

FIT 5137 Assignment 5 – GPX Report

The Analysis and Visualisation of Geospatial Data from a Driving Route

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Table of Content

1. Introduction -----	3
2. Methodology -----	3
3. Results -----	4
4. Conclusion -----	8
Reference -----	9
Appendix -----	10

1. Introduction

The report presents an in-depth analysis of the geospatial data recorded during a driving route within Melbourne, Victoria. The purpose of the analysis is to provide insights into various aspects of the recorded route.

The data was collected with the GPS Tracker mobile application, and the route is chosen since it aligns with my frequent traveled path. The analysis and data visualisations are dedicated to illustrating the facets, including the calculation of average speed, the enumeration of red lights and roundabouts within the route, and an exploration of the suburbs traversed.

2. Methodology

- Data Exploration and Analysis**

The data collection process involved the GPS Tracker application. The collected data is saved in Google drive. To begin the exploration, the data is retrieved from Google Drive and imported into DBeaver using the “ogr2ogr” program within a Docker Container, managed through terminal commands.

The endpoint of the route leads to an underground carpark where there is no internet connection. As a result, data points in the carpark remained unchanged for extended durations. These carpark data points are excluded from the entire route to ensure the accuracy of average speed calculations during the data-cleaning process.

In addition, the analysis included an examination of encountering red lights and roundabouts in relation to both time and distance. The exploration associates mech blocks and suburb names, ultimately revealing the specific suburbs traversed by this route.

- Data Visualisation**

The data visualization process is carried out using QGIS. Data points and an OpenStreetMap are employed to depict the data point density and street conditions. This helps to identify the scenarios where data points exhibit minimal movement, implying the potential traffic light locations. To validate the hypotheses, an SQL script is applied to perform and ensure the encounter of the red lights. In addition, the number of roundabouts is also displayed by datapoints and an OpenStreetMap.

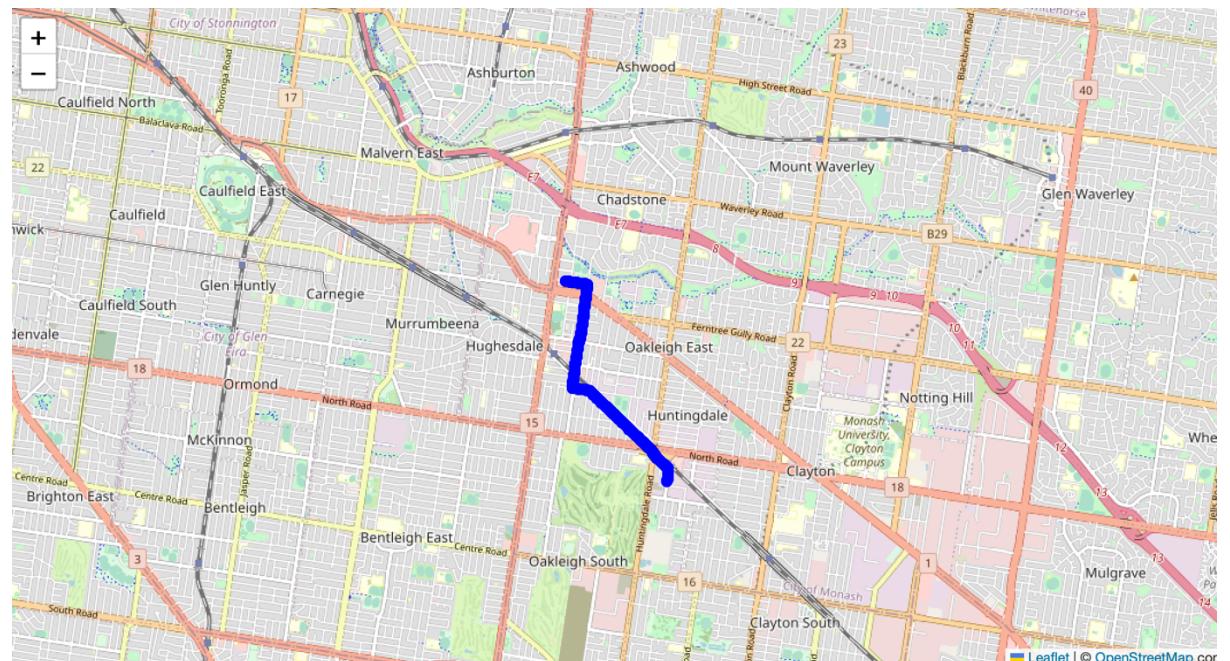
Furthermore, for the purpose of effectively illustrating the precise suburbs traversed by this route, data points are overlaid onto a map displaying the suburbs of Melbourne. The approach enhances the visualisation of the route's geographic trajectory.

