

960:486

# Statistical Learning

## Final Project

F1 22 Lap Time Analysis

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## What is F1?

Formula One (F1) is the highest class of single-seater auto racing. F1 cars are some of the fastest and most advanced racing machines in the world, capable of reaching speeds of up to 220 mph (354 km/h) and producing over 1,000 horsepower. The cars are designed to be lightweight, aerodynamic, and highly responsive, with advanced technologies such as hybrid power units and sophisticated electronics systems.

## What is F1 22?

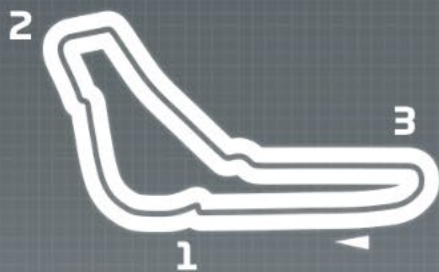
The game we collect the data from is called F1 22. It is the latest official video game series based on the F1 World Championship. The game also includes advanced features such as realistic weather conditions, tire wear, and vehicle damage, as well as a detailed telemetry system that allows us to analyze our performance and improve our driving skills.



DRY **WET** F5 F6

## SELECT EVENT

ITALIAN GRAND PRIX



**TURNS**  
11

**CIRCUIT LENGTH**  
5.793 km/ 3.599 miles

**TRACK DIFFICULTY**  
Very Easy

**LAP RECORD**  
1:21.046

**LAP RECORD HOLDER**  
R. Barrichello (2004)



HUNGARY



BELGIUM



NETHERLANDS



ITALY



SINGAPORE



JAPAN



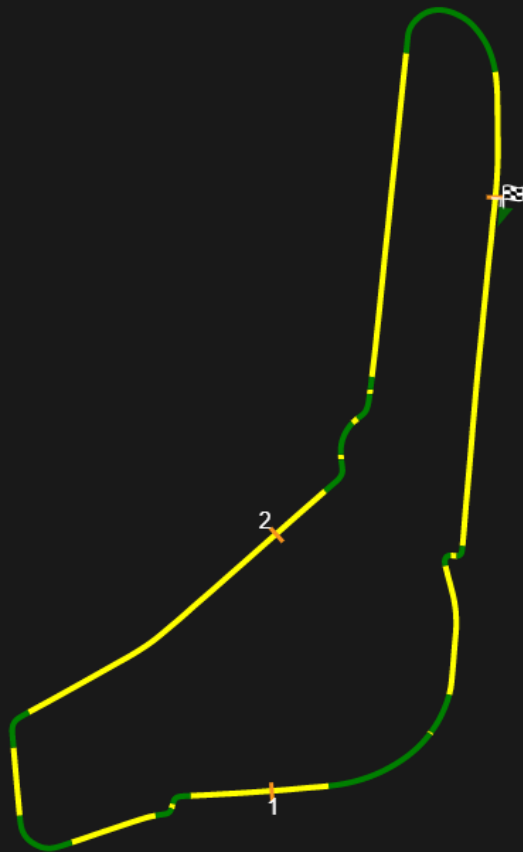
USA



F2 VIEW LEADERBOARD

START SESSION

Esc BACK

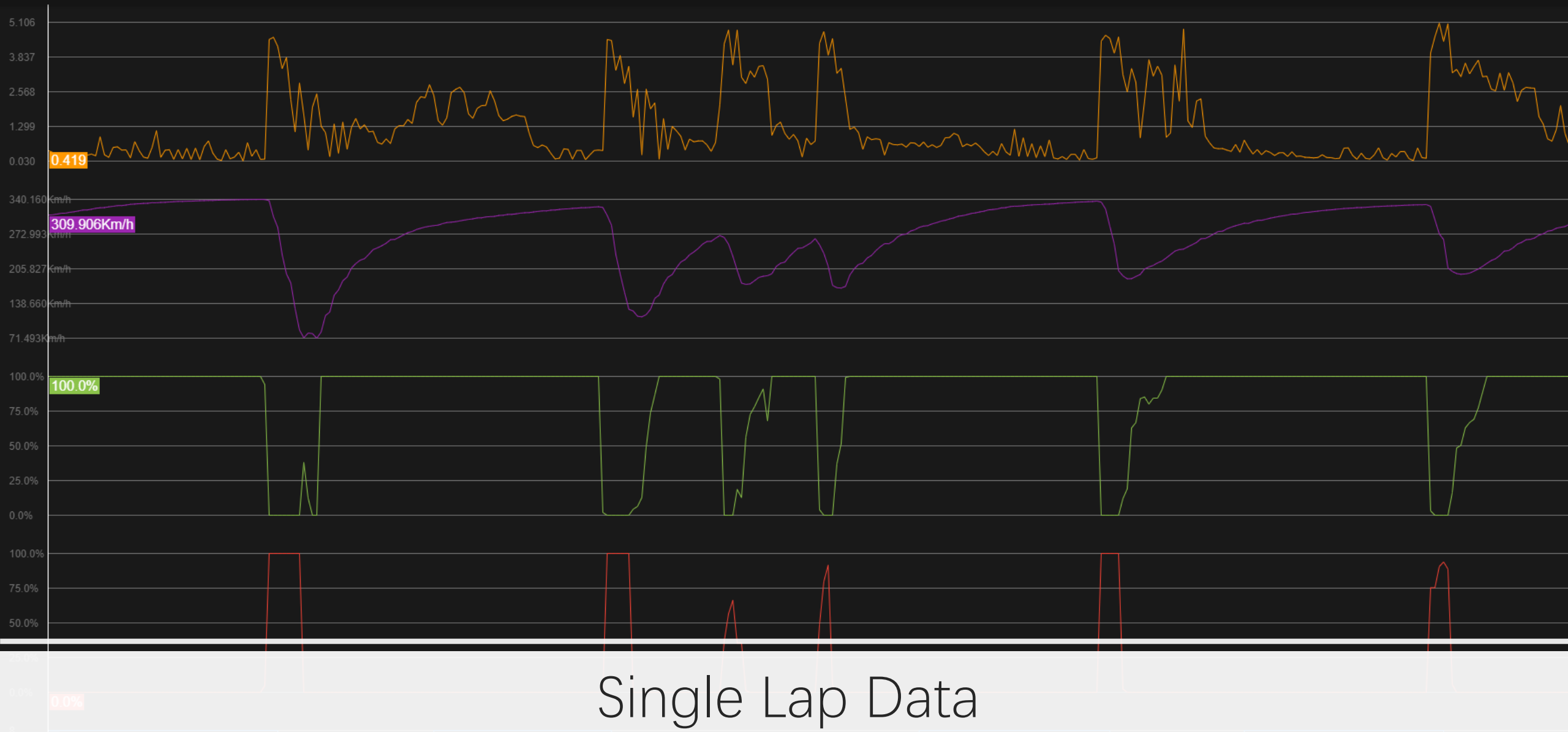


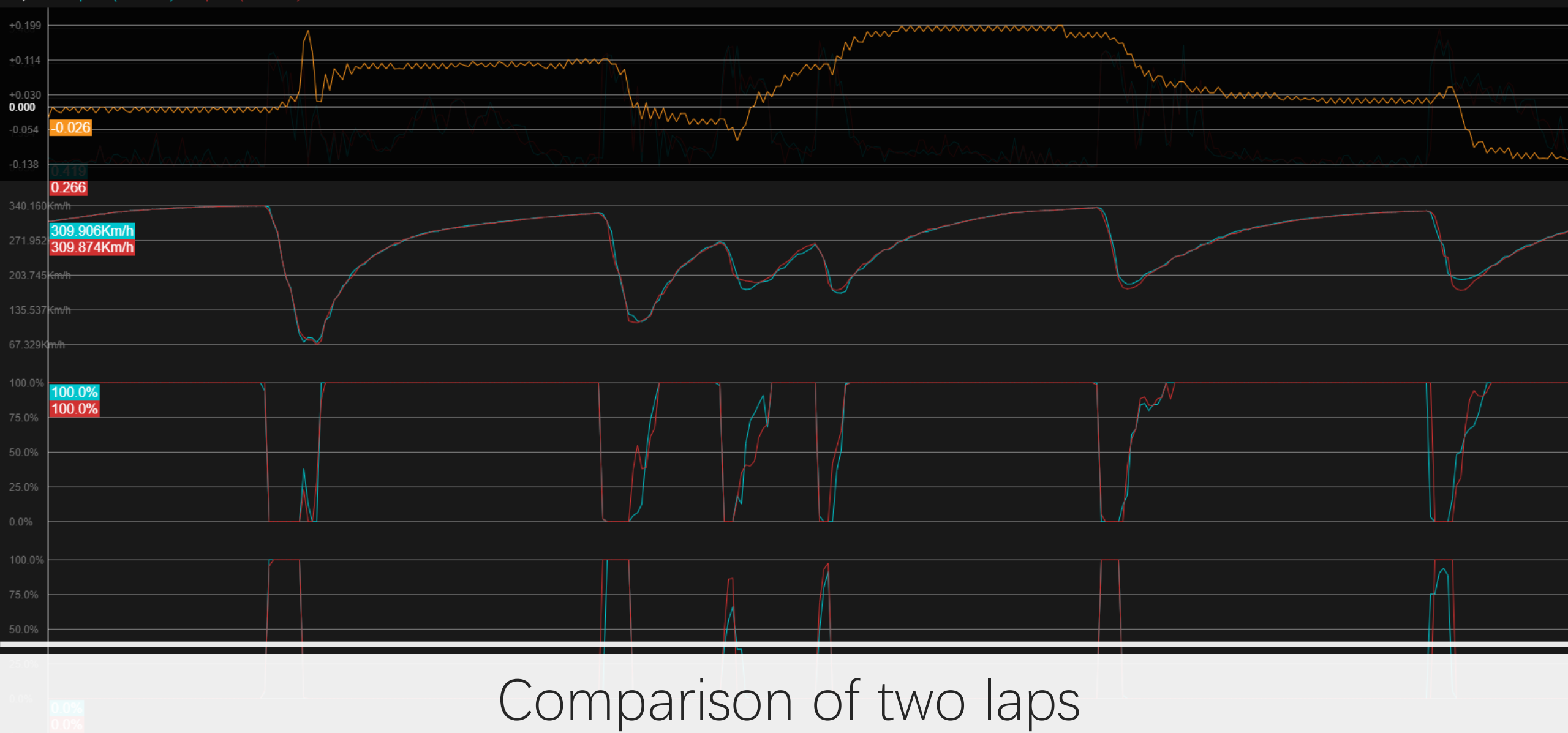
300m

Parameter	Value	Compared value
Throttle	100.0%	100.0%
Brake	0.0%	0.0%
Steering	0.9%	-0.5%

Why Sectors?







