Here WeGo!

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Are there any troublesome stops or routes?

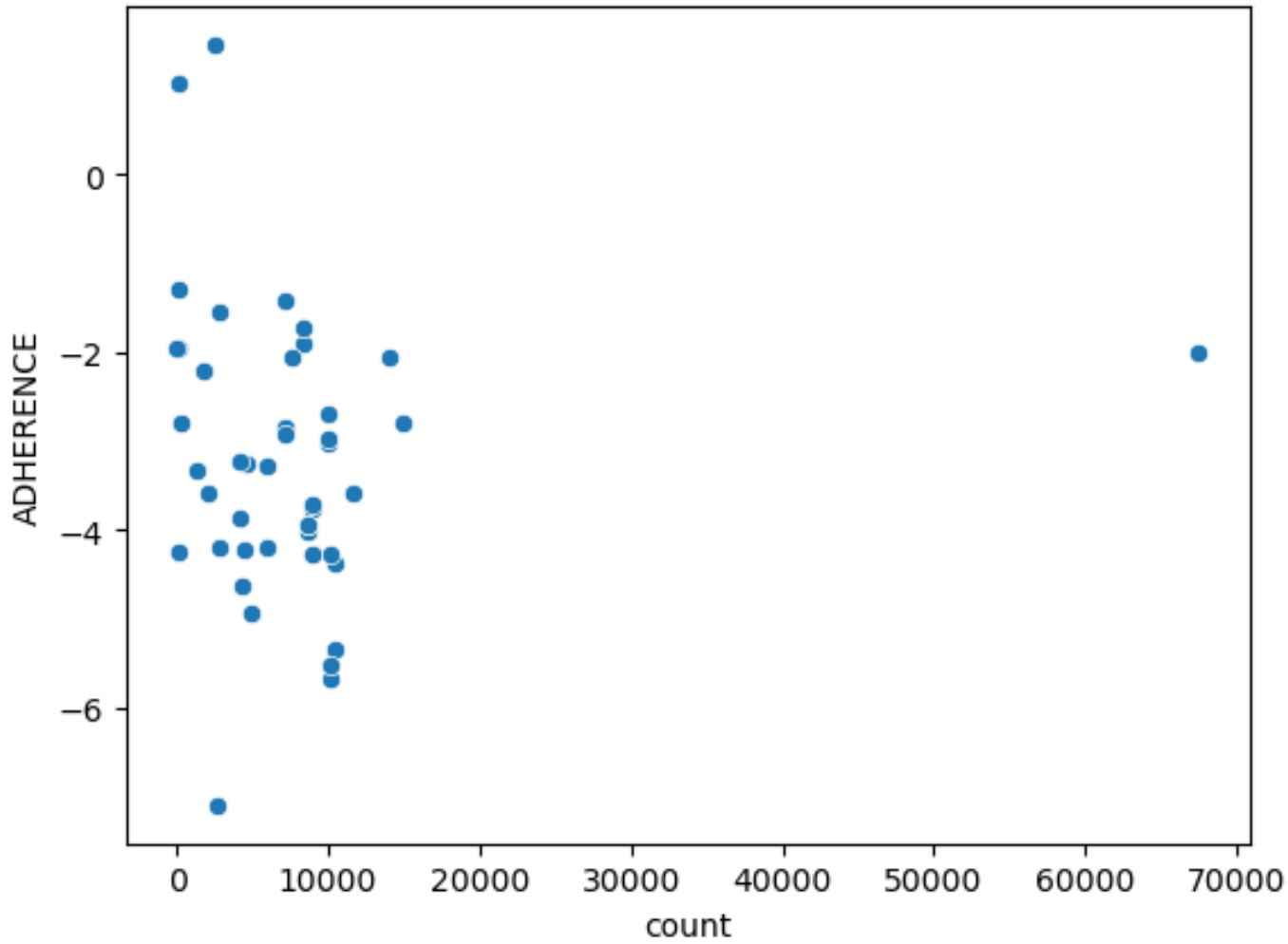
- We explored overall adherence at all stops as well as each route.
- Aggregated data for each stop and route as well as number of checkpoints to see if the higher volume stops had any deterioration of adherence.
- Routes were inspected with generalized maximum sequence counts.

BUSIEST BUS STOPS

TIME POINT	Checkpoints	Average Adherence
MCC	67463	-2.01
GXRVRGAT	14954	-2.79
DWMRT	14085	-2.05
WHBG	11602	-3.58
MXTHOMP	10384	-4.36