3. Results

The analysis results are organized into three distinct categories, as outlined below.

- **Speed Analysis**

The spatial representation of the driving route is demonstrated in the following graph.



The objective of the speed analysis is to compute the average speed. This calculation relies on the data sourced from the restored table, specifically the total time and total distance, which are extracted and processed using an SQL script (refer to appendix for the code). The total time is 7 minutes and 29 seconds, covering an approximate total distance of 3.56 kilometres. Consequently, the average driving speed is calculated at approximately 28.51 kilometres per hour, as evidenced by the result screenshots provided below.

	total_duration	
1	00:07:29	

	123 total_distance ▾
1	3.556134348

	123 average_speed ▾
1	28.5124357525

- **Analysis of Traffic Lights and Roundabouts within the Route**

From the preceding speed analysis, it is evident that the average driving speed on the recorded route falls below the typical driving speed observed in Melbourne (VicRoads, 2019). To understand the underlying causes for this outcome, an investigation into the frequency of red lights and roundabouts is conducted, which are two factors hypothesised to potentially reduce the average speed.

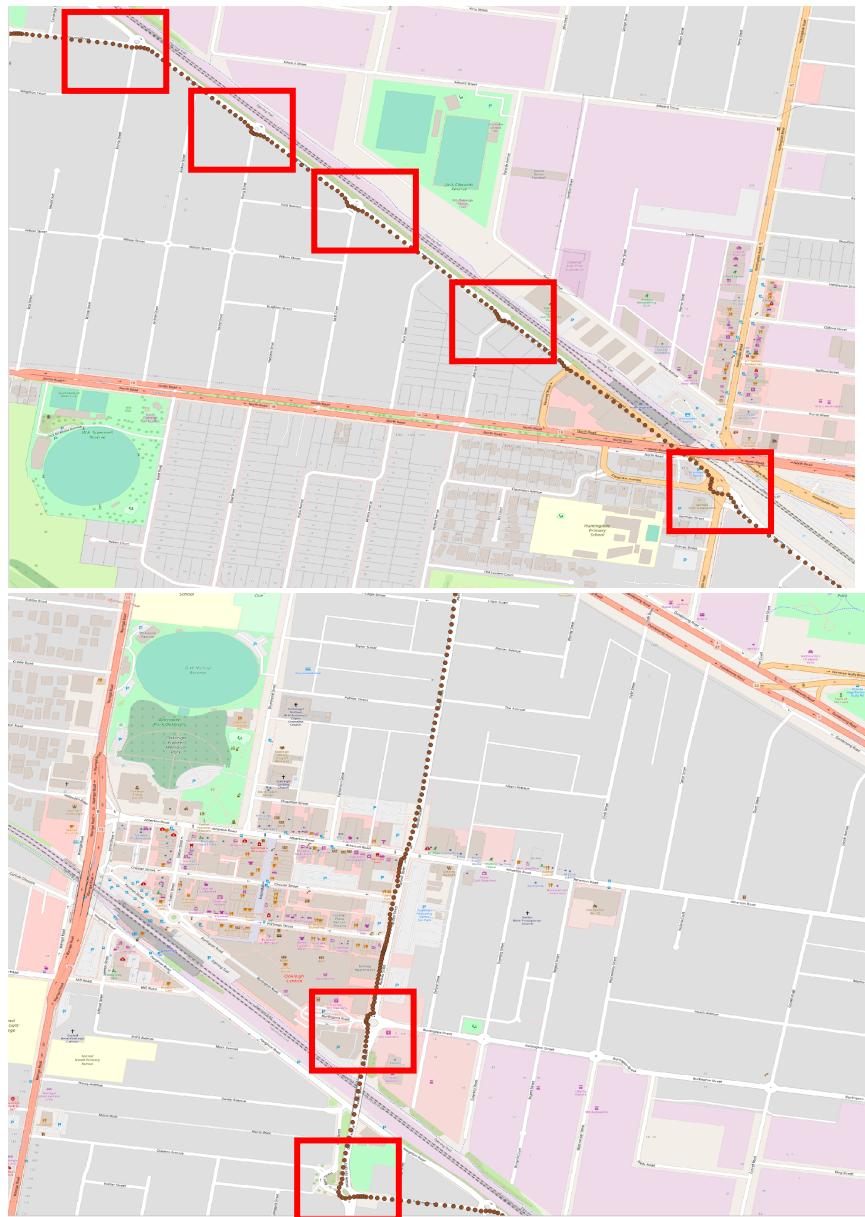
According to the data collected by the GPS Tracker, it is evident that the time interval between two consecutive points is consistently one second. As a result, in the event of encountering a red light, the distance between two points may be 0 kilometre per hour since the vehicle remains stationary. To determine this, the distance between two consecutive points is calculated with SQL (see the following SQL code and results). The analysis reveals that there are no instances of two consecutive points remaining in the same location, indicating that no red lights are encountered during the driving.

```

select
    st_distance(p1.wkb_geometry,
    p2.wkb_geometry::geography) as distance
from
    a5.pshi0013 p1,
    a5.pshi0013 p2
where
    p1.ogc_fid = p2.track_seg_point_id;
  
