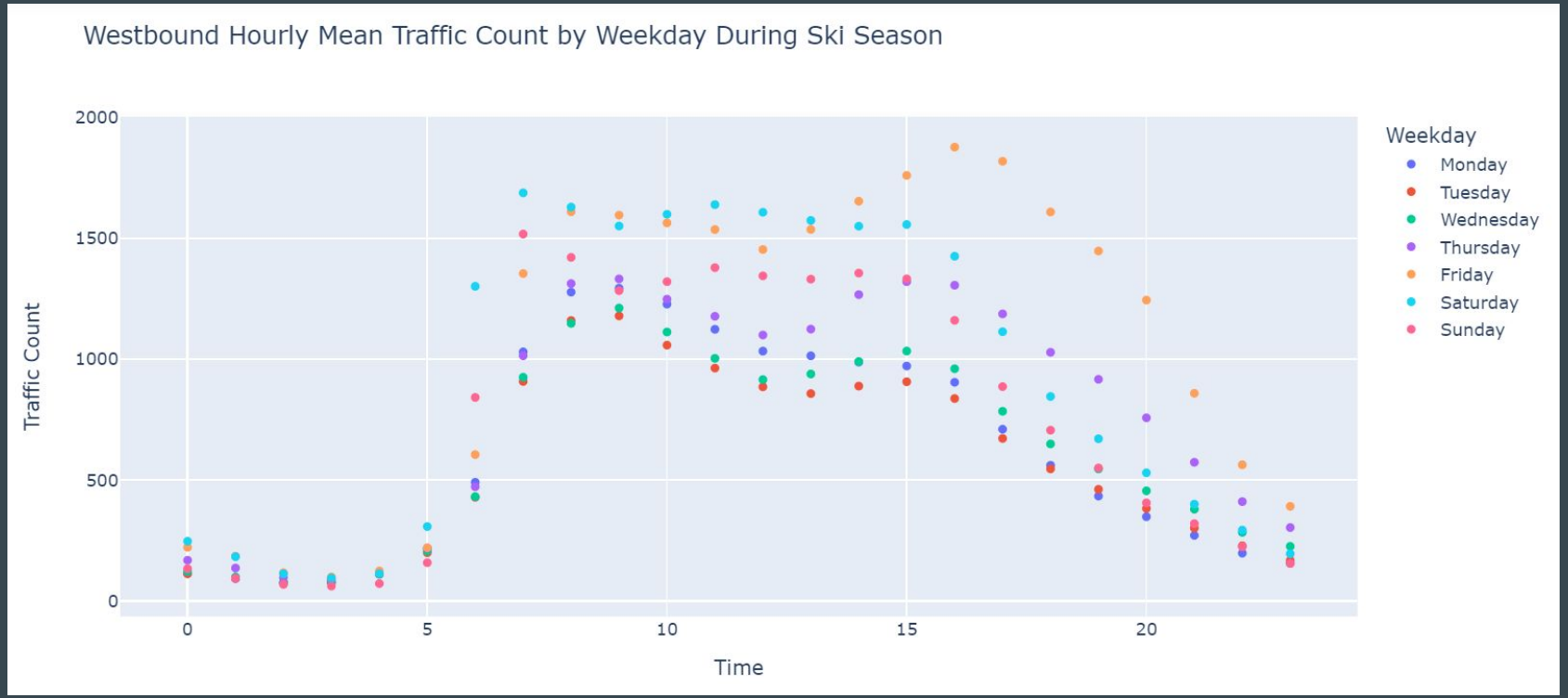
High volume in the morning during ski season on Fridays and Saturdays.

High volume on Friday afternoons in both ski season and the summer.