CORRELATION: BUS STOP VOLUME vs MEAN ADHERENCE

Correlation: -9.80369661e-04



BUS STOP ADHERENCE

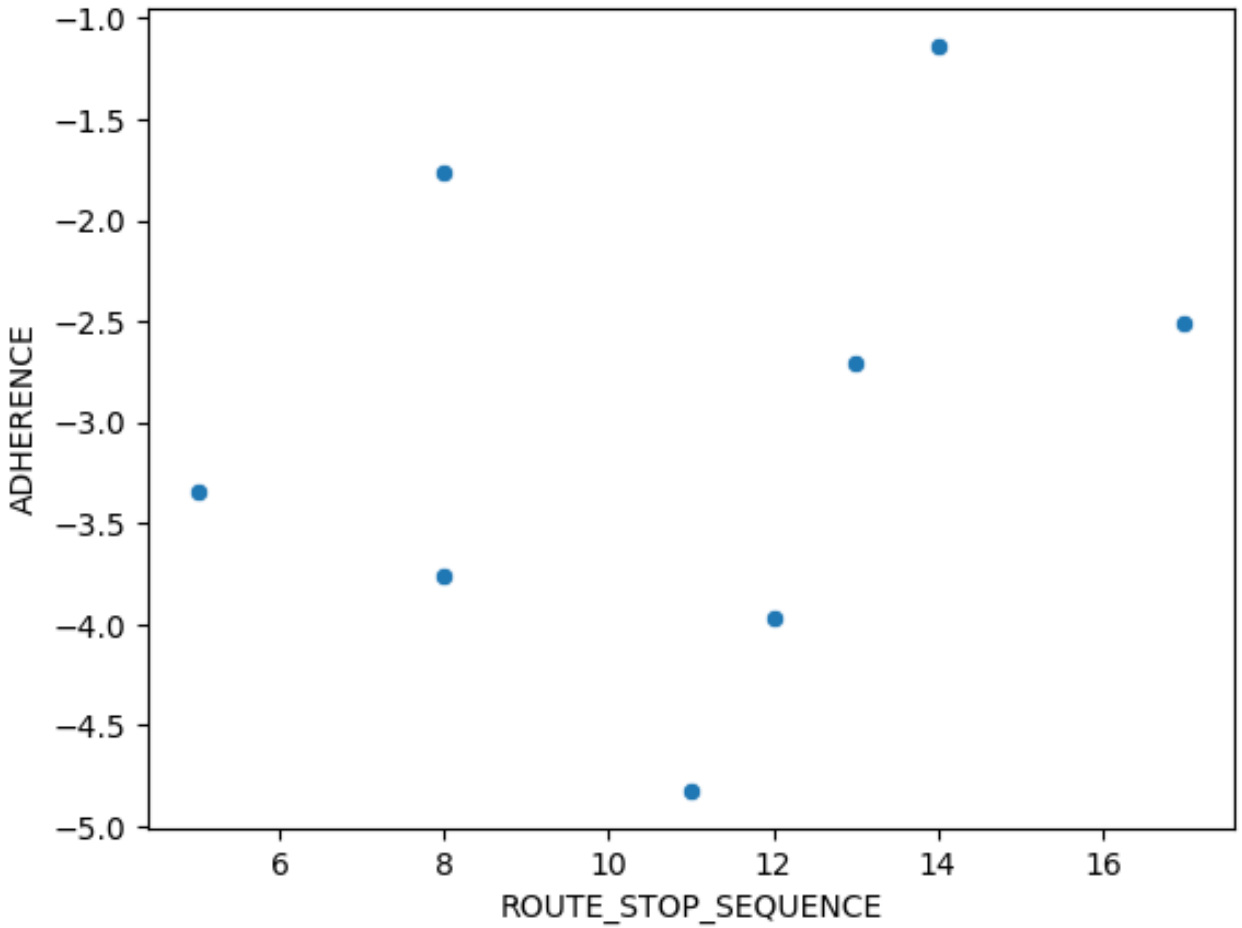
HIGHEST ADHERENCE DEVIATION

TIME POINT	Checkpoints	Average Adherence
DCSCC	2747	-7.09
MXDONEL	10194	-5.68
MXBELL	10194	-5.52
MXWHARF	10382	-5.34
SAMS	4992	-4.92

OVERALL ROUTE ADHERENCE

ROUTE	OVERALL MEAN ADHERENCE	MAXIMUM ROUTE STOP SEQUENCES
ROUTE 3	-3.76	8
ROUTE 7	-3.35	5
ROUTE 22	-1.14	14
ROUTE 23	-1.76	8
ROUTE 50	-2.51	17
ROUTE 52	-3.97	12
ROUTE 55	-4.82	11
ROUTE 56	-2.70	13

CORRELATION: ROUTE vs ADHERENCE



How much impact does being late or too spaced out at the first stop have downstream?

- We decided to explore adherence at the first stop along a bus route and the last stop.
- Our group explored this by grouping our data by bus routes and whether the bus is going downtown or coming from downtown.

DETAILED ROUTE ADHERENCE

ROUTES	Average Starting Adherence to downtown	Average Ending Adherence to downtown	Average starting adherence from downtown	Average ending adherence from downtown
ROUTE 3	-2.82,	-2.64	-3.18	-5.81
ROUTE 7	-2.19	-2.34	-2.62	-4.19
ROUTE 22	-1.07	2.27	-2.19	-0.42
ROUTE 23	-1.96	2.19	-2.48	-0.99
ROUTE 50	-2.24	-0.49	-3.08	-0.59
ROUTE 52	-2.46	-2.69	-3.9	-4.69
ROUTE 55	-2.7	-3.61	-3.76	-5.65
ROUTE 56	-1.74	1.56	-3.11	-4.91

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ROUTE 56	-1.74	1.56	-3.11	-4.91

ROUTE 7

HBHS, 21BK, MCC5_12

TO DOWNTOWN

- The correlation between the first stop and the last stop is 0.6279.
- Final stop = 0.8931(First stop) - 0.3846

FROM DOWNTOWN

- The correlation between the first stop and the last stop is 0.6616.
- Final stop = 1.0030(First stop) - 1.5649

ROUTE 52
HCKP, WMRT, THNV, NVFG, MCC4_19

- The correlation between the first stop and the last stop to downtown is 0.6550
- Final Stop = 0.8862(First Stop) -0.5048

ROUTE 55
HHWM, MXBELL, MXDONEL, MXTHOMP, MCC4_15

- The correlation between the first stop and the last stop from downtown is 0.6780.
- Final Stop = 1.0783(First Stop) - 1.5983


In order for the Bus route to arrive within 1 minute late, what time will they need to leave?

Staying on Schedule…

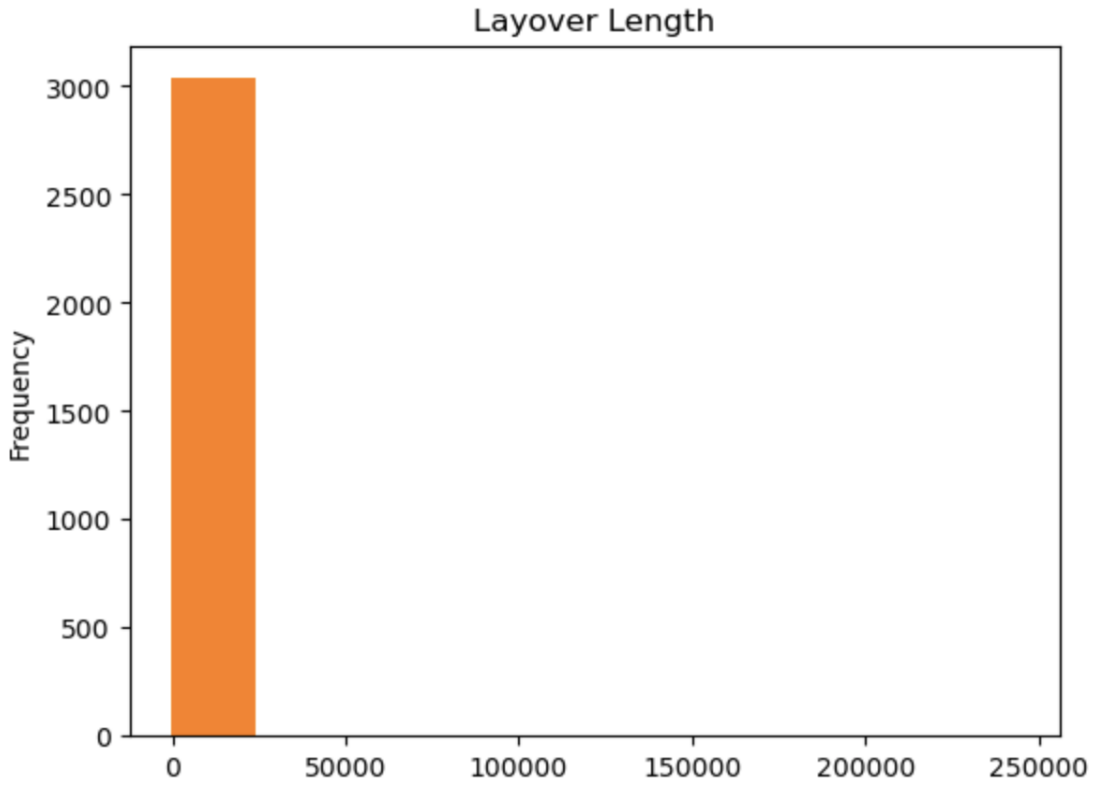
ROUTE 7 To Downtown	ROUTE 7 From Downtown	ROUTE 52 To Downtown	ROUTE 55 From Downtown
34 Seconds after scheduled departure time	33 seconds before scheduled departure time	25 seconds after scheduled departure time	28 seconds before scheduled departure time

