Formula 1 Driver Comparison by Elo and Plots

Ryan Matus
Santa Clara University
Santa Clara, USA
rmmatus@scu.edu

***Abstract*—This document is an analysis of different drivers on the Formula 1 grid. The purpose is to compare different drivers and try to find out who is under-performing and over-performing to gain more insight on the raw skill of each driver.**

***Index Terms*—Formula 1, driver, comparison, Elo, box plot**

I. Introduction

Formula 1 (F1) is one of the most data-driven sports in the world. The cars have lots of telemetry being sent back and forth to be logged, with viewers also being exposed to lap times with a difference in the thousandths making the difference between a win and a loss. Being a competitive sport as well, each driver and team is trying their best to shave off a little bit of time and gain an advantage on the other drivers and teams on the grid. Many teams on the grid analyze the telemetry they have and make adjustments in the wind-tunnel and design of the car to make themselves faster. While it is technically a team sport, every driver is competing against all drivers on the grid to gain the most points to win the World Driver's Championship, whereas each team of two drivers (such as Mercedes or Ferrari) are trying to maximize their points to beat other teams for the World Constructor Championship.

Typically, the best indicator of each driver's performance is how they are doing compared to their teammates. Each team has a different car, with some being faster than others. The variable of the car is controlled by comparing teammates only. However, this limits a lot of analysis that is possible. As a result, it would be interesting if there was some sort of Elo system for drivers, where there could be a power-ranking of sorts between drivers on the grid. Elo is a system that was born out of ranking professional chess player performance but has been applied to many major sports such as basketball, baseball, football, and esports. An Elo rating system will be applied to the drivers on the F1 grid to gain some better understanding of driver comparisons.

Also, other plots will be compared to help gain understanding as well. Drivers will be compared at different Grand Prix using some box plots, and also some other charts comparing year-over-year lap-times for drivers about whether the team is progressing their car fast enough, and if the driver is potentially getting faster or slower.

II. Methods

All of the results were scraped from the Formula 1 official website, as well as the Ergast database [**?**, 1]hich recorded race results between 1950 to 2021. Some older results before 1950 were scraped from Wikipedia since they were not official "World Championship" races. Importing the data was fairly straightforward and did not require too much additional processing since it was fairly clean to start.

Python was used for the programs, with different implementations based on the task. Elo was done through a Python program called via a Terminal since the main work was calculating the Elo throughout the history of drivers in F1. Changing the arguments allowed to change the date at which the Elo was fetched from, so it was a good solution for it. Additionally, the data was stored in a SQLite database, so different queries were also possible using the database structure (which ended up being important for calculating the top F1 drivers of all time during each of their respective 5-year peaks in career).

Box plots and line plots were created using MatPlotLib, since it created good plots with not too much code to write. The code was written in Jupyter Notebook since the speed of the graphs being created was more important, and Jupyter allows individual cells to be executed instead of the entire program. As a result, it was easy to change some variables and re-plot the data to reflect certain changes.

NumPy, SciPy, Pandas were used for some general data organization, processing and such. I was familiar with these already, and they were simple to implement.

urllib and zipfile was used to fetch data from the main database I was utilizing, and it came in a zipped format.

A. Elo Calculation and Methodology

When calculating Elo, it is assumed that the points is a closed system. Points are constant from race to race, but drivers take and relinquish points depending on their performance in a race. There are a total of 20 drivers on the grid, and only the ones that finish in the top 10 in each race are awarded "points" that count towards the championship. Different ordinal numbered "groups" were established and are as follows:

Group 1 includes the singular race winner for the grand prix. Group 2 includes drivers who finished 2 and 3, which comprises of the rest of the podium excluding the race winner.

Group 3 includes places 4 and 5, which are drivers who narrowly missed out on the podium. Group 4 includes places 6 through 10, which are the rest of the drivers who scored championship points in the race. Group 5 includes the rest of the non-points scoring finishing drivers, which is 11 through 20.

Continuing, there are accidents that occur in F1 where drivers can crash out of the race or also have a mechanical issue causing them not to finish the race. Whenever there is an accident that is classified as being the driver's fault, they are placed below the other drivers. If there is a mechanical issue and the driver had to retire from the race, they are in a special group 0 since such an issue is not their fault.

Using the data and the general Elo structure, there needs to be a "rating" process that occurs only once where all drivers are compared against one another in "duels". Every driver in a non-group 0 is paired with another driver and assessed a win/loss depending on whether the driver was in a different group or not. If two drivers were on the podium (group 2), then they are assessed as a draw. However, a race-winner in group 1 will be assessed a win against a driver who was just on the podium (group 2).