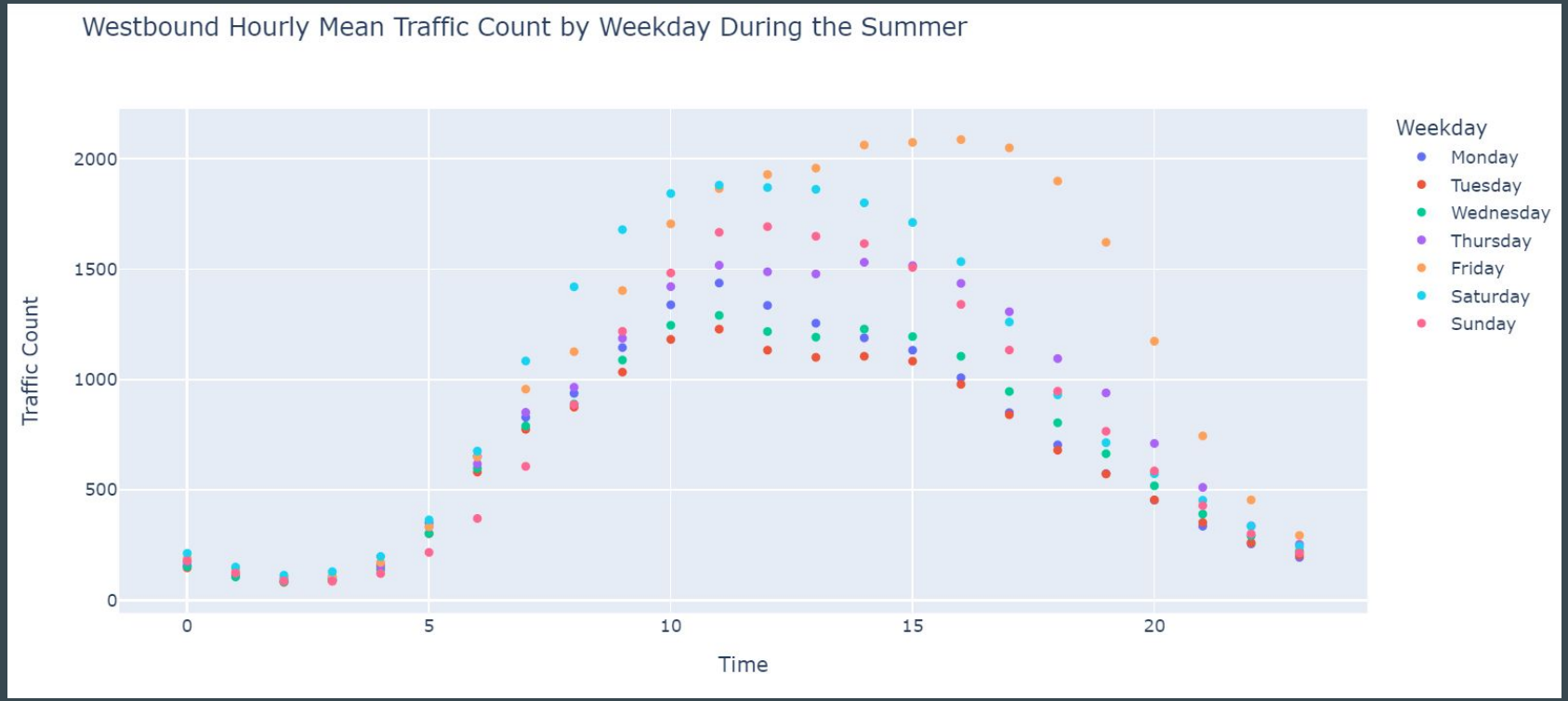