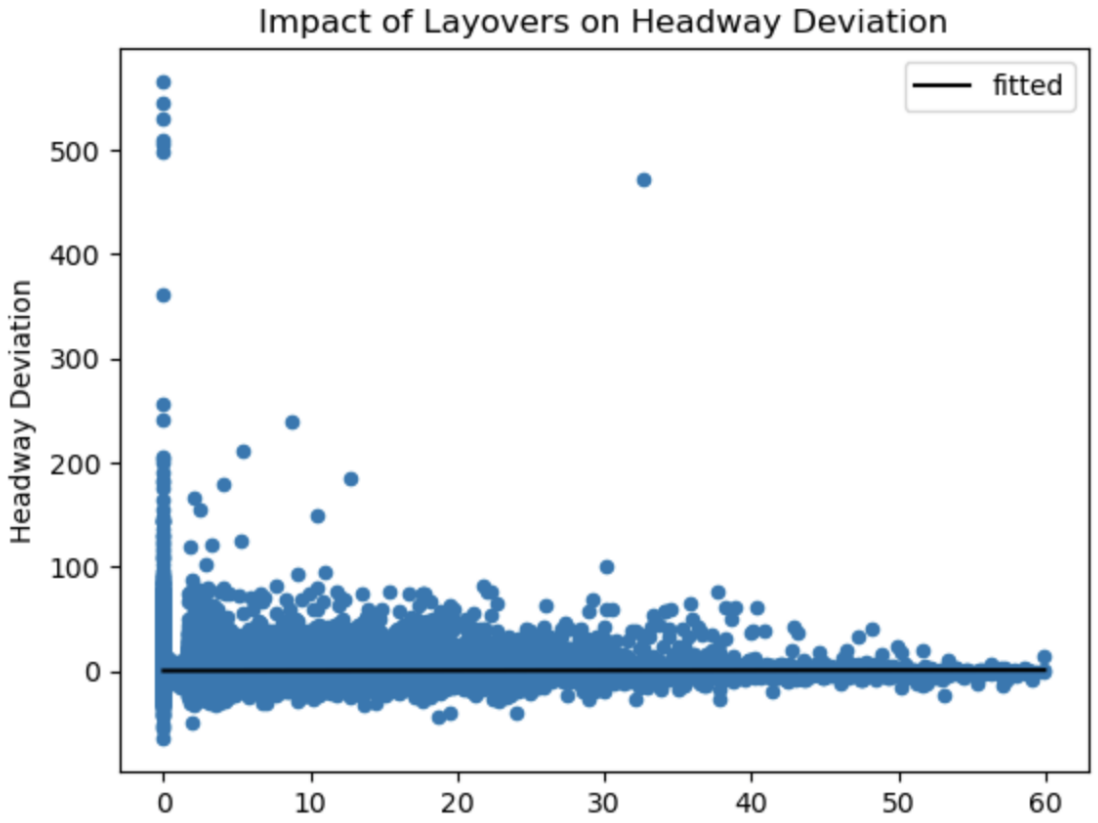
-1 = (coeff one)x + intercept

How much impact do layovers have on being too spaced out downstream?

- We decided to explore the impact of layovers on headway deviation.
- Data is grouped by bus routes, and extreme outliers removed by limiting layovers to one hour.
- Negative values were dropped, and headway deviation is represented by the change in headway deviation between stops, to better illuminate the impact.

