ORIE 3120 First Milestone: Formula One Project

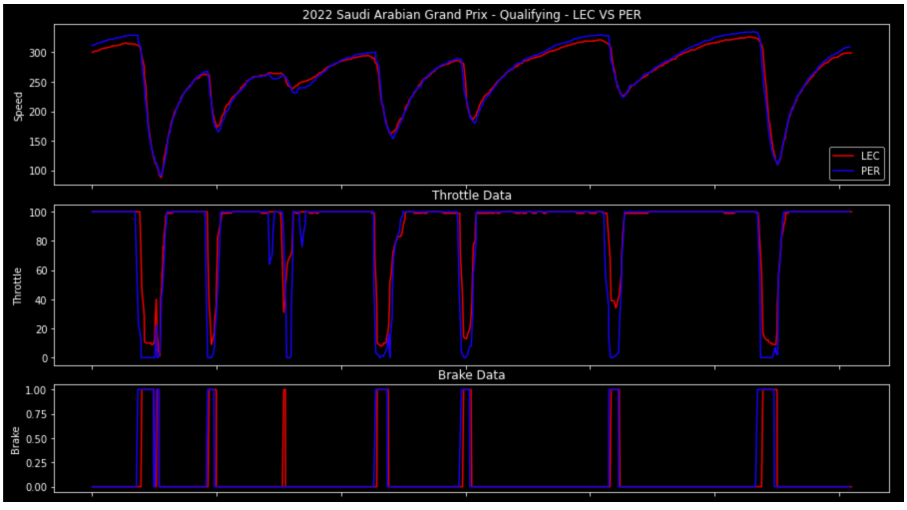
Introduction:

Our group is using FastF1, an API with data from every formula race, to answer questions about engine, tire, and driver performance. The dataset is very large, spanning from 1951 to 2022, with lap-by-lap data available for every driver and for every practice session, qualifying, and race. Most races also have telemetry and car performance data. Formula 1 is one of the most data-friendly sports, and FastF1 is evidence of that. For this milestone, we looked at two questions:

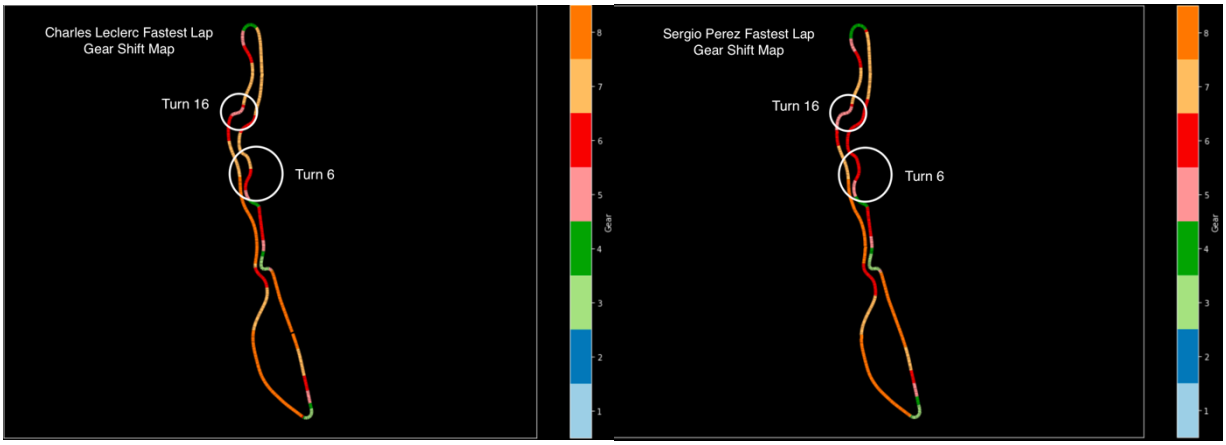
1. Are the new car development regulations restricting the types of car strategies teams can pursue?
2. Are the types of tires available on race weekends too similar, and limiting unique race strategies?