```

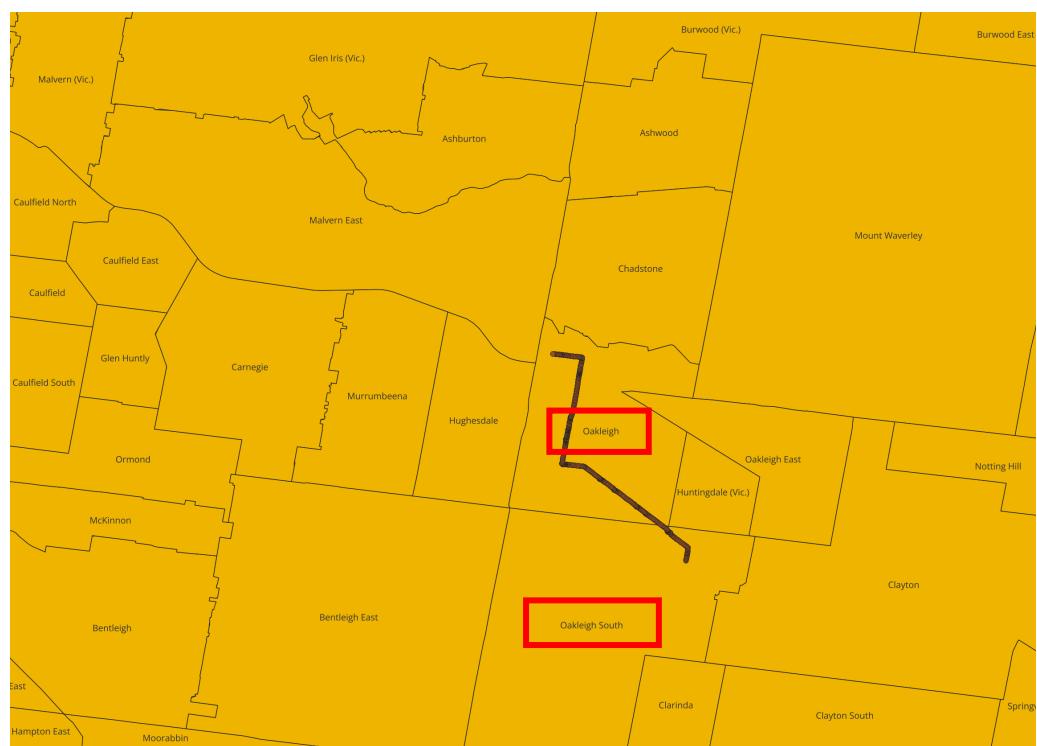
	<a>▲ 123 distance ▼						
1	11.51582952	35	11.47351404	70	10.43241474	105	14.07865594
2	11.9942467	36	11.140505917	71	7.08877369	106	14.2185895
3	10.5523756	37	9.36440639	72	7.1262684	107	14.6196799
4	11.31290948	38	8.56879556	73	6.39846087	108	14.73744871
5	11.31416445	39	7.32476698	74	6.1984533	109	12.37816038
6	13.3378492	40	8.83184316	75	8.36406332	110	11.00373599
7	9.07008033	41	6.84176172	76	9.861641	111	9.54550055
8	9.01321168	42	6.74583391	77	10.80219328	112	8.1508753
9	8.18144966	43	7.06643242	78	11.69627516	113	6.47779525
10	6.58229564	44	6.78591962	79	12.06809887	114	5.94010863
11	8.47542261	45	6.37431471	80	12.37385825	115	5.67623959
12	9.12930392	46	6.16923507	81	12.15570615	116	5.72268993
13	8.76928194	47	7.68912886	82	10.58706868	117	6.66669268
14	8.14875955	48	7.84986043	83	8.13173021	118	7.82305878
15	8.06726135	49	10.30985332	84	6.71002886	119	8.38447756
16	2.8543341	50	11.30969883	85	6.73262295	120	9.68575432
17	9.0907021	51	11.28986231	86	3.79041551	121	10.55630976
18	10.27652076	52	12.6812923	87	4.82806471	122	10.45307917
19	9.94881761	53	12.89569025	88	4.86254102	123	12.94412908
20	10.8696833	54	12.69784381	89	12.78080849	124	12.78080849
21	11.98787525	55	12.95001651	90	5.91943846	125	12.51377704
22	12.88231741	56	13.45237888	91	7.97938731	126	12.72389362
23	13.51563995	57	14.34448487	92	9.92646876	127	12.92508225
24	14.08561533	58	13.40480299	93	11.33324319	128	12.94724014
25	14.82146432	59	13.10455265	94	12.28891174	129	12.54405727
26	14.59794593	60	12.84085784	95	13.08615232	130	11.61997205
27	15.94198116	61	13.12274712	96	12.99033528	131	10.70783687
28	14.8778137	62	12.36136445	97	13.12942493	132	8.64335749
29	14.92746855	63	13.01451769	98	13.27634394	133	7.26192493
30	13.87988376	64	13.05413426	99	12.36869531	134	5.91846153
31	13.303853205	65	12.94953133	100	12.50581389	135	5.24833916
32	12.95665803	66	12.65197625	101	13.0674928	136	4.56634832
33	12.71493753	67	12.86224552	102	13.35724673	137	2.60550237
34	11.8925	68	11.8977279	103	13.21360551	138	3.37394716
35	11.47351404	69	11.13200764	104	13.4870721	139	6.67546324
							11.07607135
							9.66656804
	<a>▲ 123 distance ▼						