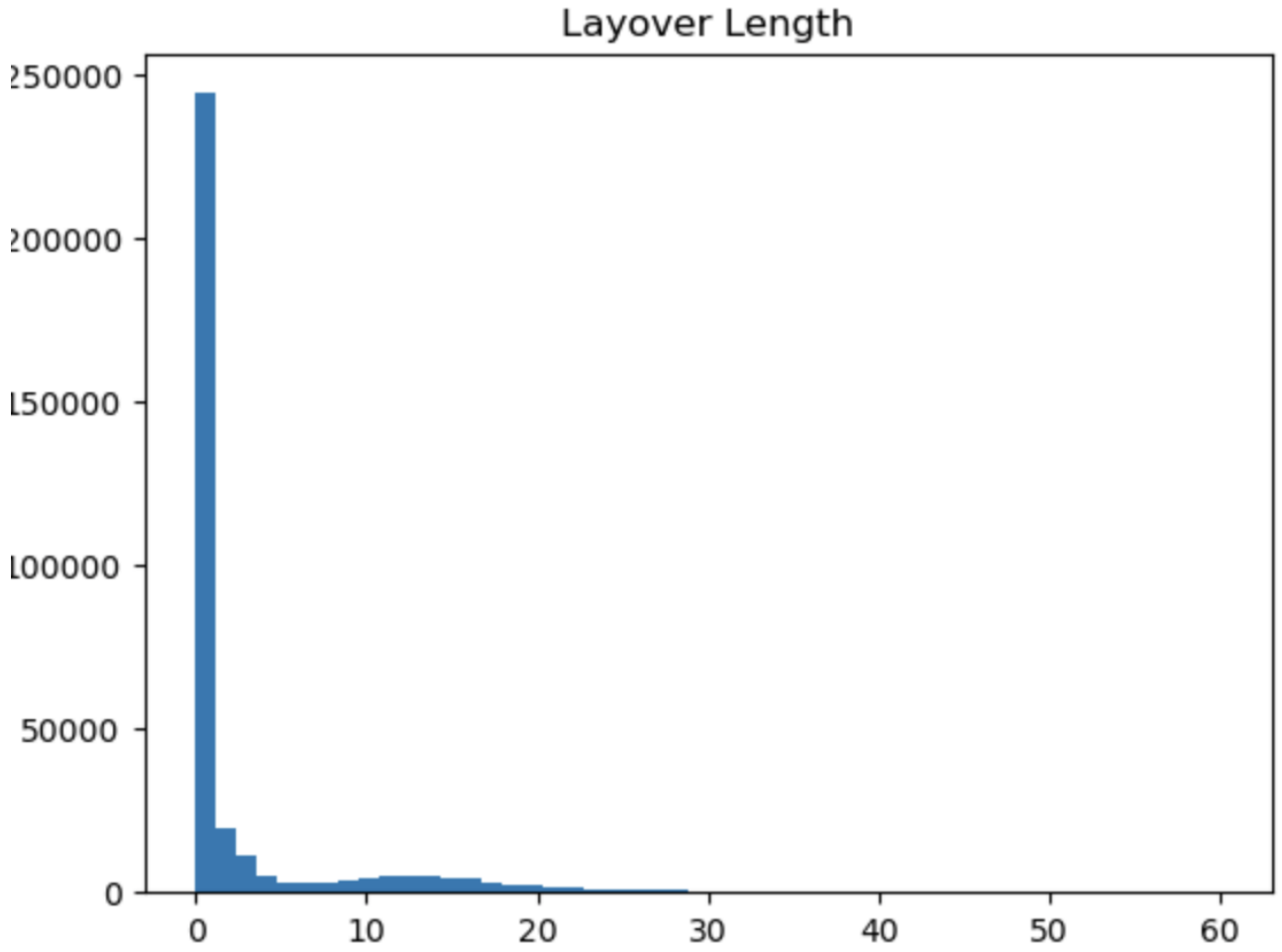
How It Started





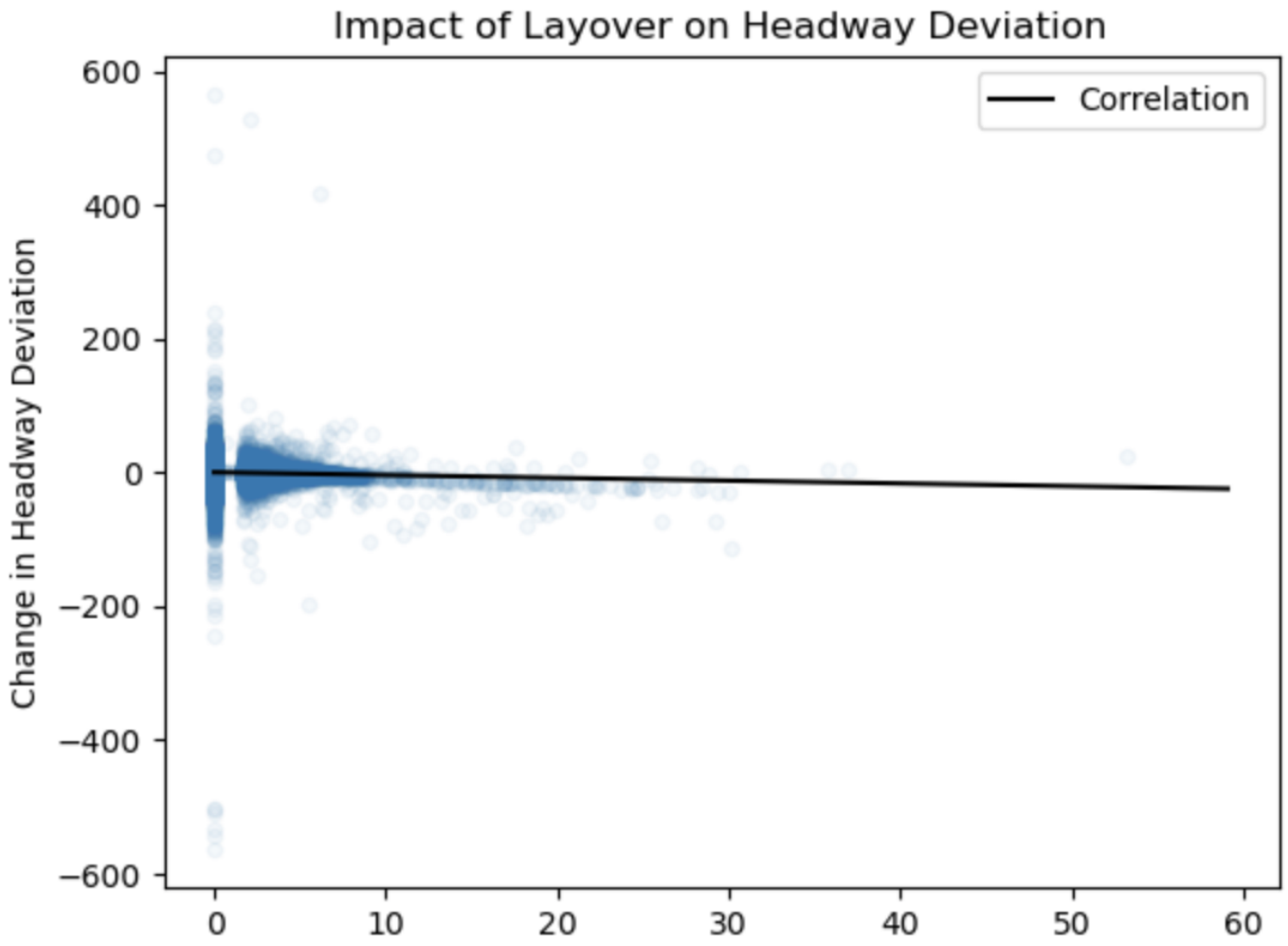
How long are buses usually waiting?

- The average layover is 2.93 minutes.
- The vast majority of layovers are recorded at or near zero, which may be an artifact of the data collection device rather than reflective of reality.



How does the wait time impact headway deviation?

- For every additional minute of layover, there is a 0.42 minute decrease in headway deviation.
- The p-value was 0.000, but R2 was .005, so it's possible the real-world impact is negligible.



