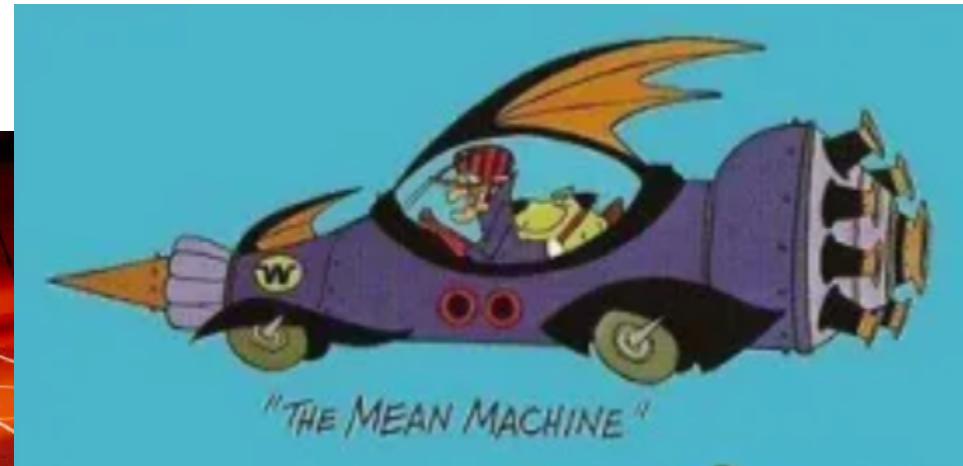


Formula 1 Data Challenge

(nyoom)



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Project Description

The 2024 Formula 1 Season Data Challenge involves analyzing a comprehensive dataset that includes every lap from all 2024 races. Participants will focus on strategic decisions related to pit stops, tire choices, and race management and explore correlations between key variables.

The dataset offers detailed information, including lap times, tire compounds, stint lengths, pit stop timings, and race positions. Participants will identify and interpret patterns in the data, such as how race length impacts strategy or the influence of tire compounds on lap times. Additionally, the challenge includes exploring relationships like how tire choice and pit stop timing affect final race outcomes.

The analysis will reveal how different strategies were employed across various races and provide insights into the factors influencing race outcomes. By working with this detailed dataset, participants will contribute to a better understanding of race strategy in Formula 1 and showcase their data science skills in a real-world context.

Participants will demonstrate their analytical abilities through both EDA and correlation analysis. The findings could potentially inform future decisions in the sport and contribute to a broader understanding of race strategy in Formula 1.

Objective

Submit a comprehensive report synthesizing your findings from the data analysis in a format that is accessible and engaging for technical and non-technical audiences.

Data Exploration

In this data set, we decide to work with the following set of files to better scope our analysis:

result_2024.csv

EventName - The name of the race / track

Abbreviation - The 3 letter abbreviated name of a driver

ClassifiedPosition - Where that driver placed in this race, total

The other columns contain data related to more granular times and speeds in certain sectors on specific tracks, and specific driver & team information present in other files.

lap_2024.csv

EventName - The name of the race/track

LapTime - Time taken to complete a lap

LapNumber - Which lap was completed, out of some total

Stint - Described as the time between pit stops. Stint 1 happens before the first pit stop.

PitOutTime - When a driver pulls out of the pit

PitInTime - When a driver pulls into the pit

Compound - What tire compound a driver's car uses during a lap

Team - A driver's team

Position - Where a driver places in a race at that specific time

Driver - Some guy?

The other files contain data that is not relevant to the scope of the questions I choose to ask and answer in this report. Not for lack of trying, just because I only have so much time in the day. Other possible analytics might include how weather affects car times, 3D simulation of each car and track, a meta-analysis of track length compared to driver effectiveness (does lap length affect lap time? Probably), or other information about cars / gearing / throttle / specific events that happen (crashes, DQs), etc. Maybe in the future.