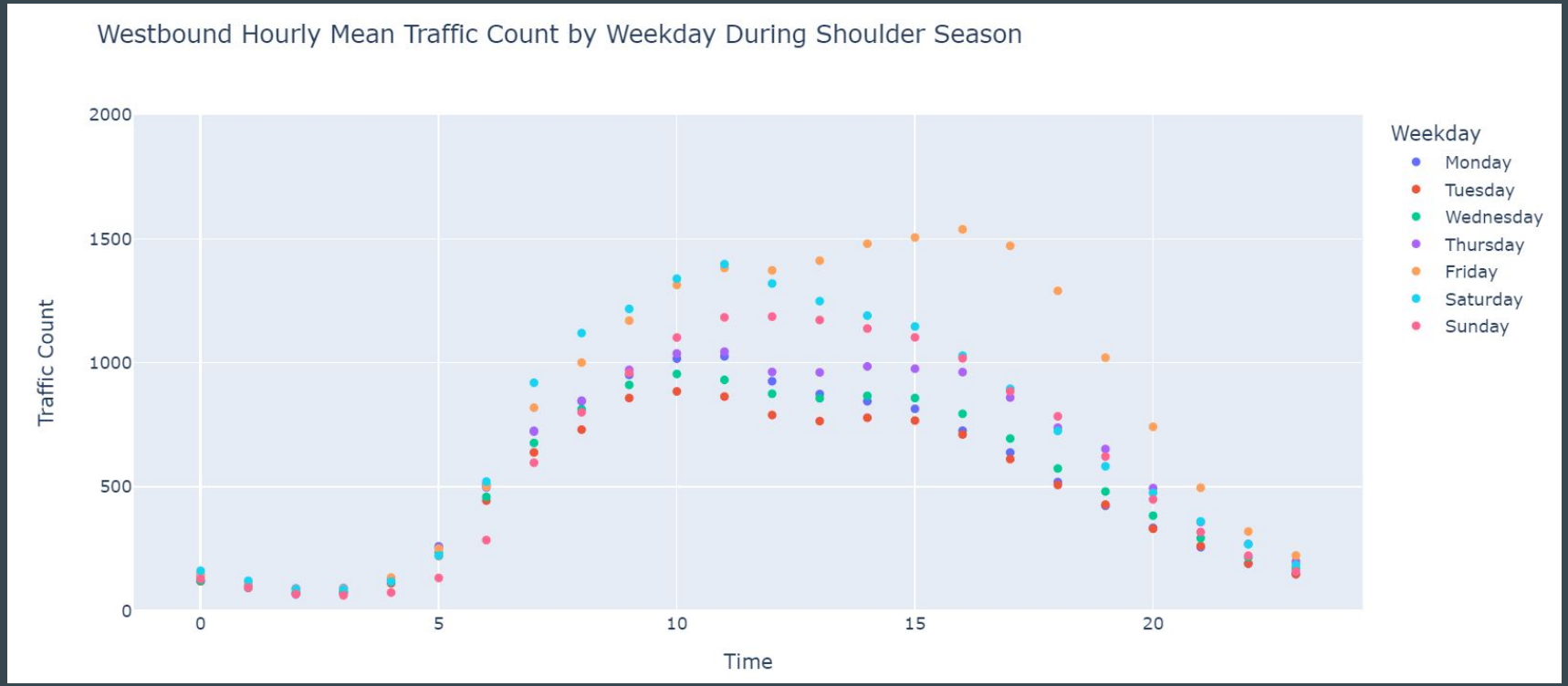
Daily trends westbound during ski season