Question 1:

To begin answering the first question, it's important to cover some background information. In 2022, the FIA, the governing body of Formula 1, instated new regulations for how teams could develop cars. Formula 1 cars gain most of their speed by generating downforce, and more downforce means cars can move faster in corners and accelerate more quickly. Some feared the regulations were too strict and would effectively force teams to develop identical cars. Three races into the season, we can begin to answer whether the cars have similar aerodynamic philosophies. For this milestone, we looked at telemetry, gear shifting, and track-pace data at the Saudi Arabian Grand Prix, the second race of the year. We chose this track because it has a lot of high-speed sections as well as low-speed corners. If it is true the regulations are too strict, driver's data will show similar gear-shifting and top speeds.



This telemetry data shows the speed, throttle level, and brake level for Sergio Perez and Charles Leclerc during the fastest laps during qualifying. They were the two fastest drivers and drove for different teams, presenting an opportunity to examine if there are multiples successful car philosophies. Differences in telemetry data can look small, but even the slightest difference could make all the difference during qualifying. Perez has a higher top speed, shown in the speed plot (first plot), but they also step off the throttle more in corners, as seen in the second plot. By contrast, Leclerc has a lower top speed, but they carry a higher average throttle throughout the lap. This suggests that Leclerc (Ferrari) and Perez (Red Bull) have different car philosophies. Red Bull is faster in long straights while Ferrari is quicker in corners.

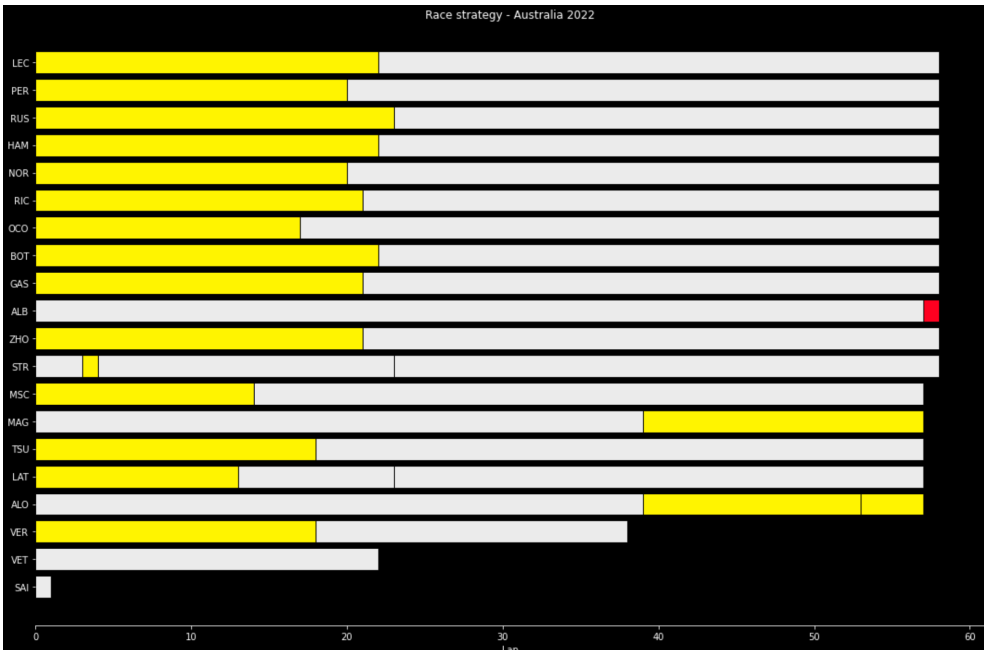


This is a visualization of each driver's gear shifts during their fastest qualifying lap. Formula 1 cars have 8 gears, and each one has an optimal speed. Eighth gear is for the highest speeds, and first is for the slowest corners. In turns 6 and 16, Leclerc upshifts quicker than Perez. In turn 6, Perez is in sixth gear and spends the following sequence in the same gear, while Charles upshifts to seventh. In turn 16, Leclerc shifts spends less time in fifth gear (pink), upshifting at the exit of the corner, while Perez only upshifts at the exit of the next corner. The difference in gear shifting indicates that Leclerc carried more speed through corners, suggesting that the Ferrari car philosophy depends on generating more downforce, while Red Bull makes up for lost time by having higher top speeds (shown by the telemetry data).