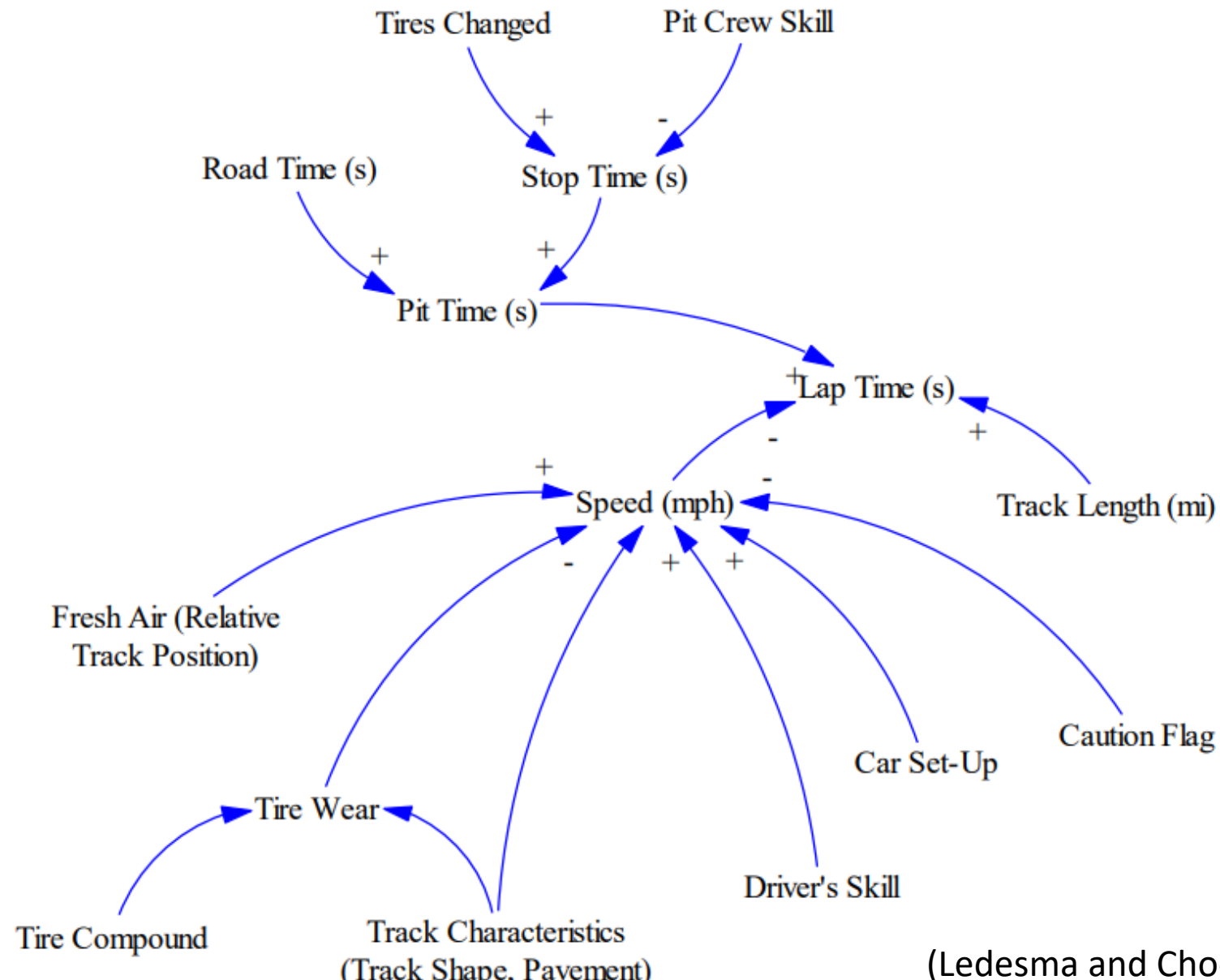
Comparison of two laps

F1 Script.R* × F1an1 × F12022.2 ×																
Filter 1 - 50																
	carId	trackId	trackLength	lapIndex	lapNum	lapFlag	binIndex	validBin	lap_number	lap_distance	lap_time	lap_time_invalid	world_position_X	world_position_Y	world_position_Z	world_for
2	Ferrari	Monza	5798	0	13	0	0	1	13	0.8125	0	0	618.852	601.63	-3.27516	-0.0805
3	Ferrari	Monza	5798	0	13	0	1	1	13	1.57812	0.00866667	0	618.791	600.871	-3.27202	-0.0805
4	Ferrari	Monza	5798	0	13	0	2	1	13	2.34375	0.0173333	0	618.731	600.111	-3.26887	-0.0813
5	Ferrari	Monza	5798	0	13	0	3	1	13	3.10938	0.026	0	618.67	599.352	-3.26572	-0.0817
6	Ferrari	Monza	5798	0	13	0	4	1	13	4.25391	0.0395	0	618.578	598.212	-3.26106	-0.0823
7	Ferrari	Monza	5798	0	13	0	5	1	13	5.39844	0.053	0	618.486	597.072	-3.2564	-0.0826
8	Ferrari	Monza	5798	0	13	0	6	1	13	6.54688	0.0665	0	618.393	595.932	-3.25163	-0.0834
9	Ferrari	Monza	5798	0	13	0	7	1	13	7.69531	0.08	0	618.3	594.791	-3.24686	-0.0835
10	Ferrari	Monza	5798	0	13	0	8	1	13	8.85156	0.093	0	618.205	593.65	-3.2419	-0.0845
11	Ferrari	Monza	5798	0	13	0	9	1	13	9.61719	0.102	0	618.142	592.89	-3.23842	-0.0846
12	Ferrari	Monza	5798	0	13	0	10	1	13	10.3828	0.111	0	618.079	592.129	-3.23494	-0.0851
13	Ferrari	Monza	5798	0	13	0	11	1	13	11.1484	0.12	0	618.015	591.368	-3.23146	-0.0855
14	Ferrari	Monza	5798	0	13	0	12	1	13	12.2969	0.133	0	617.919	590.227	-3.22602	-0.0860
15	Ferrari	Monza	5798	0	13	0	13	1	13	13.4492	0.1465	0	617.822	589.085	-3.22042	-0.0864
16	Ferrari	Monza	5798	0	13	0	14	1	13	14.6016	0.16	0	617.725	587.943	-3.21481	-0.0865
17	Ferrari	Monza	5798	0	13	0	15	1	13	15.75	0.173	0	617.627	586.801	-3.20915	-0.0873
18	Ferrari	Monza	5798	0	13	0	16	1	13	16.8984	0.186	0	617.529	585.658	-3.20348	-0.0877
19	Ferrari	Monza	5798	0	13	0	17	1	13	17.6667	0.195	0	617.462	584.896	-3.19974	-0.0880
20	Ferrari	Monza	5798	0	13	0	18	1	13	18.4349	0.204	0	617.396	584.134	-3.19601	-0.0882
21	Ferrari	Monza	5798	0	13	0	19	1	13	19.2031	0.213	0	617.33	583.372	-3.19227	-0.0885
22	Ferrari	Monza	5798	0	13	0	20	1	13	20.3594	0.226	0	617.23	582.229	-3.18673	-0.0885
23	Ferrari	Monza	5798	0	13	0	21	1	13	21.5117	0.2395	0	617.129	581.085	-3.18125	-0.0893
24	Ferrari	Monza	5798	0	13	0	22	1	13	22.6641	0.253	0	617.028	579.942	-3.17577	-0.0897
25	Ferrari	Monza	5798	0	13	0	23	1	13	23.8165	0.2665	0	616.926	578.798	-3.17029	-0.0901
26	Ferrari	Monza	5798	0	13	0	24	1	13	24.9688	0.28	0	616.825	577.654	-3.16482	-0.0905
27	Ferrari	Monza	5798	0	13	0	25	1	13	25.5469	0.2865	0	616.773	577.061	-3.16207	-0.0907
28	Ferrari	Monza	5798	0	13	0	26	1	13	26.125	0.293	0	616.722	576.509	-3.15932	-0.0905
29	Ferrari	Monza	5798	0	13	0	27	1	13	27.2773	0.306	0	616.619	575.364	-3.15379	-0.0913
30	Ferrari	Monza	5798	0	13	0	28	1	13	28.4297	0.319	0	616.515	574.219	-3.14825	-0.0917