Daily trends westbound during the summer



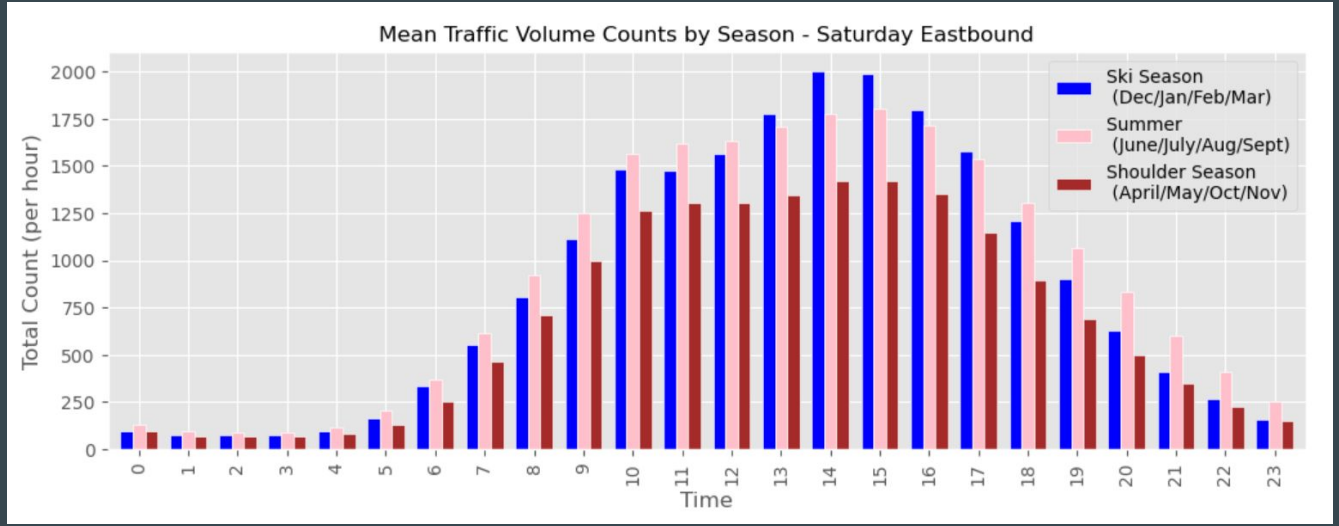
Daily trends westbound during shoulder season

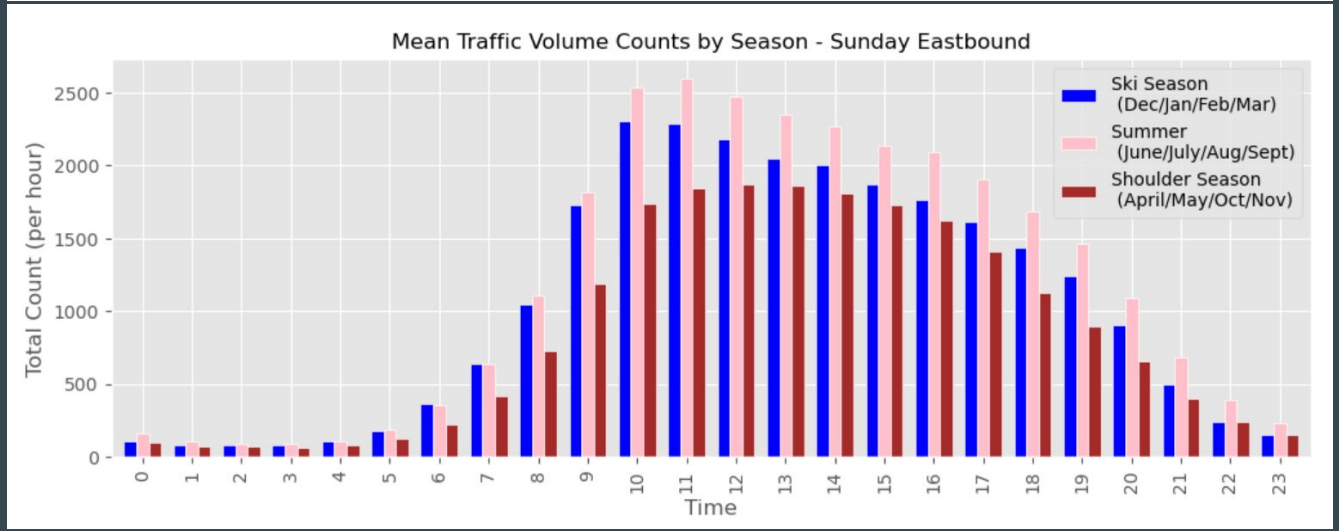


Daily and seasonal trends in eastbound traffic through the Eisenhower Tunnel:

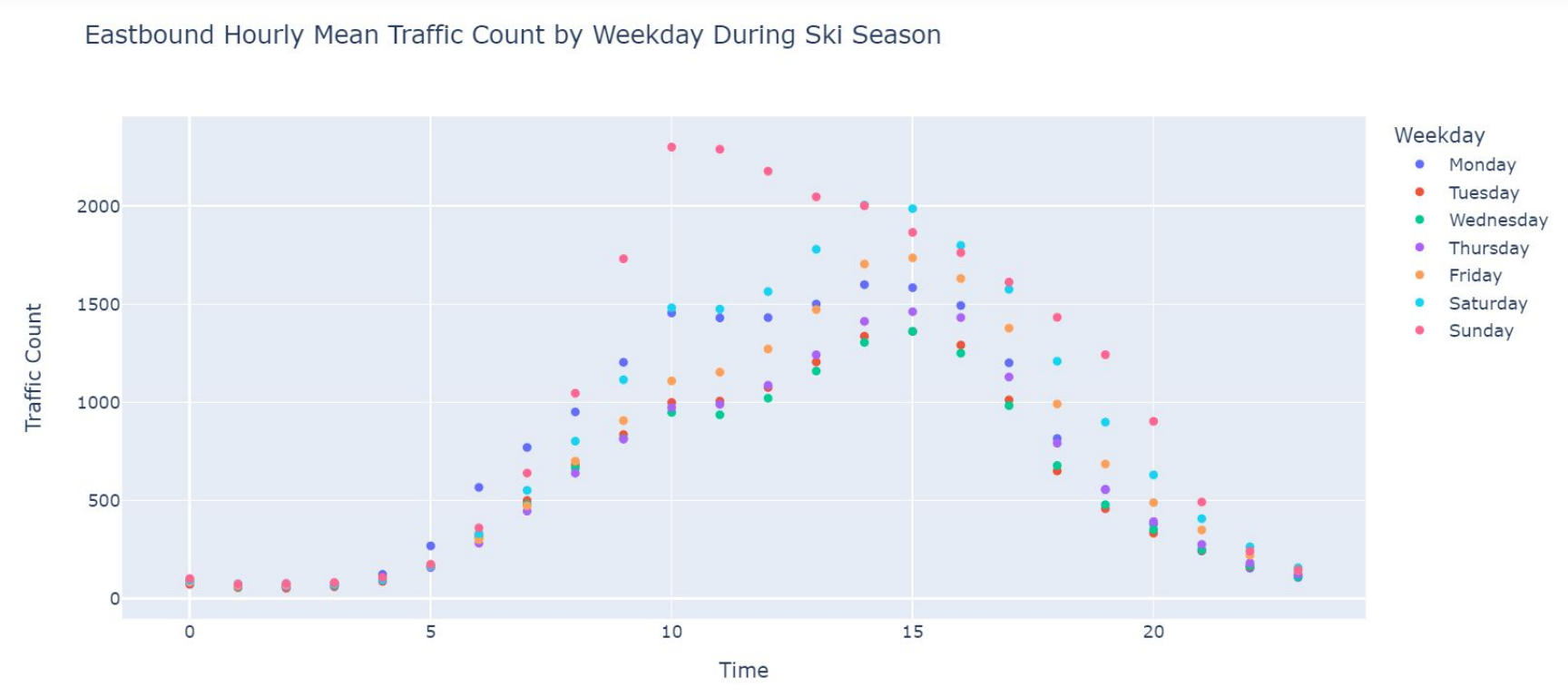
High volume Saturday and Sunday afternoons

Extremely high volume during ski season and the summer on Sunday mornings from 9 am to 12 pm.