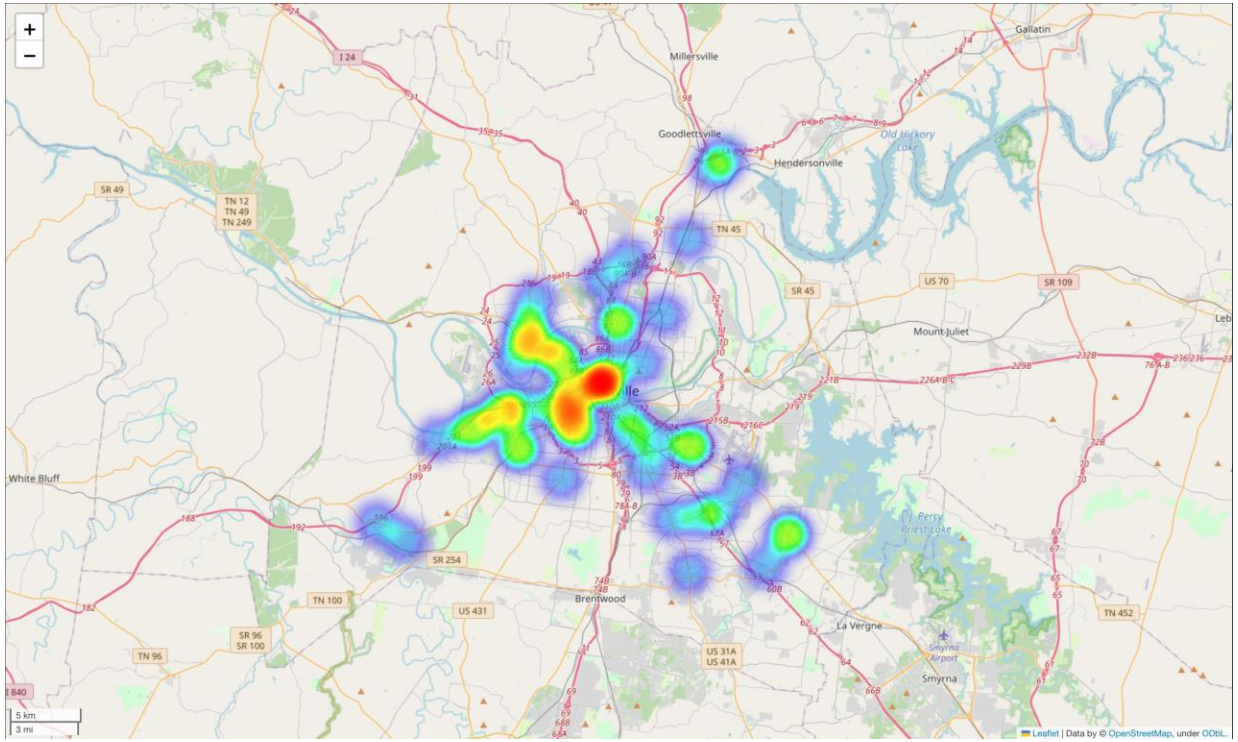

BUS
STOP

Caveats / Limitations to Keep in Mind

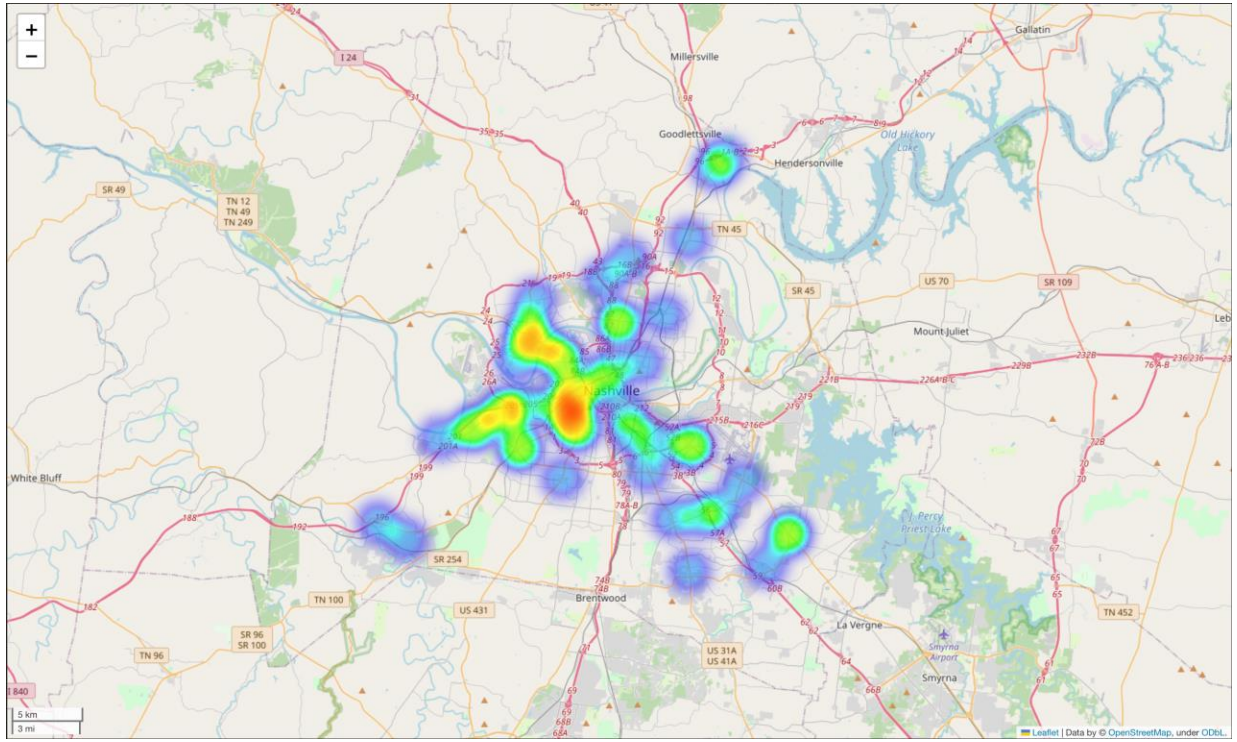
- Data collection (observing from the dataset that we were given) only shows data from certain stops.
  - Therefore, absence of evidence doesn't necessarily mean/imply evidence of absence.
  - In this case, just because we don't see data points of lateness, doesn't mean that lateness isn't happening at that locale. We simply just don't know (for locales that aren't represented in the dataset).
  - Cautionary note against making overreaching conclusions.
- A combination of deductive and inductive reasoning / analyses.
  - Convenience sampling from experience is deployed here for some (NOT all) of the analyses, due to constraints in human resource.
  - Instead of all-inclusive inductive analysis for everything about everything, which would be the most robust approach / study design.

Heat Maps for
All Uneventful Trips with Overload_ID == 0

Adherence (segmented to visualize **Lateness**)



Adherence (segmented visualize to **Earliness**)