# Data Cleaning Progress



## 2.2 Factors Influencing Racing Performance



F1 Script.R* × F1lan1 × F12022.2 × F12022version1 ×						
Filter						
	lapNum	lap_distance	lap_time	throttle	brake	steering
5800	3	1.29688	0.013000	1	0	0.007461670
5801	3	1.29688	0.013000	1	0	0.007461670
5802	3	2.44141	0.026000	1	0	0.008133050
5803	3	3.58594	0.040000	1	0	0.009048580
5804	3	4.73145	0.053000	1	0	0.009262200
5805	3	5.87695	0.066000	1	0	0.009475830
5806	3	6.64128	0.075000	1	0	0.009424960
5807	3	7.40560	0.084000	1	0	0.009374100
5808	3	8.16992	0.093000	1	0	0.009323240
5809	3	9.31641	0.106000	1	0	0.009140130
5810	3	10.46290	0.119500	1	0	0.008346680
5811	3	11.60940	0.133000	1	0	0.007553220
5812	3	12.75780	0.146500	1	0	0.006408810
5813	3	13.90620	0.160000	1	0	0.005264400
5814	3	14.67190	0.168667	1	0	0.004196250
5815	3	15.43750	0.177333	1	0	0.003128090
5816	3	16.20310	0.186000	1	0	0.002059940
5817	3	17.35160	0.200000	1	0	-0.001297000
5818	3	18.50100	0.213000	1	0	-0.004119930
5819	3	19.65040	0.226000	1	0	-0.006942870
5820	3	20.80080	0.240000	1	0	-0.011581600
5821	3	21.56770	0.248667	1	0	-0.013514400
5822	3	22.33460	0.257333	1	0	-0.015447200
5823	3	23.10160	0.266000	1	0	-0.017380000
5824	3	24.25290	0.279500	1	0	-0.019256900
5825	3	25.40430	0.293000	1	0	-0.021133700
5826	3	26.55470	0.306000	1	0	-0.022507100
5827	3	27.70700	0.319500	1	0	-0.022903800
5828	3	28.85940	0.333000	1	0	-0.023300500
5829	3	29.43550	0.339500	1	0	-0.023300500

Showing 1 to 30 of 173,940 entries, 6 total columns



F1 Script.R* × F1lan1 × F12022.2 × F12022version1 × s1summary ×					
Filter					
	lapNum	lap_time	s1t	s1b	s1s
1	3	26.8670	0.9026124	0.06808249	0.01587341
2	4	27.1585	0.9108684	0.07110725	0.02547515
3	5	26.8950	0.8567747	0.06844611	0.02352978
4	6	26.8470	0.8377931	0.06640979	0.02301935
5	7	27.0903	0.9061383	0.06734783	0.02100971
6	8	26.8130	0.8586117	0.06427871	0.01730966
7	9	27.5460	0.8964002	0.06509722	0.01786364
8	10	26.8953	0.9030660	0.06423150	0.01748468
9	11	26.7730	0.9045434	0.07063640	0.01686985
10	12	27.1440	0.8581753	0.07118013	0.02187034
11	13	34.1290	0.8911804	0.05858960	0.01476683
12	14	26.8210	0.9033413	0.06853427	0.01570693
13	15	27.0293	0.9044506	0.06849528	0.02074720
14	16	26.8313	0.9083223	0.07294546	0.02222475
15	17	27.2000	0.8971602	0.06410260	0.01663674
16	23	27.6370	0.8962839	0.05824986	0.02082986
17	24	27.3435	0.8807097	0.05643885	0.01293333
18	25	28.0960	0.8913132	0.05572094	0.01458262
19	26	26.8260	0.9012051	0.06850735	0.01787531
20	27	27.0510	0.9094297	0.07321321	0.02363178
21	28	27.2010	0.9012288	0.06434546	0.01752912
22	30	26.8875	0.9013225	0.06020885	0.01238786
23	31	26.8740	0.8698564	0.09583198	0.02358747
24	32	26.9960	0.9073514	0.07128958	0.02524680
25	33	26.7313	0.9059800	0.07031511	0.02043401
26	34	26.7287	0.9052668	0.06327616	0.01643163
27	35	27.1470	0.9019974	0.07143871	0.01785333
28	36	26.7050	0.9027295	0.07080446	0.02113226
29	37	26.6647	0.9087168	0.07067696	0.02398921
30	38	27.0270	0.9056345	0.06659083	0.02434135

Showing 1 to 30 of 30 entries, 5 total columns

# Regression

```
Call:
lm(formula = lap_time ~ s1t + s1b + s1s + I(s1t^2) + I(s1b^2) +
    I(s1s^2) + s1t * s1b + s1t * s1s + s1b * s1s, data = s1summary)
```

Residuals:

Min	1Q	Median	3Q	Max
-0.30020	-0.17350	0.01063	0.09315	0.41191

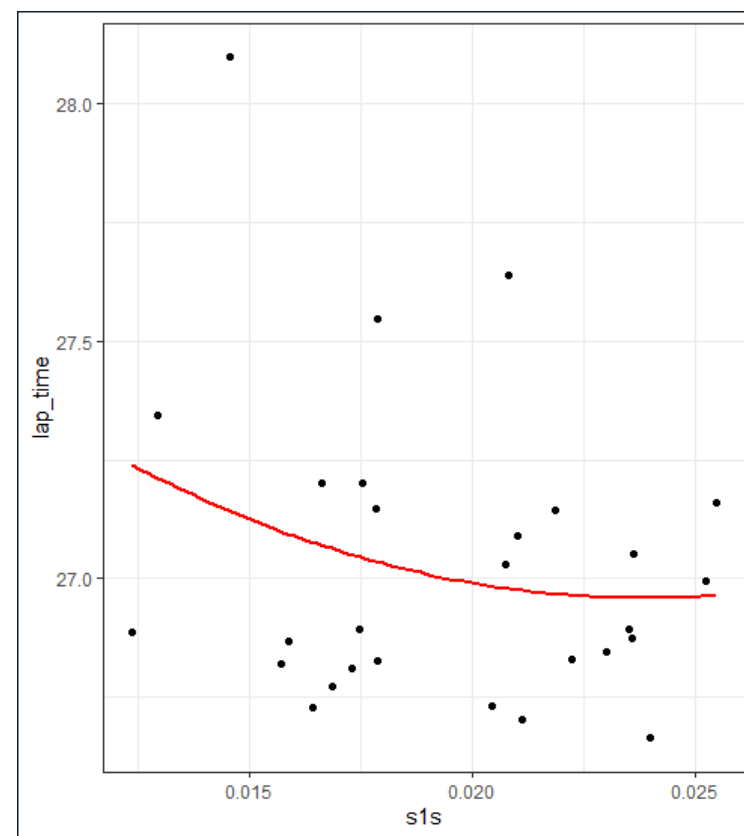
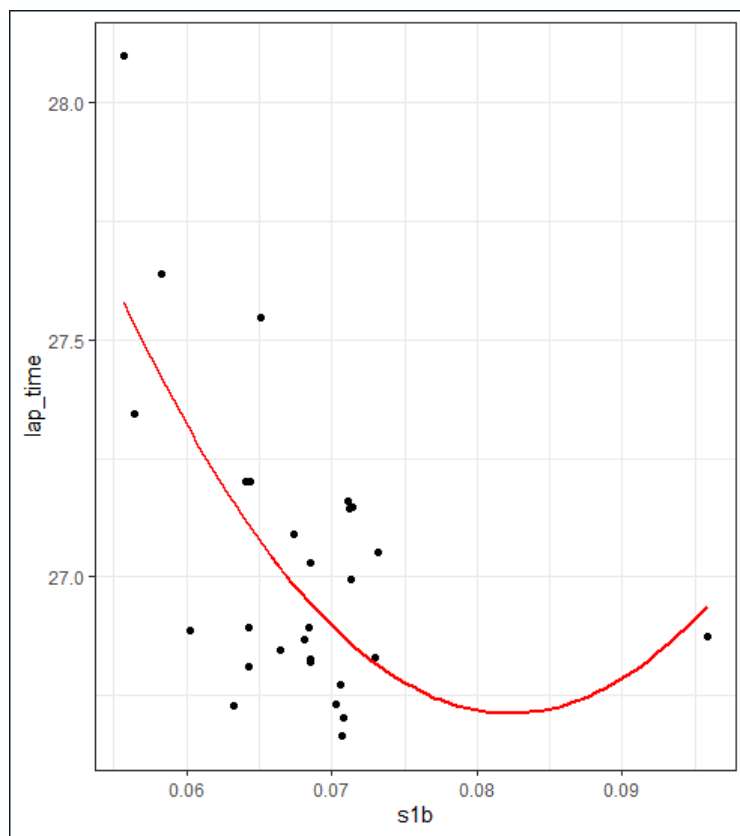
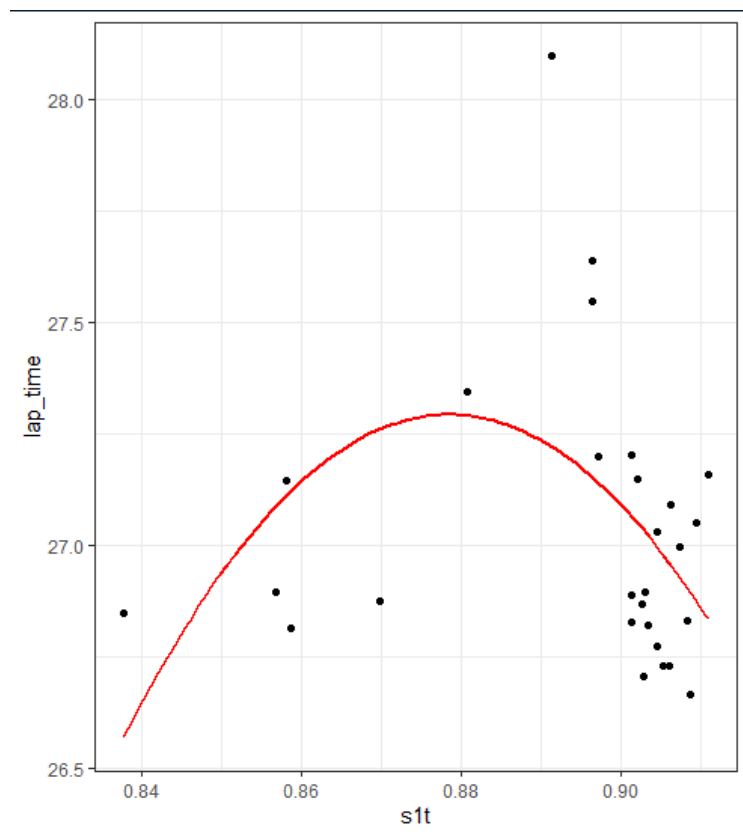
Coefficients:

	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	-290.8	197.3	-1.474	0.158
s1t	780.7	458.8	1.702	0.106
s1b	-1095.2	1174.6	-0.932	0.363
s1s	1169.1	1417.3	0.825	0.420
I(s1t^2)	-463.4	271.6	-1.706	0.105
I(s1b^2)	1526.3	1257.0	1.214	0.240
I(s1s^2)	-3702.6	6800.2	-0.544	0.593
s1t:s1b	908.6	1210.8	0.750	0.463
s1t:s1s	-1205.1	1630.0	-0.739	0.469
s1b:s1s	1590.8	5977.3	0.266	0.793

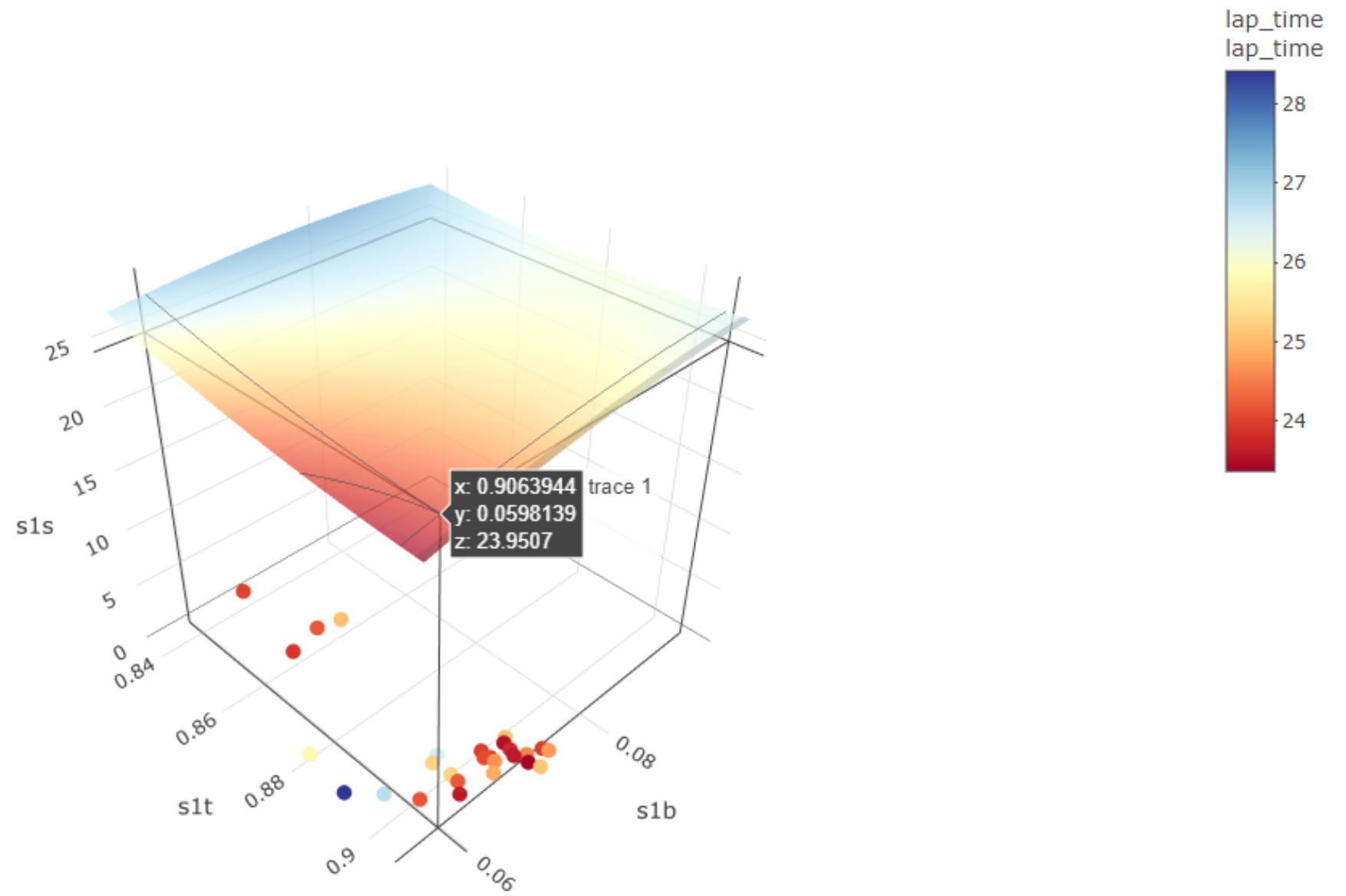
Residual standard error: 0.2501 on 18 degrees of freedom