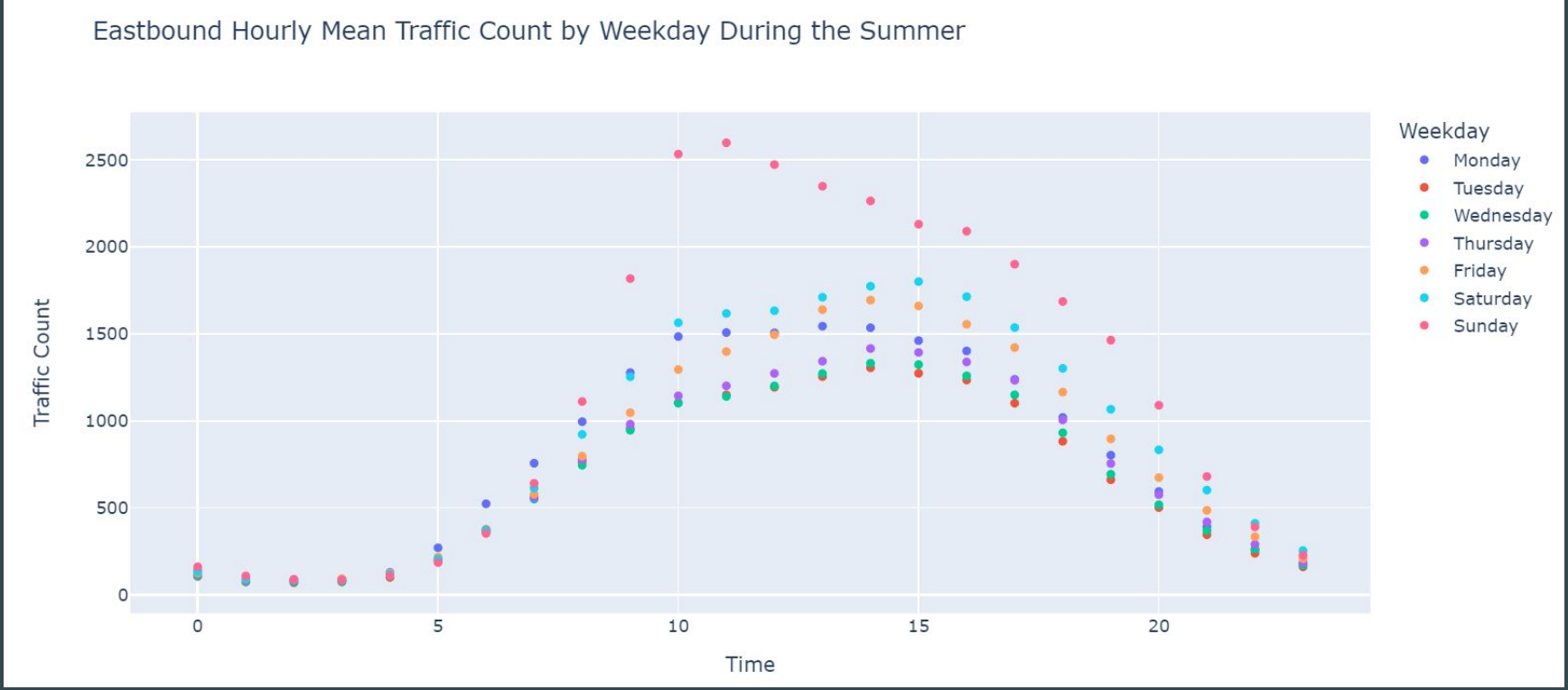




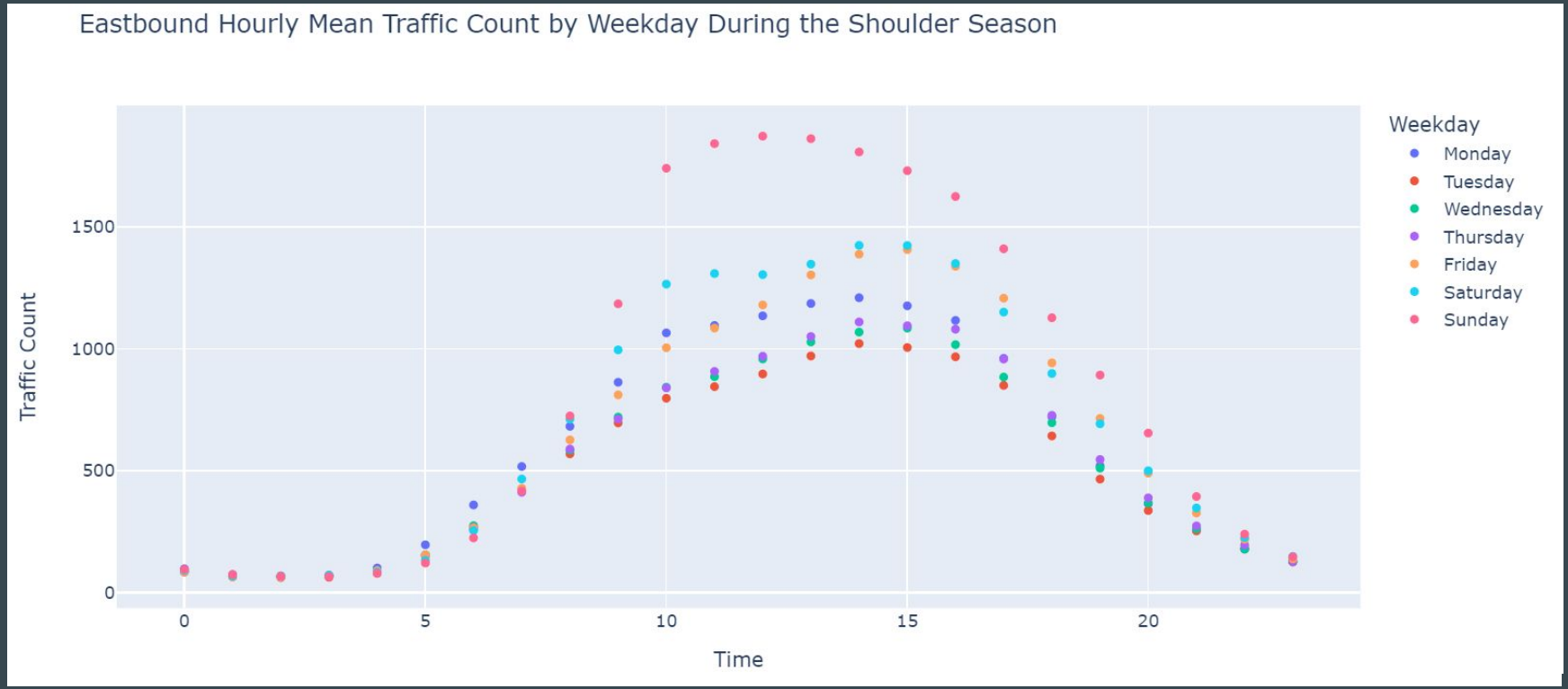
Daily trends eastbound during ski season