210	8.77986365	245	3.35338376	280	11.72372513	315	5.80408905
211	8.17167921	246	5.35350704	281	11.77596607	316	5.49829929
212	7.64539101	247	4.78527622	282	12.47613275	317	4.57321063
213	7.15340196	248	4.98771209	283	13.37680435	318	4.48695263
214	6.31396195	249	5.7375325	284	13.1167861	319	3.77054818
215	5.32912571	250	5.74900471	285	13.71571781	320	3.20383207
216	2.72826403	251	5.39625235	286	13.655324664	321	2.09583891
217	2.84388956	252	6.31697909	287	13.5688976	322	2.56686484
218	3.67076919	253	7.6367267	288	13.15187834	323	4.51442978
219	2.86485413	254	8.41994546	289	12.91788217	324	6.65397918
220	5.234202304	255	9.14362286	290	13.27770014	325	7.94038803
221	4.71829335	256	10.01567121	291	13.07355503	326	8.30973359
222	7.03878962	257	11.0277852	292	13.4713813	327	9.31995664
223	6.45485693	258	10.64863189	293	13.52303731	328	10.13799412
224	6.28184852	259	10.63184399	294	13.882282682	329	10.62002504
225	6.26478412	260	9.69790322	295	13.68999757	330	11.49482448
226	6.06722791	261	8.3269477	296	13.52249623	331	12.30588843
227	6.91709181	262	7.29749596	297	13.67198197	332	12.82771238
228	7.36378794	263	6.6658648	298	13.86772633	333	12.94101852
229	7.66218048	264	5.57442394	299	13.7963946	334	12.71899943
230	7.36096015	265	4.02467755	300	13.66632885	335	12.08338211
231	6.89424958	266	2.21435888	301	14.13920057	336	10.76798457
232	6.87297749	267	4.11504637	302	13.94598928	337	8.95197672
233	6.26744004	268	5.366559397	303	13.66576053	338	7.93243061
234	5.90742285	269	6.83357248	304	13.76652029	339	6.81031248
235	5.4135888	270	8.24528025	305	13.85373753	340	4.71285032
236	4.8549544	271	9.6168806	306	12.59378153	341	3.40362817
237	4.91086553	272	11.03345775	307	12.07463693	342	12.88869203
238	3.962123016	273	11.56031849	308	11.70777309	343	6.86689552
239	2.30983682	274	11.12561331	309	10.98987456	344	7.71630919
240	2.36394954	275	11.30689951	310	10.30435877	345	8.66885172
241	2.33438151	276	11.15897286	311	9.7091647	346	9.42172981
242	2.29582418	277	11.40593444	312	8.44166517	347	9.51693262
243	2.16979022	278	12.01728656	313	7.70089444	348	9.04942766
244	2.45217718	279	10.81051027	314	6.5473318	349	10.56702796
							376
							4.90876071