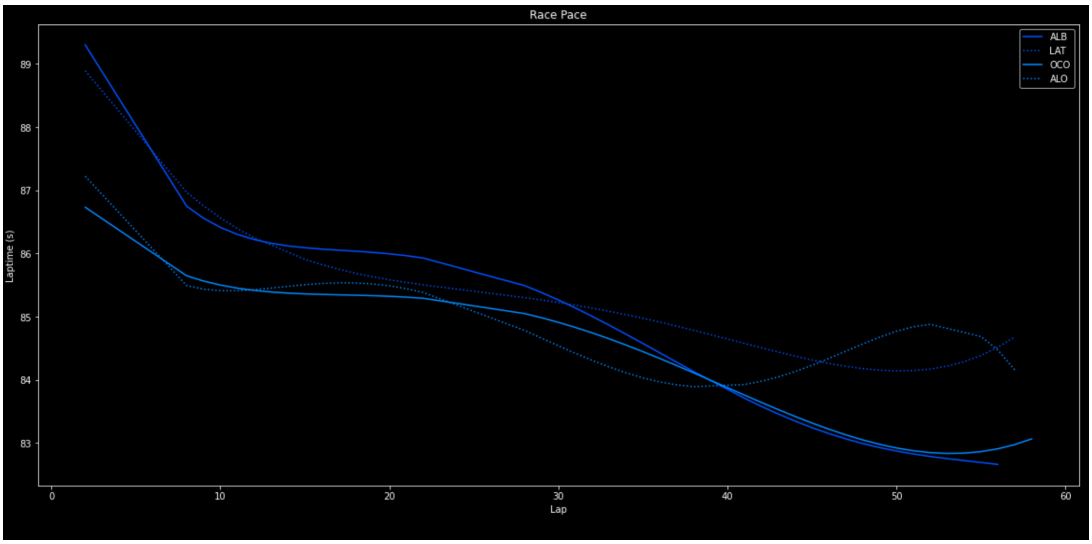
Looking at both visualizations, we can begin to answer the first question. Are the new car development regulations restricting the types of car strategies teams can pursue? At least at this race, it seems like the answer is no. The top two teams pursued different car philosophies, and the difference in speed was

only a couple hundredths of a second. Each strategy has its downsides, but the visualizations suggest the regulations are not encouraging homogenous car designs.

Question 2:



In Formula 1, there are three tire compounds: soft (red), medium (yellow), hard (white). The soft tires offer the most grip over one lap but degrade the quickest. By contrast, hard tires off the least grip over one lap, but the last the longest. During a race, teams must balance tire life with tire performance. While most drivers began the race on mediums and switched to hard tires, ALB's strategy stands out. They ran almost the entire race on hard tires and were rewarded with their first top ten finish of the year.



The first plot is in descending order of finishing position, indicating that the most successful strategy was overwhelmingly the medium to hard strategy. ALB's finish in tenth was highly unexpected, as he qualified last. The second plot further highlights how successful strategy was. ALB is the dark blue full line, and manages to keep pace with OCO, the light blue full line. In fact, ALB approaches OCO's race pace the older his tires become, which is counter intuitive since the older tires are, the worse they perform. ALO also pursues a unique strategy, as the first plot shows they pit almost 20 laps after most drivers. The second plot, shows, however, that their pace worsened after pitting (light blue dotted). This shows how variable tire strategy is, and answers the second question well. Are the types of tires available on race weekends too similar, and limiting unique race strategies? No, ALB's unique strategy got him his best finish of the year, going against the grain of the other top finishers.

Conclusion:

These visualizations indicate that the new regulations are not too restrictive, and that unique tire strategies are viable. To answer our first question, we used telemetry and gear-shift data to demonstrate how Red Bull and Ferrari pursue different car philosophies but have similar performance. In the second question, we use tire and race pace data to show how unique tire strategies are viable and rewarded and punished.