Ratings are assessed after each qualifying and race session, which are the essential parts of any grand prix weekend. Qualifying shows the raw one-lap pace of each driver and sets them up for a better starting position for the race. The race itself is what gets the drivers the points and has many moving parts in terms of tire strategy, consistency, and race-craft that help the great drivers shine. There is no initial grace period for each driver when they enter their first career race, but every driver starts with the same initial rating ("Elo") points.

Lastly with Elo, duels between higher-ranked drivers change their rating points by fewer points than lower-ranked drivers. Essentially, if the number 1 rated driver wins a duel against the one who typically places last, it should not boost the number 1 driver's points much.

The entire Elo ratings are calculated using some Python code, elo.py and db.py as the main drivers for rating and storing the data. There was also some database usage by using SQLite for some of the entries and organization. With the number of calculations done by the program, it made sense to have cleaner ways of organizing the data. NumPy, MatPlotLib, SQLAlchemy, were some of the tools used to achieve the Elo calculations.

The best drivers of all time are evaluated using a simple calculation using Elo. For each driver, a 5-year slice is taken where they peaked in terms of average Elo rating. This average Elo during the interval represents a driver's peak performance. 5 years was chosen since too short would be not factoring in driver consistency, whereas too long would put drivers with shorter careers at too much of a disadvantage. Each average is compared, and a top driver list of all time based on average Elo can be calculated.

B. Lap Comparison Box Plots and Line Charts

The number of calculations for Elo is easy to get lost in, so there was also another methodology of creating box plots for different races based on lap pace for drivers. Generally, a tighter box plot with a better lap pace is an indicator for a faster driver, since they are generally faster and more consistent. There are also line plots where the deltas of each lap are compared between drivers. A delta of "zero" means that the driver is putting in the same lap time as their previous one. A positive delta means the driver is slower (longer lap time) than the previous lap, and a negative delta the opposite.

For the plots, NumPy, SciPy, Pandas, and MatPlotLib were used. Jupyter notebook was preferred for these plots since rapid re-graphing was necessary whenever a few variables were changed, such as which driver was being focused on.

III. Results

A. Elo Comparisons

Using the aforementioned average Elo calculation over a 5-year span, the table below shows the best drivers in terms of average Elo.

TABLE I
Top F1 Drivers by Average Elo

Driver	Average Elo
Ayrton Senna	2186
Lewis Hamilton	2151
Michael Schumacher	2100
Sebastian Vettel	2076
Juan Manuel Fangio	2049
Alain Prost	2043
Mika Hakkinen	2029
Niki Lauda	2025
Damon Hill	2001
David Coulthard	1988

These results are generally not surprising since these top drivers are regarded as "greats" within the F1 community. However, there are still some drivers on the list that are active such as Lewis Hamilton and Sebastian Vettel. As a result, they could actually go up in rankings but not down, since we are slicing their maximum and their previous maximum wouldn't change. They could still perform better on average for future races and raise their average Elo and still have their "best 5 years" in the future.

For present-day comparisons, the 2020 season came to a close and so comparing the drivers once the dust settled proved for some good insight. The Elo from 2020 is higher than the average Elo in the previous table since having a high "instantaneous" Elo is not difficult, but maintaining a high average over 5 years is difficult. Many drivers swap teams after a few years, which can either see themselves raise or lower in terms of Elo.

Usually drivers on the same team are paired up, since the car has a lot of say in terms of how quickly it goes around lap-by-lap. The main points of comparison are between the

TABLE II
F1 DRIVERS BY ELO 2020

Driver	Elo (as of end of 2020 season)
Lewis Hamilton	2645
Sergio Pérez	2401
Valtteri Bottas	2376
Max Verstappen	2339
Alexander Albon	2329
Lando Norris	2220
Carlos Sainz	2105
Daniel Ricciardo	2095
Esteban Ocon	1983
Lance Stroll	1930
Pierre Gasly	1882
Daniil Kvyat	1801
George Russell	1779
Charles Leclerc	1768
Sebastian Vettel	1756
Antonio Giovinazzi	1643
Kevin Magnussen	1630
Kimi Räikkönen	1629
Nicholas Latifi	1576
Romain Grosjean	1491

teammates as mentioned before, since the teammate with the higher Elo is typically the one that is better.

However, there are some drivers in the list that are out of place, which shows some over-performance. Sergio Pérez, who is number 2 on the list, has a teammate that is in 10th place. The overall team is not the fastest team, and it shows that Pérez over-performed both his teammate and his car. Likewise, George Russell drives a car that is typically regarded as the worst on the grid, yet there are still 7 drivers who place under him since he is getting lots of performance out of his car due to his driving.