To identify and calculate the roundabouts within the route, the data is visualised in QGIS (refer to the graphs below). The visual representation clearly indicates the presence of seven roundabouts along the route. Moreover, the density of data points around these roundabouts is notably high, signifying that the distance between two consecutive points is shorter, and therefore, the driving speed is lower in these areas. This observation leads to the conclusion that the driving speed on this route is influenced by the number of roundabouts.



- **Suburb analysis**

To determine the suburbs covered by this route, boundary data for the suburbs is acquired from the mesh blocks and suburb boundaries from Victorian government. By intersecting the suburb boundaries with the route data, it is established that the route passes through the suburbs of Oakleigh South and (refer to the graphs below).



4. Conclusion

The analysis of the geospatial data from the recorded driving route has provided valuable findings. Firstly, the calculation of the average driving speed prompted a deeper investigation into the factors contributing to the relatively slower speed on this route. Subsequently, it was observed that no red lights were encountered during the

journey, while the presence of multiple roundabouts was identified as a key factor influencing the lower driving speed. This information is crucial for comprehending the potential elements affecting traffic flow in this area.

While the current analysis provides important insights, it is worth noting that further improvement is possible with more extensive data and a larger sample size. These enhancements could result in even more precise calculations and investigations. In summary, this analysis primarily centres on the driving speed and conditions along the chosen route, offering the foundation for future research on traffic patterns and their impact.

Reference

- Vicroads. (2019, August 29). Speed limit: VicRoads. Vic.gov.au.
<https://www.vicroads.vic.gov.au/safety-and-road-rules/road-rules/a-to-z-of-road-rules/speed-limits>

Appendix

(1) Output of Task 1: A GPX file (Contents of the GPX file)

My Drive > a5 ▾

Type People Modified

Name	Owner	Last modified	File size	⋮
21-Oct-2023-1843.gpx	me	22 Oct 2023 me	62 KB	⋮

```
<?xml version="1.0" encoding="UTF-8"?>
<gpx xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://www.topografix.com/GPX/1/1" xsi:schemaLocation="http://www.topografix.com/GPX/1/1 http://www.topografix.com/GPX/1/1/gpx.xsd" version="1.1" creator="Open
GPX Tracker for iOS">
<trkseg>
<trkpt lat="-37.91520522809245" lon="145.10543465537822">
<ele>69.667823188968</ele>
<time>2023-10-21T07:23:52Z</time>
</trkpt>
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<ele>71.17289919699695</ele>
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</trkpt>
```