Data Cleaning

Because we're really only working with two CSVs in this data, I only take a look at them when determining most of the data for this report.

lap_2024.csv

	unique	null	dtypes	dupe	outliers	count	mean	std	min	max
Sec	13266	113	float64	0	171	17010	91.3725	74.7567	67.694	2526.253
Position	20	15	float64	0	0	17108	9.9174	5.5015	1	20
LapNumber	78	0	float64	0	151	17123	31.1761	18.6523	1	78
Stint	5	0	float64	0	137	17123	2.096	0.8618	1	5
Team	10	0	object	0						
Compound	5	0	object	0						
PitInTime	556	16567	object	0						
LapTime	13266	113	object	0						
EventName	15	0	object	0						
Driver	21	0	object	0						

In order to clean this data, I primarily look at the use case: The information I'll be taking from this is mostly about **averages** and specific min/maxes based on certain criteria. For example, much of this report aggregates lap times within each Stint, or by each Driver; as such, much of the data integrity and verification happens on a per-race basis. Partly because it's just easier that way, partly because it provides context to each race. For instance, most LapTime outliers (not pictured here, but there are several) are based on DNQ / DNF drivers having never stopped their clock. This gives me insight into that player DNQ / DNF and why, so **we choose not to remove this type of data at the global level**.

NULL values are pretty few and far between. NULL values in the LapTime / Positional column fall into two categories:

- A driver's car did not record a specific time for a specific lap in a specific race
 - This is easily filled in with an average time for that driver if it was a technical error, or provides insight into a crash / DNF
- For some lap or set of laps, none of the drivers recorded positional data for them
 - Easily dropped / recorded and provides information about a lap repair / lap reset

result_2024.csv

	unique	null	dtypes	dupe	outliers	count	mean	std	min	max
Position	20	0	float64	0	0	299	10.4682	5.7593	1	20
EventName	15	0	object	0						
ClassifiedPosition	23	0	object	0						

Thankfully this data has no null values and is pretty straightforward categorical data. No cleaning required here.

The source of this data is straight from sensors and other hardware located directly on the cars, or part of the track or some other service. So we don't really need to worry about missing data existing because of a bad data source. It's reasonable to suggest that the \$18bn industry that is Formula 1 probably has their sensor quality nailed down. **NULL values that do exist in this dataset are primarily the result of things like laps not being completed** (breakdowns, disquals, etc), or not every lap having a pit stop. Because this data (or lack thereof) is still relevant, **we don't globally clean this data before we start working with it.**

Columns added:

Sec - A digest of the LapTime column into a single integer, seconds

LapTimeDt - LapTime converted to a different datatype, *datetime64[ns]*

SecDelta - The difference between the first lap time and last lap time in a single stint

PitStops & Pit Time - Number of pit stops a driver had in a race / Time they were in the pit

- This data was created by comparing the PitInTime and PitOutTime, subtracting the difference (to get PitTime) and tallying a counter for that driver in that race (to get PitStops)

There's a lot of other data combinations & columns I could produce *for all races* (like ClassifiedPosition on laps) but I choose not to because... I didn't think about it until much later. Oops. As such these explored combinations take place on a per-race basis. This doesn't affect the report, but it does affect my sleep schedule.

Insights & Analysis - Global Analysis

We break this section down into a **Global** analysis, which describes trends that exist over *all* races, tracks, and vehicle compounds, and **Per-Race** analysis, which predictably describes those same metrics on a per-race basis.

Insights about our Insights

- **Some of the global insights are too generic to be useful, but we provide them for brevity**
 - Global insights tend to be too generic and we see significant inter-race differences, because there are many variables that factor into driver performance like weather, track shape, car adjacency, and tire strategy, on top of drivers being more or less skilled at driving and/or just having a bad racing day sometimes
 - As such, any graphs or analysis that are not consistent with per-race behavior are noted and explained individually in the global analysis section