Another insight offered is when the clock is set back by a year. The table below shows the Elo for the grid a year ago, right after the 2019 season ended.

TABLE III
F1 DRIVERS BY ELO 2019

Driver	Elo (as of end of 2019 season)
Lewis Hamilton	2547
Valtteri Bottas	2521
Max Verstappen	2420
Charles Leclerc	2390
Sebastian Vettel	2312
Alexander Albon	2250
Carlos Sainz	2190
Lando Norris	2022
Daniel Ricciardo	1954
Kimi Räikkönen	1932
Antonio Giovinazzi	1865
Sergio Pérez	1810
Daniil Kvyat	1790
Kevin Magnussen	1743
Nico Hulkenberg	1710
Romain Grosjean	1690
Pierre Gasly	1629
Lance Stroll	1610
George Russell	1559
Robert Kubica	1421

Many drivers are towards the same spots, but this table reflects the difference between team performance. The Ferrari team with Charles Leclerc and Sebastian Vettel was much better in 2019 than 2020, which is reflected in how much higher their Elo was in 2019 compared to 2020.

B. Non-Elo Comparisons

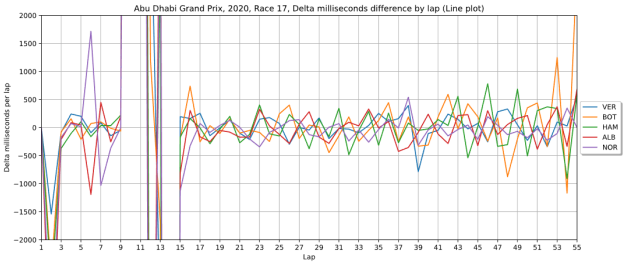

Fig. 1. Delta time per lap for 2020 Abu Dhabi Grand Prix

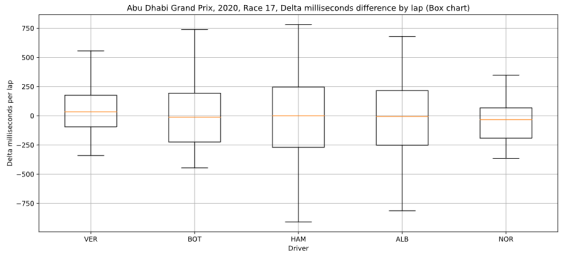

Fig. 2. Box plot of delta time per lap for 2020 Abu Dhabi Grand Prix

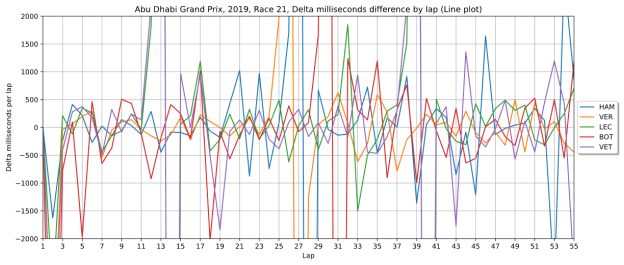

Fig. 3. Delta time per lap for 2019 Abu Dhabi Grand Prix

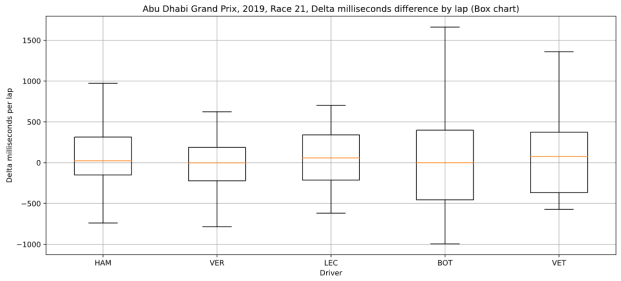

Fig. 4. Box plot of delta time per lap for 2019 Abu Dhabi Grand Prix

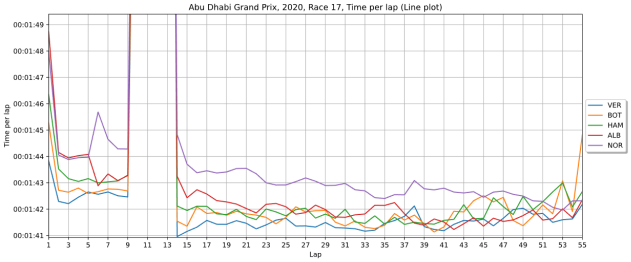

Fig. 5. Time per lap line plot for 2020 Abu Dhabi Grand Prix

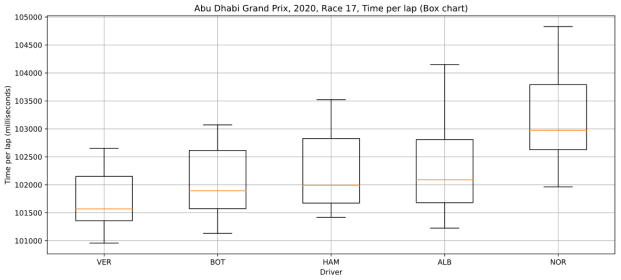

Fig. 6. Time per lap box plot for 2020 Abu Dhabi Grand Prix

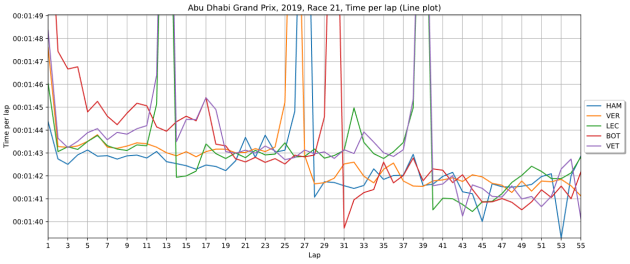

Fig. 7. Time per lap line plot for 2019 Abu Dhabi Grand Prix

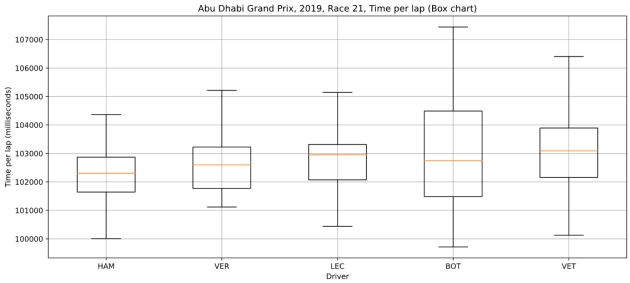

Fig. 8. Time per lap box plot for 2019 Abu Dhabi Grand Prix

The line plots are a great way to see some spikes in minimums and maximums for lap times and deltas. Technically, both of them are showing the same data, but the deltas are a better way of just showing the change between laps. The box plots offer the most condensed information that is easier to analyze.

The biggest standout performance was Verstappen for the 2020 Abu Dhabi Grand Prix, where his box plot was very tight meaning that is slowest lap was still not that slow compared to his fastest one. The delta box plot for the 2020 Abu Dhabi Grand Prix shows a similar story, but also shows that Norris was catching up throughout the race and going faster every lap. Had the race been longer, he may have caught up to a higher position.