(2) Output of Task 2: Restore the Authcate table in the spatial database (Screenshot of terminal)

```
(base) peichunshih@PeichundeMacBook-Pro ~ % docker container ls
CONTAINER ID IMAGE COMMAND CREATED STATUS PORTS NAMES
8fafcbe22849 monashfit/fit5137-postgis "docker-entrypoint.s..." 8 weeks ago Up 45 hours 0.0.0.0:5432->5432/tcp hopeful_kapitsa
(base) peichunshih@PeichundeMacBook-Pro ~ % docker exec -it 8fa bash
root@8fafcbe22849:/home/student# cd /data/vector/
root@8fafcbe22849:/data/vector# apt update && apt install wget
Hit:1 http://deb.debian.org/debian bullseye InRelease
Get:2 http://deb.debian.org/debian-security/bullseye-security InRelease [48.4 kB]
Get:3 http://deb.debian.org/debian-security/bullseye-security InRelease [44.1 kB]
Get:4 http://apt.postgresql.org/pub/repos/apt bullseye-pgdg InRelease [123 kB]
Get:5 http://deb.debian.org/debian-security/bullseye-security/main amd64 Packages [256 kB]
Get:6 http://apt.postgresql.org/pub/repos/apt bullseye-pgdg/main amd64 Packages [392 kB]
Fetched 774 kB in 8s (94.1 kB/s)
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
36 packages can be upgraded. Run 'apt list --upgradable' to see them.
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
Reading package lists... Done
0 upgraded, 0 newly installed, 0 to remove and 36 not upgraded.
root@8fafcbe22849:/data/vector# wget "https://drive.google.com/uc?export=download&id=10qswDhepm6-7vD151ZLQ5xMH7D6VEV18" -O pshi0013.gpx
--2023-10-26 13:41:26-- https://drive.google.com/uc?export=download&id=10qswDhepm6-7vD151ZLQ5xMH7D6VEV18
Resolving drive.google.com (drive.google.com)... 142.250.70.206, 2484:6800:4a15:802::200e
Connecting to drive.google.com (drive.google.com)|142.250.70.206|:443... connected.
HTTP request sent, awaiting response... 303 See Other
Location: https://doc-00-b8-docs.googleusercontent.com/docs/securesc/ha0ro937gcuc717deffksulg5h7mbp1/oheasnpoifdfcpmb43cauu11gsg1f3t7n/1698288075000/14773857628790268388/*/10qswDhepm6-7vD151ZLQ5xMH7D6VEV18?e=download&ad кудр=d82ddff74-3fd-48f5-9fc6-b671c100ef7f8 [following]
Warning: wildcards not supported in HTTP.
--2023-10-26 13:41:27-- https://doc-00-b8-docs.googleusercontent.com/docs/securesc/ha0ro937gcuc717deffksulg5h7mbp1/oheasnpoifdfcpmb43cauu11gsg1f3t7n/1698288075000/14773857628790268388/*/10qswDhepm6-7vD151ZLQ5xMH7D6VEV18?e=download&ad кудр=d82ddff74-3fd-48f5-9fc6-b671c100ef7f8
Resolving doc-00-b8-docs.googleusercontent.com (doc-00-b8-docs.googleusercontent.com)... 142.250.70.161, 2484:6800:4a15:801::2001
Connecting to doc-00-b8-docs.googleusercontent.com (doc-00-b8-docs.googleusercontent.com)|142.250.70.161|:443... connected.
HTTP request sent, awaiting response... 200 OK
Length: 43923 (62K) [application/gpx+xml]
Saving to: 'pshi0013.gpx'

Saving: 0%[=====] 0.00K 0:00:00
100%[=====] 43.92K 0:00:00
```