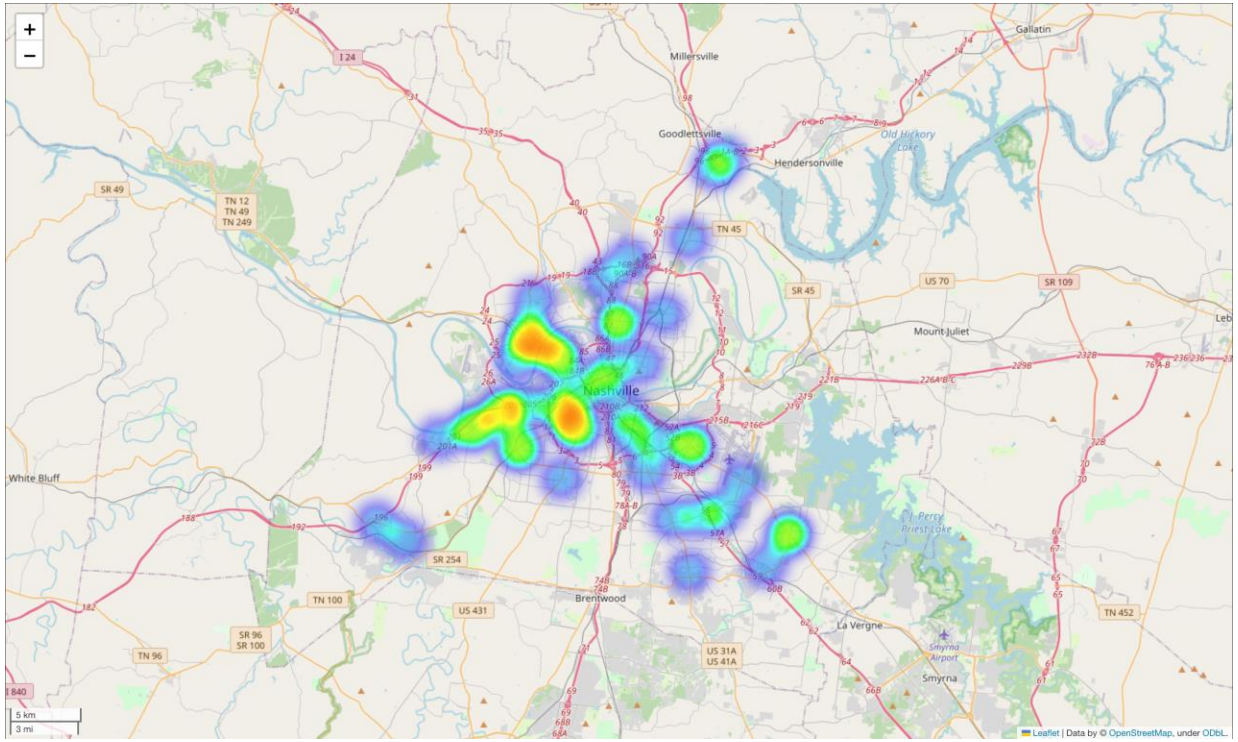


Color scale: {0.4:"blue", 0.6:"cyan", 0.7:"lime", 0.8:"yellow", 1:"red”}

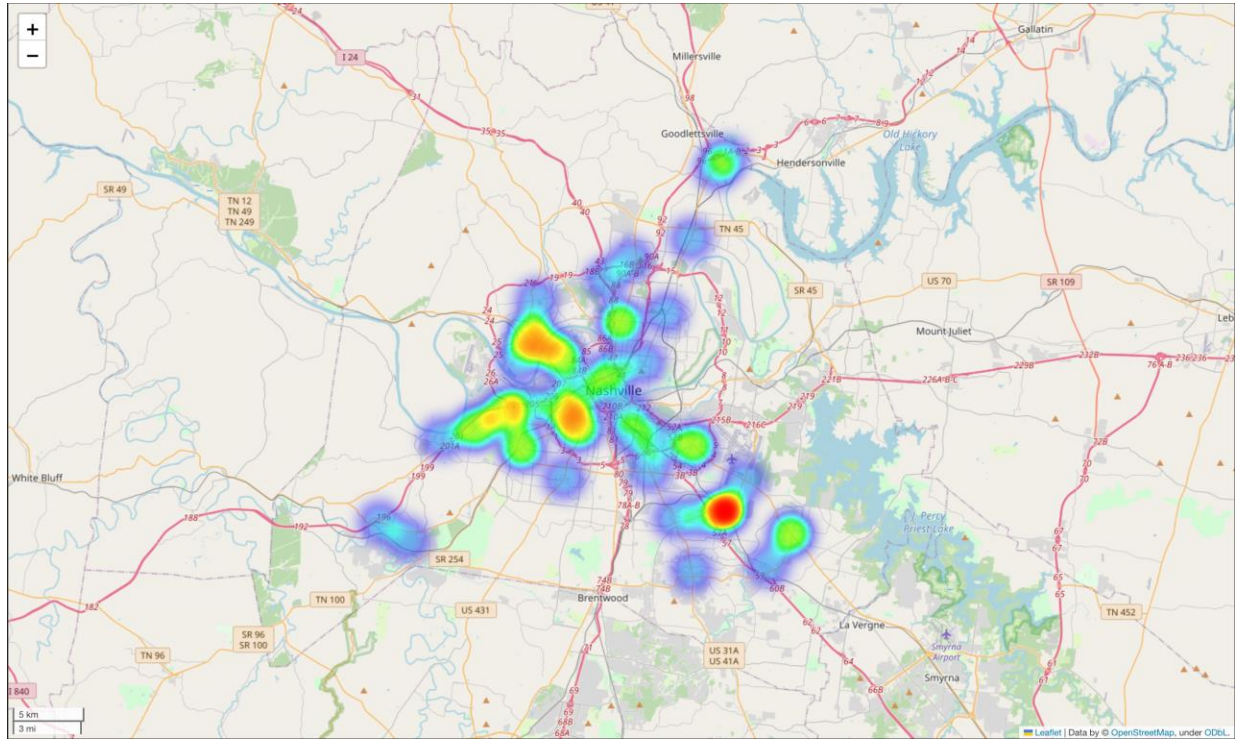
Mathematical Scale: Magnitude of Adherence Deviation / Range of Min ~ Max in Adherence Deviation

Overview – Cont’d

Headway Deviation (segmented to visualize Bunching)



Headway Deviation (segmented to visualize Gapping)



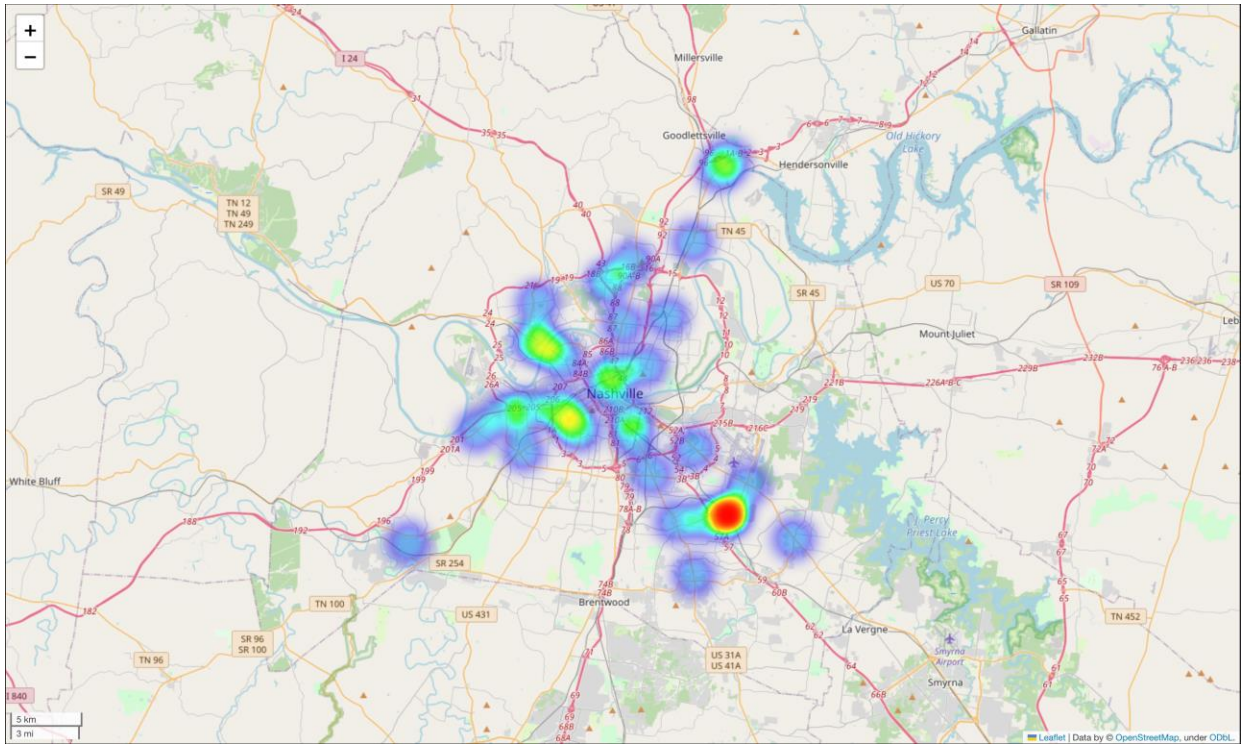
How Traffic Can Impact Adherence & Headway Deviation

e.g. Route 22, going the same direction as PM congested traffic: from Downtown → Suburb