Multiple R-squared: 0.594, Adjusted R-squared: 0.391

F-statistic: 2.926 on 9 and 18 DF, p-value: 0.02511



# Regression Surface





# Regression For Lan

Call:

```
lm(formula = lap_time ~ cs1t + cs1b + cs1s + I(cs1t^2) + I(cs1b^2) +  
    I(cs1s^2) + cs1t * cs1b + cs1t * cs1s + cs1b * cs1s, data = cs1summary)
```

Residuals:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	-0.78654	-0.38463	1.30945	0.05159	-0.37949	-0.07368	-0.49985	0.48461	-1.55806	1.54355	-0.02799	0.09094	0.25975	-0.40003	0.37037

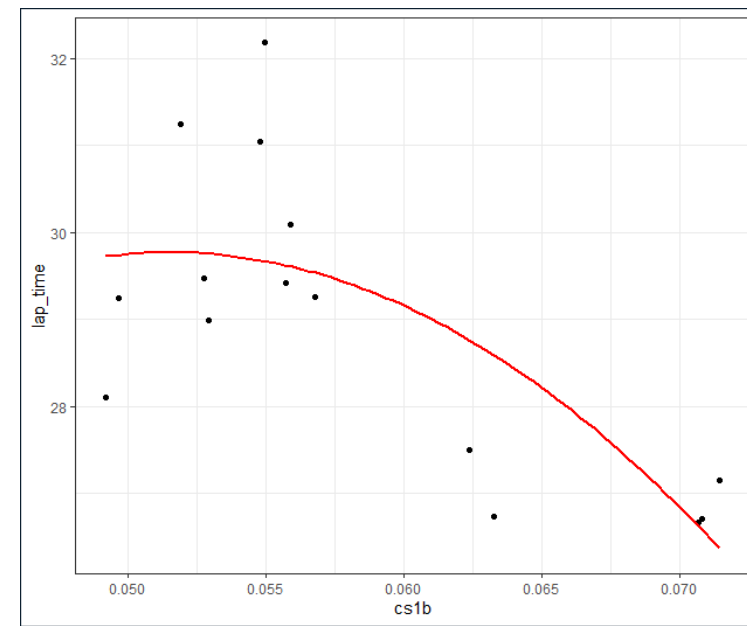
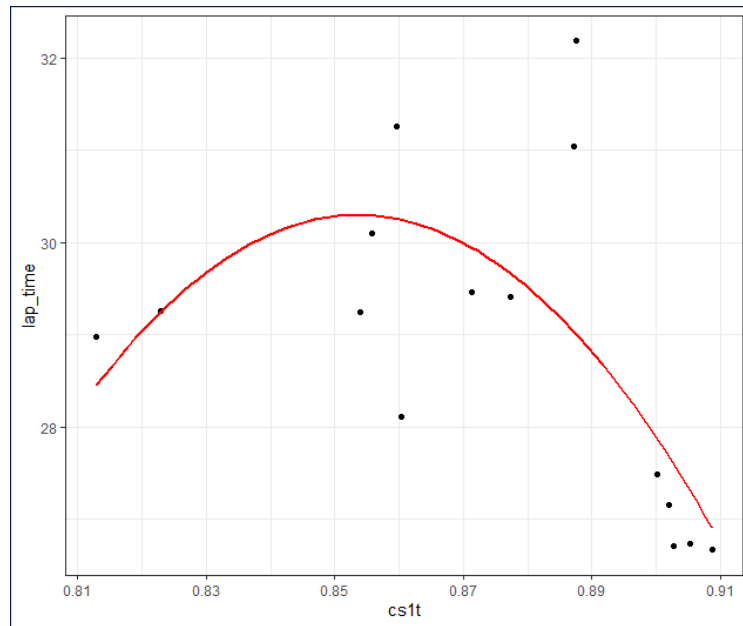
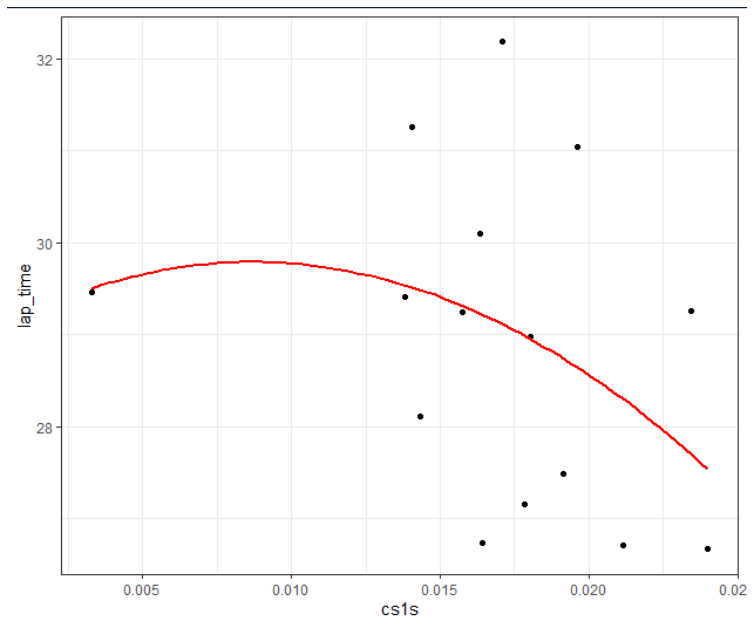
Coefficients:

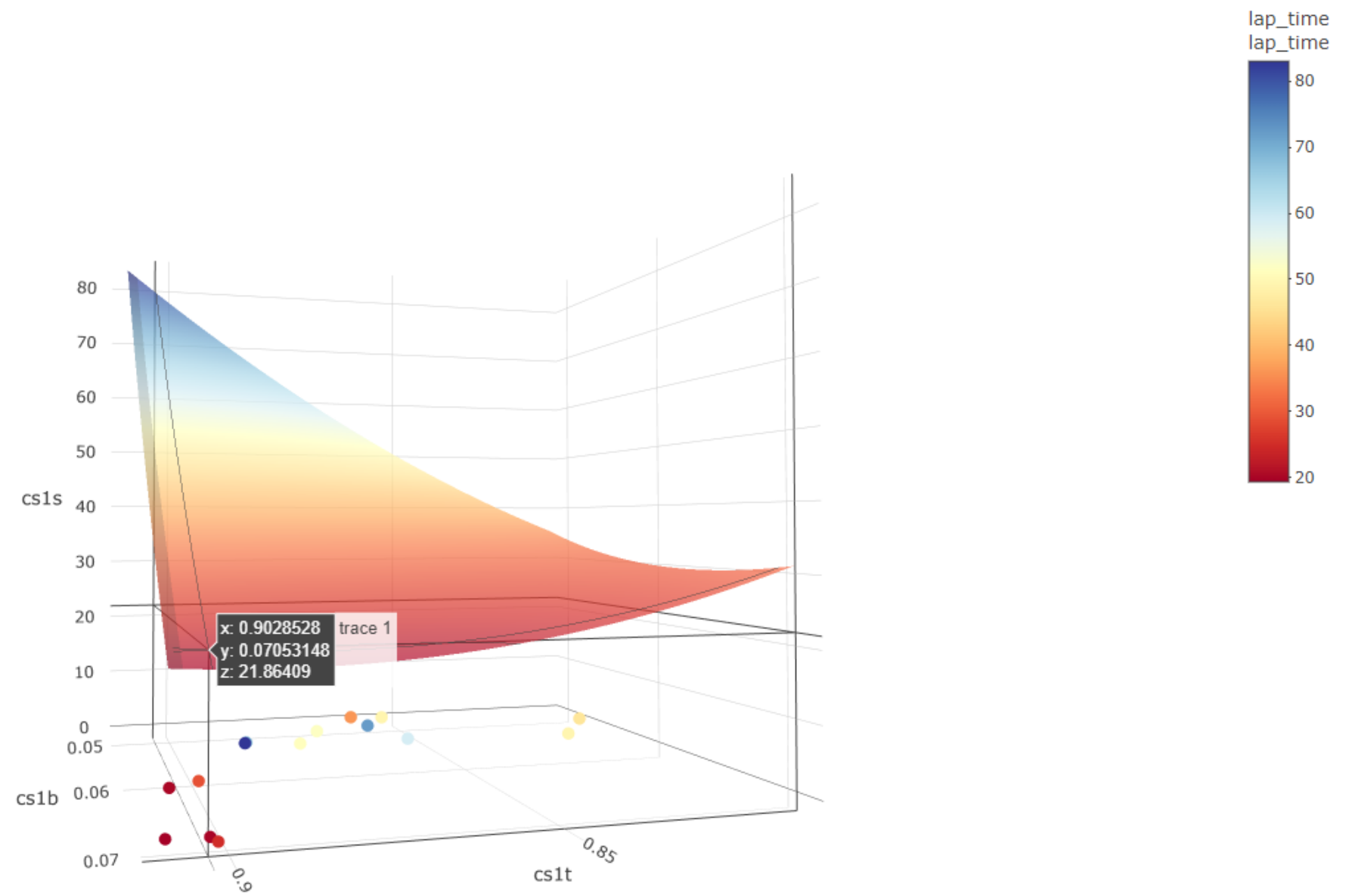
	Estimate	Std. Error	t value	Pr(> t )
(Intercept)	39.38	674.95	0.058	0.956
cs1t	-1113.73	2008.51	-0.555	0.603
cs1b	20576.43	10579.17	1.945	0.109
cs1s	-11897.23	6724.48	-1.769	0.137
I(cs1t^2)	1380.58	1567.03	0.881	0.419
I(cs1b^2)	33236.96	24168.18	1.375	0.227
I(cs1s^2)	-3507.26	28909.06	-0.121	0.908
cs1t:cs1b	-27541.90	15159.51	-1.817	0.129
cs1t:cs1s	14747.83	8811.65	1.674	0.155
cs1b:cs1s	-15659.71	49142.19	-0.319	0.763