In 2019, Verstappen had some slower laps than Hamilton, which is the opposite from 2020 where Hamilton had many laps slower than Verstappen's slowest. Hamilton had a tighter box plot, and had generally more consistent laps also shown by the delta graph.

Verstappen and Hamilton are typically regarded as the two fastest drivers on the grid. Hamilton is a much older driver than Verstappen, and with the trend shown while comparing 2019 and 2020 Abu Dhabi Grand Prix, Hamilton may be relinquishing his quick laps to the younger Verstappen.

Conclusion

There is almost too much data available when trying to analyze F1. This paper was to focus on trying to show the top

F1 drivers of all time, the few different battles between Verstappen and Hamilton who are regarded as the best currently, as well as comparing some driver Elo to see for any standout performances.

The top drivers of all time by Elo is interesting since AWS is a sponsor of F1, and offers data-driven insights. One of the conclusions AWS came to was some of the fastest drivers over one lap of all time. Many of the drivers are repeated on the list compared to their list, but there were some differences. This is likely because I am trying to find the drivers who were ”better” than their competition and dominant, whereas the fastest ones over one lap may be close in speed to the second fastest drivers. The Elo system does a good job of generally seeing how drivers fare against their competition.

The main workhorse of data science came in trying to work with databases and trying to organize the data in effective manners. It is interesting since performance of something as simple as cars going around in a track could be recorded as data and used as points of comparison for others.

Working with an Elo system was also interesting. We use lots of different models in data science, as well as trying to notice certain patterns. Elo is a little bit different, but still applicable since each ”node” is being compared to each other in a way, with different groups being made to find out whether each duel was a win or a loss and adjusting the rating as a result. Elo is a closed-system, meaning that there is only so much Elo that can be taken or given by drivers to each other (zero-sum).

Additionally, it is very satisfying to be able to run all of these calculations and generate graphs and numbers for drivers on any race I want. Once the program is made and initialized, the future calculations and adjustments are very easy to make which is the great part of this type of programming.

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