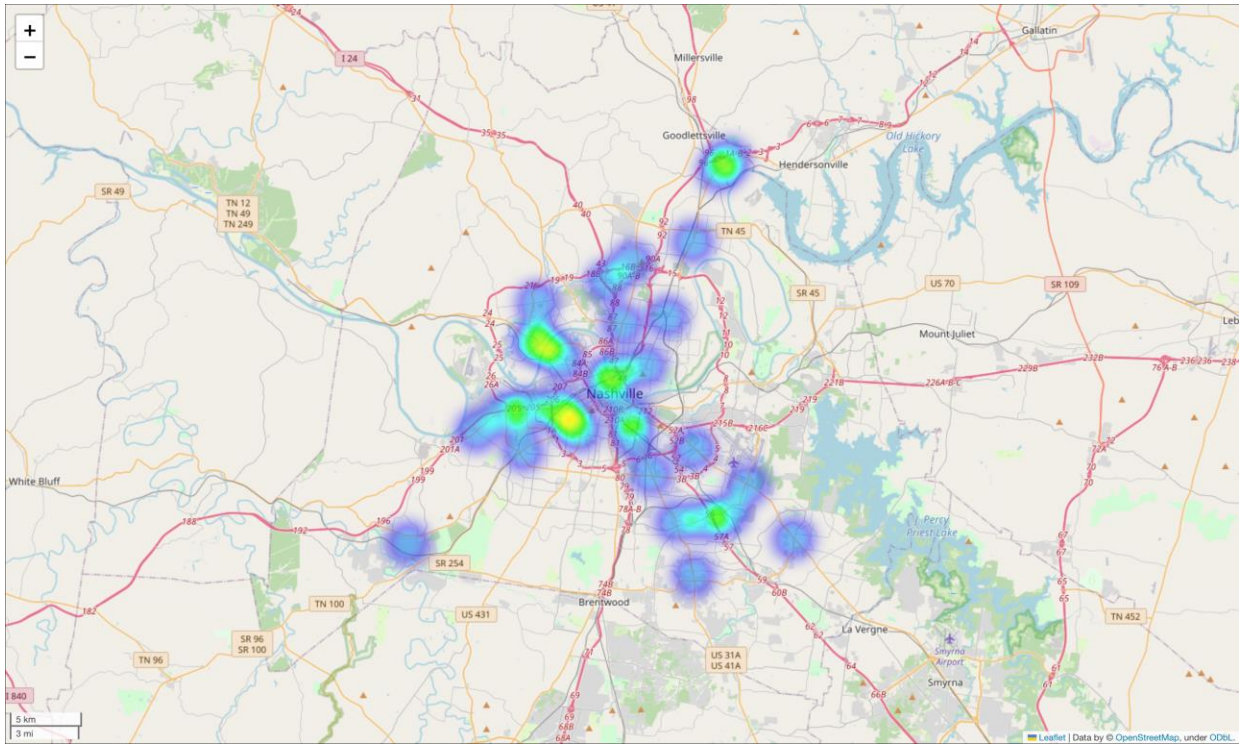
SCHEDULED_TIME	ACTUAL_ARRIVAL_TIME	ACTUAL_DEPARTURE_TIME	ADHERENCE	SCHEDULED_HDWY	ACTUAL_HDWY	HDWY_DEV
8/1/23 16:25	8/1/23 16:10	8/1/23 16:27	-2.816666	12	10.633333	-1.366667
8/1/23 16:38	8/1/23 16:41	8/1/23 16:41	-3.8	12	12.866666	0.866666
8/1/23 16:44	8/1/23 16:49	8/1/23 16:49	-5.433333	50	49.683333	-0.316667
8/1/23 16:50	8/1/23 16:54	8/1/23 16:54	-4.3			

Too Cool for School?
Overall Post-3 p.m. Traversing with Direction of Congested Traffic
Juxtaposition of Headway Deviation
Last full week of August: School in Session