Residual standard error: 1.289 on 5 degrees of freedom

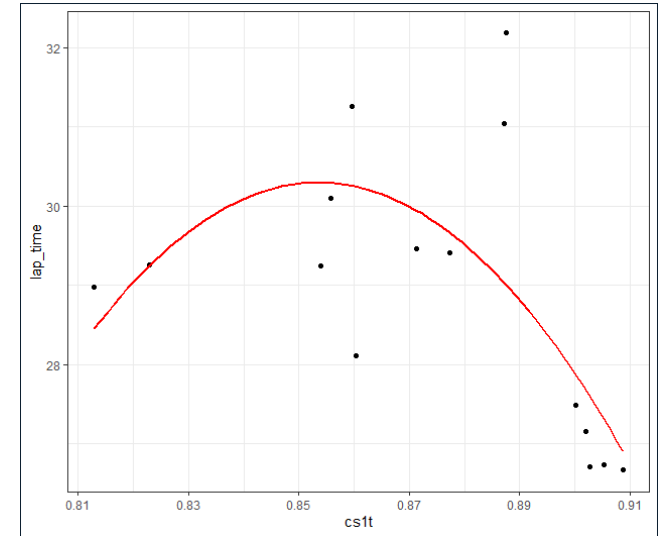
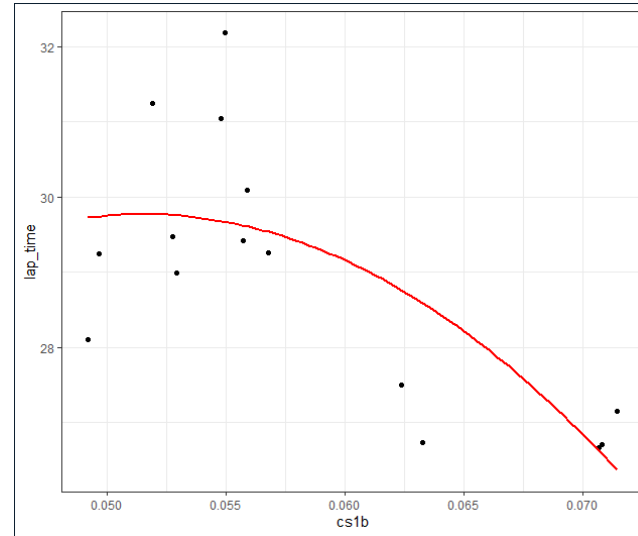
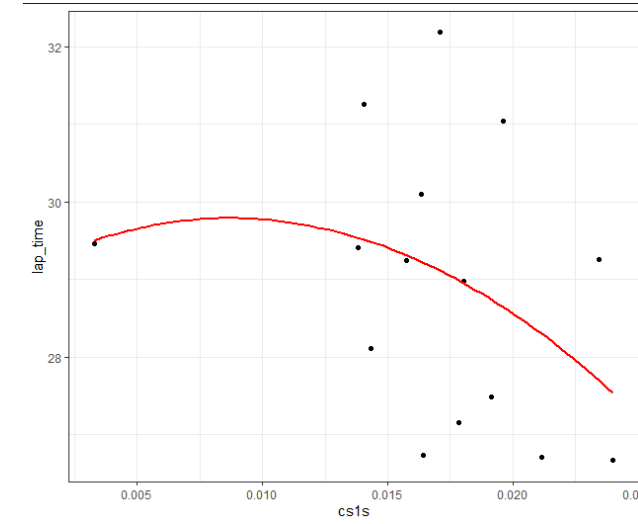
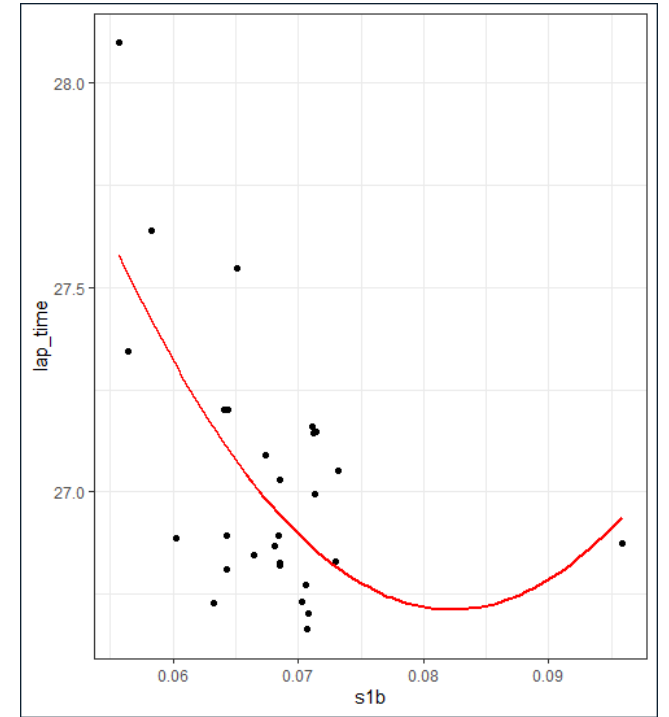
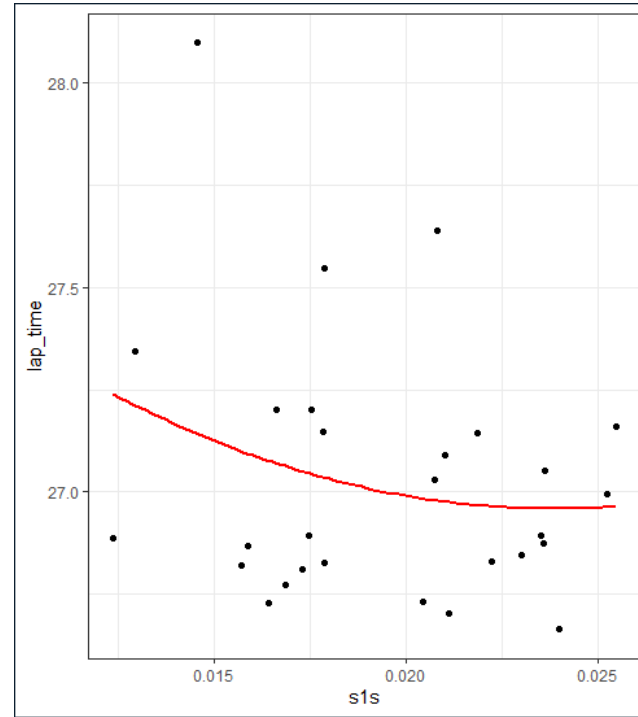
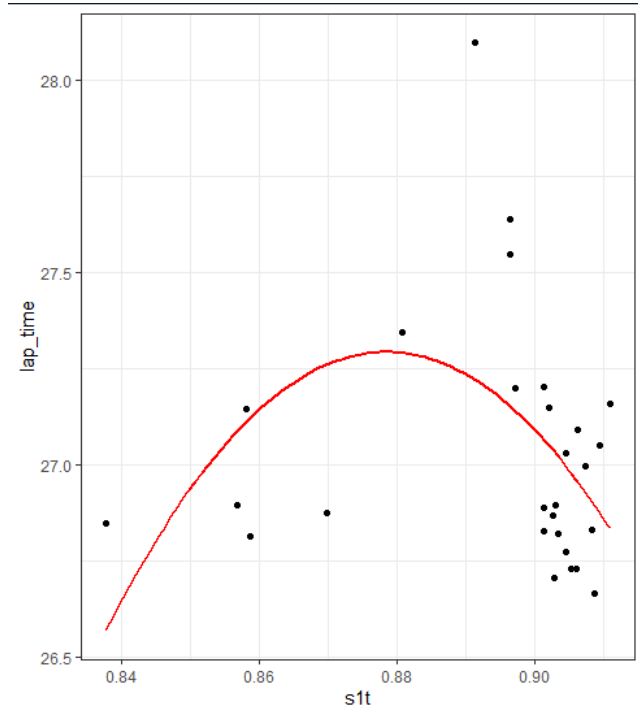
Multiple R-squared: 0.8087, Adjusted R-squared: 0.4645

F-statistic: 2.349 on 9 and 5 DF, p-value: 0.1799





# Comparison





# Limitation

1. Everything is too optimal
2. Not enough laps :(
3. Modeling of the map
4. It's a game :)





LOADING...

# TIME TRIAL

DRY | ITALIAN GRAND PRIX

## ERS

The charge status of the Energy Store is shown by the yellow bar on the Multifunction Display.



Thank you !

Drive SAFE!

## Citation

Ledesma, Christopher, and Weisen Choo. "Real-Time Decision Making in Motorsports: Analytics for Improving Professional Car Race Strategy." *Journal of Quantitative Analysis in Sports*, vol. 13, no. 4, Dec. 2017, pp. 169-188. DOI: 10.1515/jqas-2016-0078.