pshi0013															
	123	ogc_fid	123	track_fid	123	track_seg_id	123	track_seg_point_id	123	ele	time	123	magvar	123	geoidhe
Grid	1	1	0	0	0	0	0	0	69.667823188	2023-10-21 18:23:32.000 +1100	[NULL]				
Text	2	2	0	0	0	1	1	71.1728891069	2023-10-21 18:23:33.000 +1100	[NULL]					
Spatial	3	3	0	0	2	71.8125376425	2023-10-21 18:23:34.000 +1100	[NULL]							
Text	4	4	0	0	3	71.6987064024	2023-10-21 18:23:35.000 +1100	[NULL]							
Spatial	5	5	0	0	4	72.01193889296	2023-10-21 18:23:36.000 +1100	[NULL]							
Text	6	6	0	0	5	71.6641606111	2023-10-21 18:23:37.000 +1100	[NULL]							
Spatial	7	7	0	0	6	71.9289314421	2023-10-21 18:23:38.000 +1100	[NULL]							
Text	8	8	0	0	7	71.9420539998	2023-10-21 18:23:39.000 +1100	[NULL]							
Spatial	9	9	0	0	8	71.7928204257	2023-10-21 18:23:40.000 +1100	[NULL]							
Text	10	10	0	0	9	72.431553334	2023-10-21 18:23:41.000 +1100	[NULL]							
Spatial	11	11	0	0	10	72.3255937109	2023-10-21 18:23:42.000 +1100	[NULL]							
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Record	15	15	0	0	14	72.4399124248	2023-10-21 18:23:46.000 +1100	[NULL]							
Record	16	16	0	0	15	65.6654619416	2023-10-21 18:23:47.000 +1100	[NULL]							
Record	17	17	0	0	16	65.6383739738	2023-10-21 18:23:48.000 +1100	[NULL]							
Record	18	18	0	0	17	65.6008712007	2023-10-21 18:23:49.000 +1100	[NULL]							
Record	19	19	0	0	18	65.653381278	2023-10-21 18:23:50.000 +1100	[NULL]							
Record	20	20	0	0	19	65.496312866	2023-10-21 18:23:51.000 +1100	[NULL]							
Record	21	21	0	0	20	65.9679008117	2023-10-21 18:23:52.000 +1100	[NULL]							
Record	22	22	0	0	21	66.06764581	2023-10-21 18:23:53.000 +1100	[NULL]							
Record	23	23	0	0	22	66.1335908994	2023-10-21 18:23:54.000 +1100	[NULL]							
Record	24	24	0	0	23	66.2094089175	2023-10-21 18:23:55.000 +1100	[NULL]							
Record	25	25	0	0	24	66.1412428534	2023-10-21 18:23:56.000 +1100	[NULL]							
Record	26	26	0	0	25	66.1041895691	2023-10-21 18:23:57.000 +1100	[NULL]							
Record	27	27	0	0	26	66.2179891085	2023-10-21 18:23:58.000 +1100	[NULL]							
Record	28	28	0	0	27	66.3605179988	2023-10-21 18:23:59.000 +1100	[NULL]							
Record	29	29	0	0	28	66.2210391797	2023-10-21 18:24:0.000 +1100	[NULL]							
Record	30	30	0	0	29	66.4453976145	2023-10-21 18:24:01.000 +1100	[NULL]							
Record	31	31	0	0	30	66.4079217715	2023-10-21 18:24:02.000 +1100	[NULL]							
Record	32	32	0	0	31	66.2351434948	2023-10-21 18:24:03.000 +1100	[NULL]							
Record	33	33	0	0	32	65.8020690791	2023-10-21 18:24:04.000 +1100	[NULL]							
Record	34	34	0	0	33	65.9778374992	2023-10-21 18:24:05.000 +1100	[NULL]							
Record	35	35	0	0	34	66.08448890838	2023-10-21 18:24:06.000 +1100	[NULL]							
Record	36	36	0	0	35	66.3309382349	2023-10-21 18:24:07.000 +1100	[NULL]							
Record	37	37	0	0	36	66.2599553531	2023-10-21 18:24:08.000 +1100	[NULL]							

(3) Output of Task 3.1: Script for speed analysis (code)

```

 $\ominus$ --total time
SELECT
    MAX(time) - MIN(time) AS total_duration
FROM
    a5.pshi0013;

 $\ominus$ --total distance
select
    sum(st_distance(p1.wkb_geometry, p2.wkb_geometry::geography)/ 1000) as total_distance
from
    a5.pshi0013 p1,
    a5.pshi0013 p2
where
    p1.ogc_fid = p2.track_seg_point_id;

 $\ominus$ --average speed
with total_time as (
select
    MAX(time) - MIN(time) as total_duration
from
    a5.pshi0013
),
total_distance as (
select
    sum(st_distance(p1.wkb_geometry, p2.wkb_geometry::geography) / 1000) as total_distance
from
    a5.pshi0013 p1,
    a5.pshi0013 p2
where
    p1.ogc_fid = p2.track_seg_point_id
)
select
    (td.total_distance / ((extract(EPOCH
from
    tt.total_duration) / 3600.0))) as average_speed
from
    total_time tt,
    total_distance td;

```

(4) Output of Task 3.2: Data analysis (code only, as the graph is already present in the results sections.)

```

 $\ominus$ --calculation of traffic lights
select
    st_distance(p1.wkb_geometry,
    p2.wkb_geometry::geography) as distance
from
    a5.pshi0013 p1,
    a5.pshi0013 p2
where
    p1.ogc_fid = p2.track_seg_point_id;

```

```

 $\mid$ --create suburb_mel table
create table a5.suburb_mel as (
select
    s.mb_code_2021,
    sal_name_2021,
    mm.wkb_geometry
from
    ptv.suburb2021 s
join ptv.mb2021_mel mm on
    s.mb_code_2021 = mm.mb_code21);

select * from a5.suburb_mel;

```

```

--create suburb table
create table a5.suburb as
(
select
    sal_name_2021,
    st_union(wkb_geometry) as geom
from
    a5.suburb_mel
group by
    sal_name_2021);

select * from a5.suburb;

```