Segmented to visualize **Gapping**

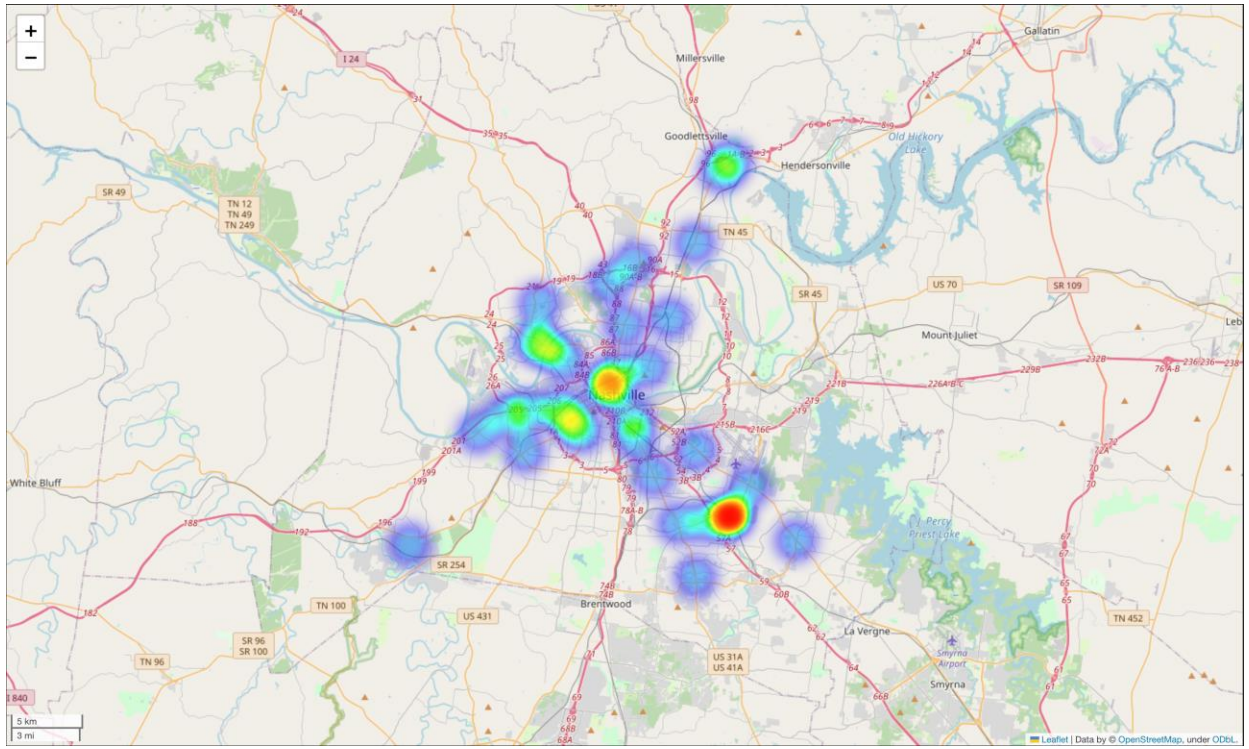


Segmented to visualize **Bunching**

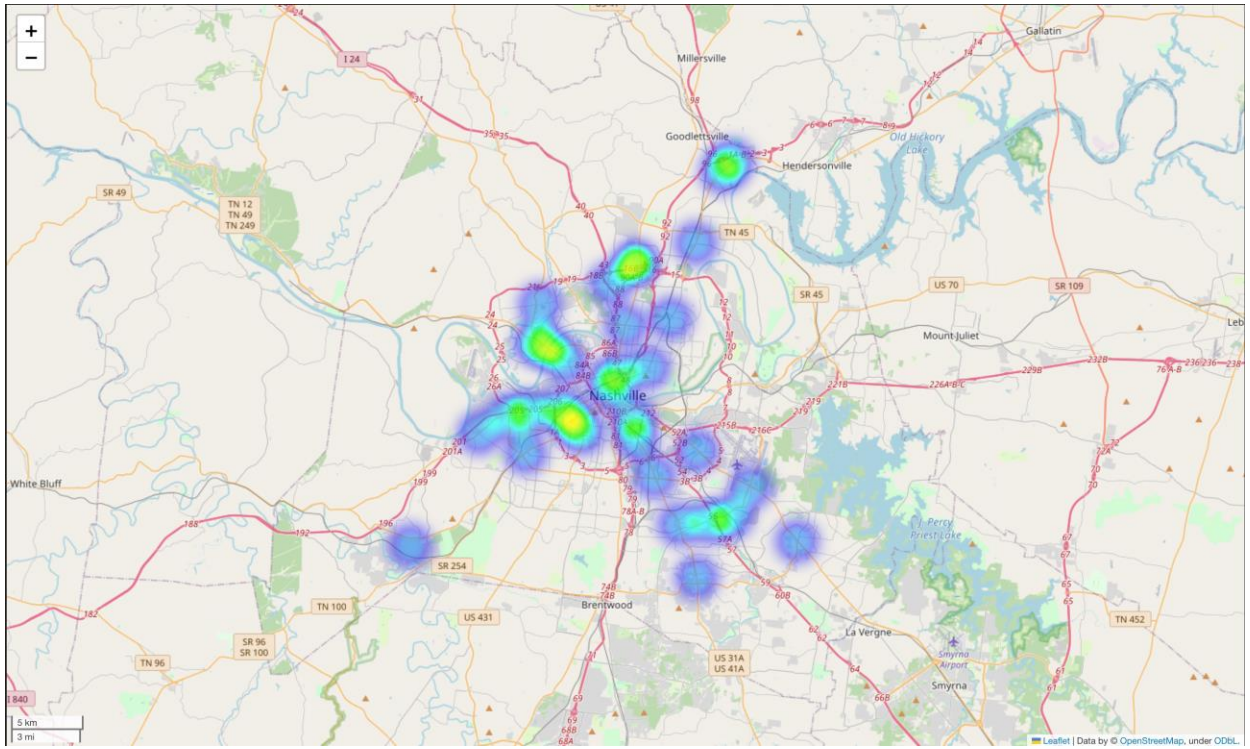


Too Cool for School?
Overall Post-3 p.m. Adherence Juxtaposition
First week of August: School NOT in Session

Segmented to visualize **Gapping**



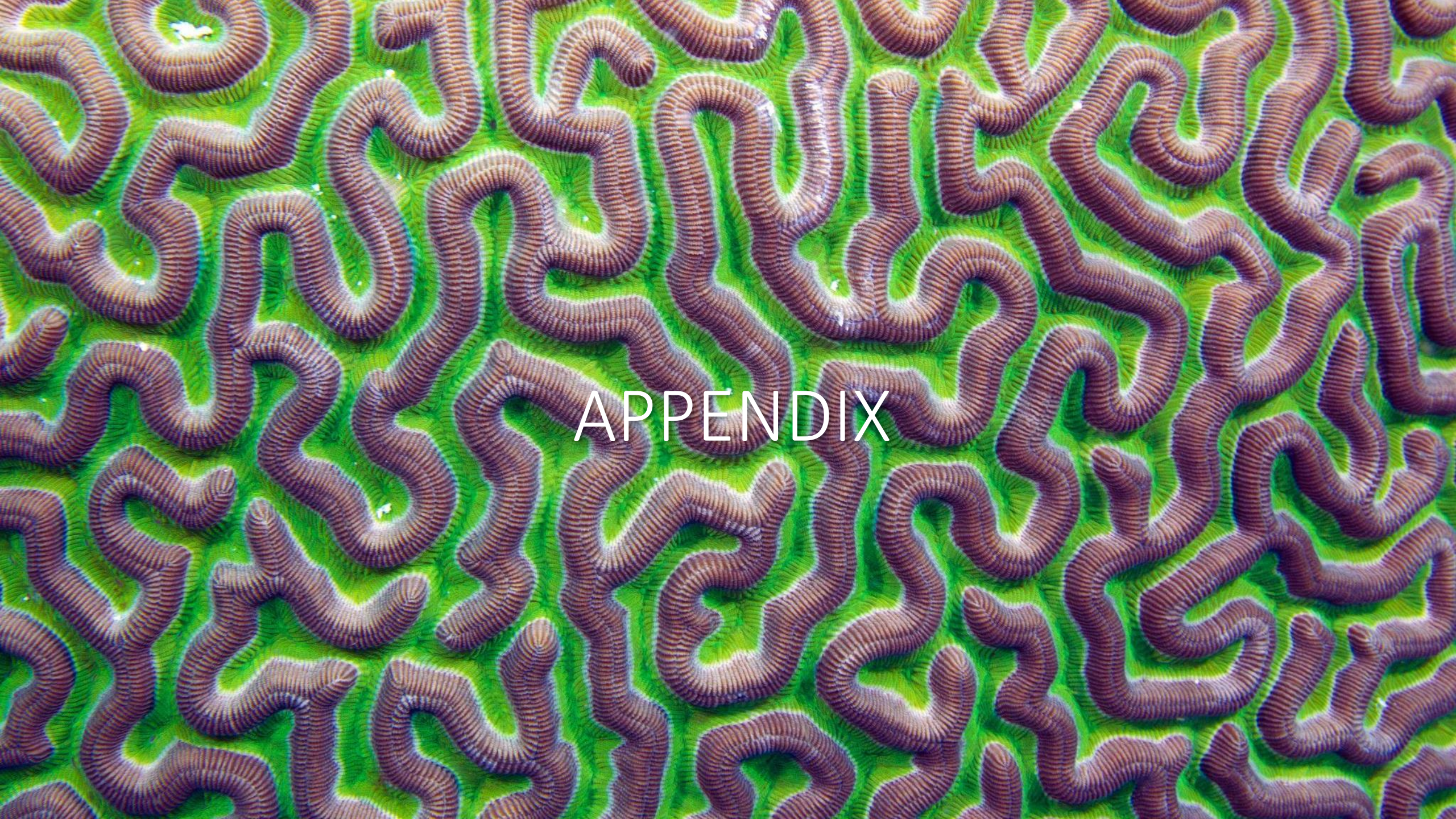
Segmented to visualize **Bunching**



Further studies

- Route-specific patterns
  - E.g. Route 3 during the School Year vs. outside of School Year
    - Arguably the route that passes most number of schools (public & private)
- Adherence analyses
- **Potential action steps to consider**:
  - adjust/refine published bus schedule to further improve planning / rider expectation at a more granular resolution

Thank you & Questions?


APPENDIX

ROUTE ADHERENCE

ROUTES	AVERAGE STARTING & ENDING ADHERENCE TO DOWTOWN In minutes		AVERAGE STARTING & ENDING ADHERENCE FROM DOWTOWN In minutes		TO DOWTOWN CORRELATION	FROM DOWNTOWN CORRELATION
ROUTE 3	-2.82,	-2.64	-3.18	-5.81	0.500	0.3829
ROUTE 7	-2.19	-2.34	-2.62	-4.19	0.6279	0.6616
ROUTE 22	-1.07	2.27	-2.19	-0.42	0.3379	0.5094
ROUTE 23	-1.96	2.19	-2.48	-0.99	0.3598	0.4210
ROUTE 50	-2.24	-0.49	-3.08	-0.59	0.4117	0.4925
ROUTE 52	-2.46	-2.69	-3.9	-4.69	0.6550	0.5315
ROUTE 55	-2.7	-3.61	-3.76	-5.65	0.5392	0.6780
ROUTE 56	-1.74	1.56	-3.11	-4.91	0.2048	0.2714

ROUTE 7 To Downtown	ROUTE 7 From Downtown	ROUTE 52 To Downtown	ROUTE 55 From Downtown
-0.57 minutes or 34 Seconds after scheduled departure time	0.56 minutes or 33 seconds before scheduled departure time	-.43 or 25 seconds after scheduled departure time	0.48 or 28 seconds before scheduled departure time

-1 = (coeff one)x + intercept

Appendectomy – The End