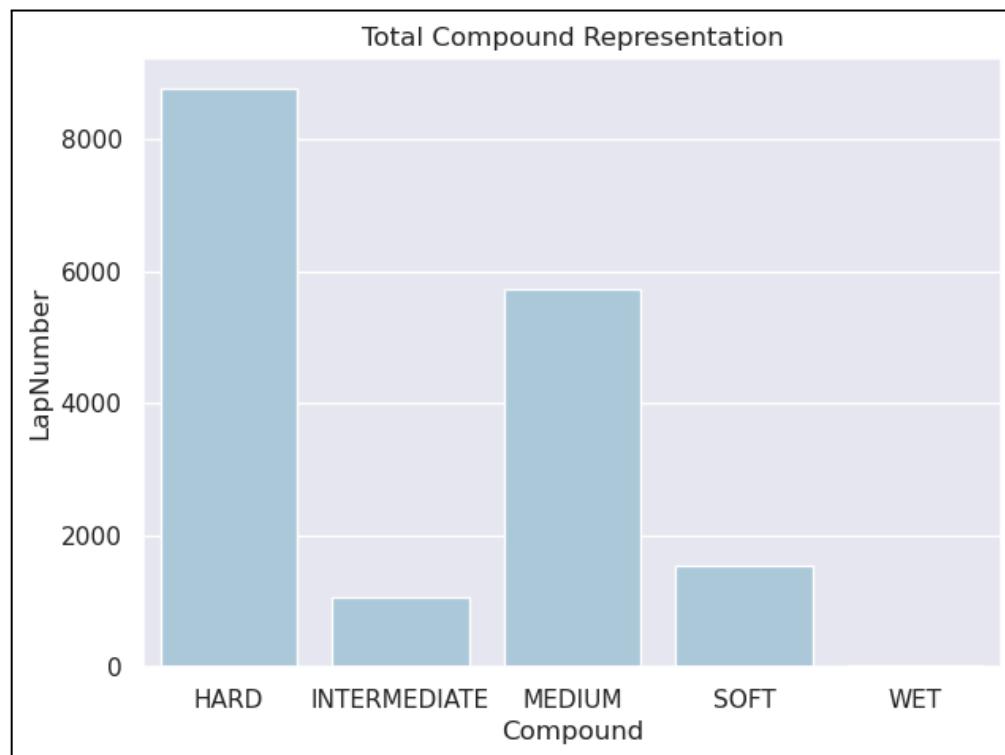
General Insights

The following insights are aggregated from patterns identified in every race. This list is not conclusive and you must look at individual races to get all the context

- Many races have what I call a "Sprint Stint", characterized by a shorter first Stint with high usage of MEDIUM or SOFT compounds, followed by a second Stint with high HARD and MEDIUM compound usage that is normally about twice as long
- HARD tires:
 - Often used by drivers at the front of the race to maintain their position, and sees significant popularity any time after Stint 1
 - **Not** often used on the first Stint unless a driver has a unique tire strategy
 - Used on tracks with lots of long straightaways and less on tracks with a significant number of sharper turns
 - Benefit disproportionately from track-wear and tire heat, and often see the greatest negative lap split over time
 - Used equally by positions in the front and back of the race
- SOFT tires:
 - Almost always used by drivers near the middle or back of the race. SOFT tire strategy is less about **speed** and more about **position**
 - Are often seen with slower lap splits than MEDIUM or HARD. This is likely because of car adjacency in the beginning of the race
- MEDIUM tires:
 - See high popularity with drivers at the front of the race in Stint 1. Instead of SOFT tires, front drivers tend to use MEDIUM in the first stint
 - Used equally by those at the front and back of the race
- INTERMEDIATE / WET tires:
 - In this dataset are only represented in a couple races, and are generally used when necessary (rain) and dont strongly factor into tire strategy
- Rain in 2024 races was sparse but present - there were no tracks that were drenched, and so general trends for WET / INT tires can not be determined
- Races with safety cars (crashes) often saw drivers continue with their tire / stint strategy, even if a crash happened during the first lap (Monaco)

Global Analysis - Total Compound Representation

Global relationships represent averages and summaries over all races. We identify them for posterity and to draw conclusions between how the universal understanding of certain metrics compares to individual races. Importantly, **we often see discrepancies between globally-scoped data and race-scoped data**, where assumptions and key takeaways & correlations turn out to be not true for specific races or situations.