Daily trends eastbound during the summer



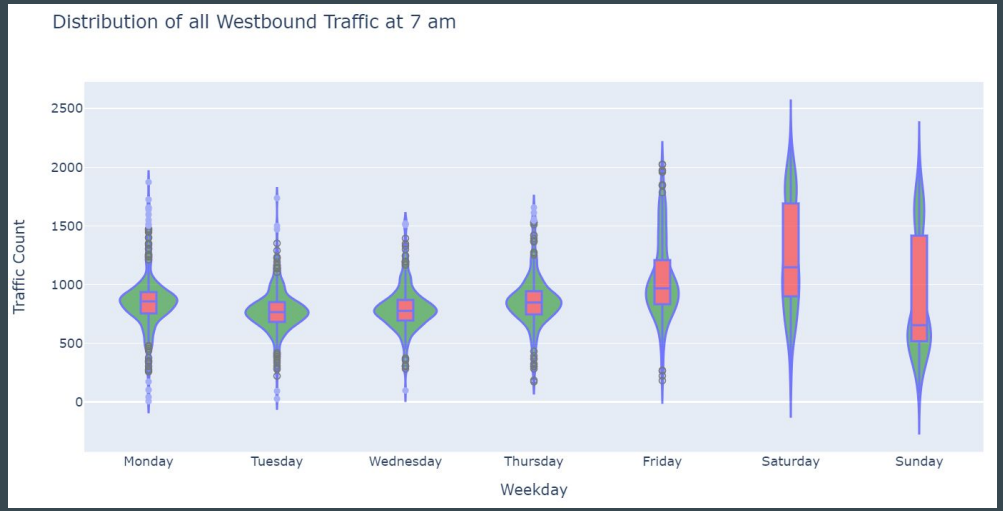
Daily trends eastbound during shoulder season

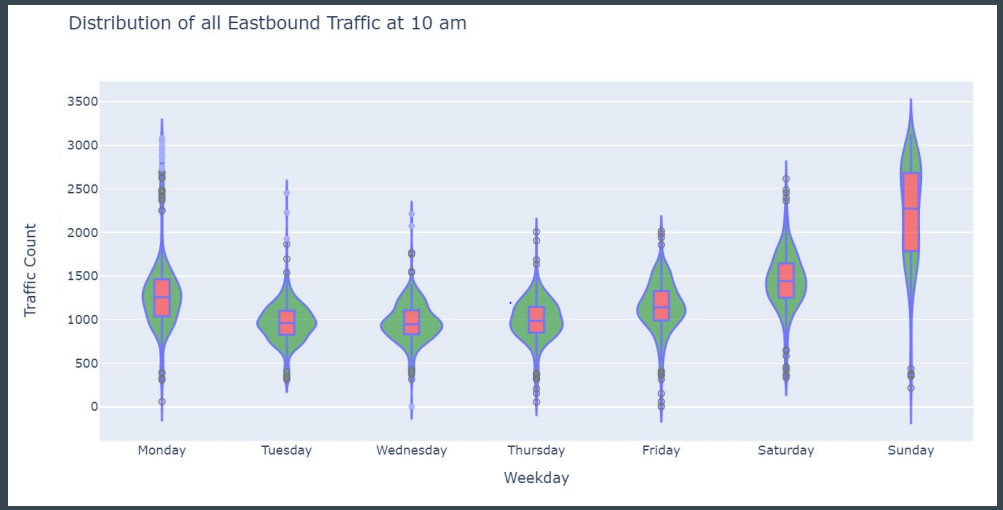


Violin plots at two high volume traffic times:

Weekend mornings are potentially high volume times going westbound depending on the season.

Sunday morning is always a high volume time going eastbound but how bad the traffic will be is unpredictable.





Conclusions:

1. There is no statistical difference in westbound winter traffic pre and post-pandemic, but a very clear difference during covid.
2. When driving westbound:
    a. Avoid leaving Denver between 2 and 6 pm on Fridays. Even during shoulder season there is likely to be traffic.
    b. Try to leave Denver by 5 am on Saturdays and Sundays during ski season.
3. When driving eastbound:
    a. The huge spike in Sunday morning traffic (particularly in the summer) is likely visitors on their way to the airport. If you need to be on the road between 10 am and 2 pm make sure you leave with plenty of extra time to be at the airport.
    b. Expect heavy traffic between 2 pm and 6 pm on Saturdays and Sundays.
4. Adding more public transportation to and from Denver at peak travel times could reduce traffic (Bustang and Vail Mountain Express could both expand).
5. A toll at the Eisenhower Tunnel at peak travel times could alleviate traffic and generate revenue for roads.

Future Work

Analyze other continuous traffic stations in the area to see if the patterns correlate with those at the Eisenhower Tunnel.

Analyze traffic stations near Winter Park, CO where they have introduced a commuter train to see if there is a difference in their traffic patterns.

How to decrease commuter traffic on CO I-70 between Denver and Vail?

- Right now there is not a good public transportation option and there are no existing train tracks.
- How many buses would be needed to make a difference, and more importantly, how could people be motivated to use them?

“The key is that people will use public transportation if it is fast, comfortable and has a reliable schedule. Modern commuter rail has these properties while buses do not, and during bad weather, rail is often reliable while roads are not.” -Christof Stork

https://coloradonewsline.com/2023/11/01/return-of-vail-area-passenger-rail-gains-support-among-some-leaders/