Insights

- INTERMEDIATE and WET compounds see the least use, highlighting their niche use case in purely wet environments
- Even in wet environments, WET tires are extremely under-utilized. This suggests either heavy rains on rainy days (standing water), or a preference for INTERMEDIATE tires regardless of wet-weather.
- Most strategies seem to bounce between HARD and MEDIUM compounds
- HARD tires are by far the most popular, suggesting a global desire to **have fewer pitstops** and **maintain pace**
- SOFT tires are the least popular non-wet tire, suggesting a more scoped use-case

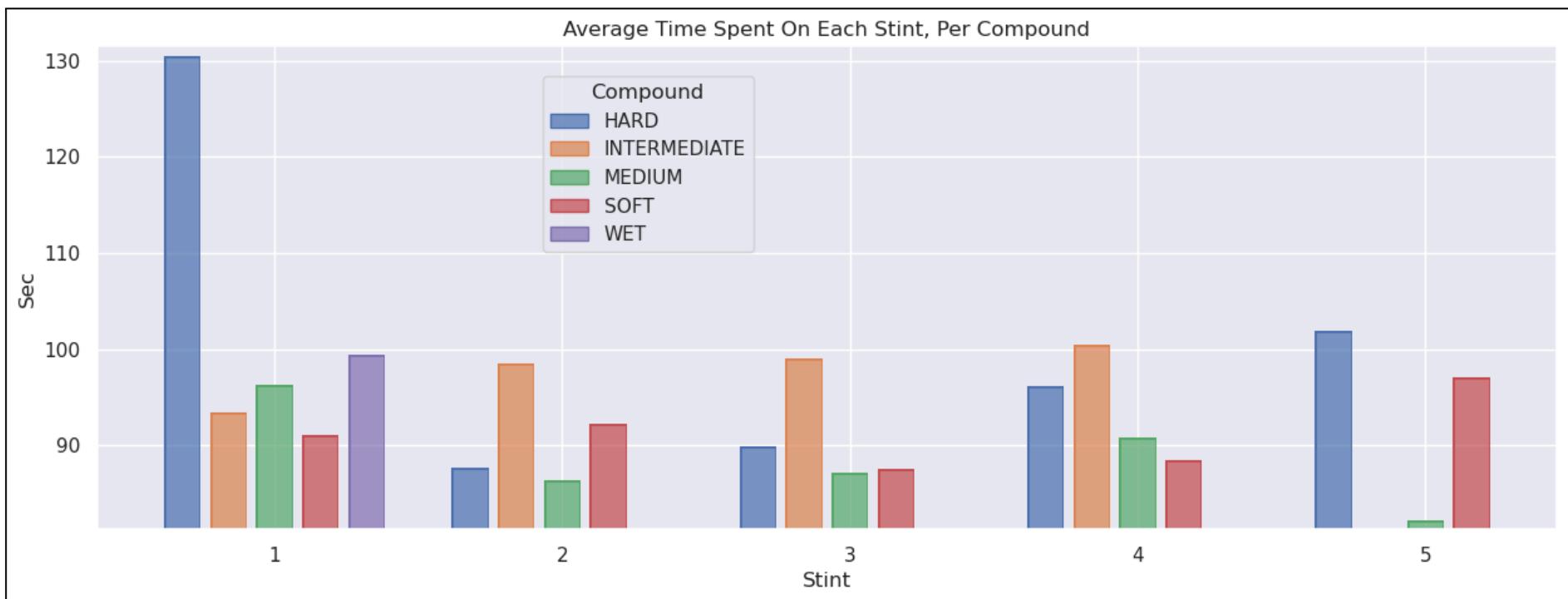
Generally it's clear that SOFT / MEDIUM / HARD tires play specific roles and have specific tradeoffs depending on specific strategy and position within the track. If the relationship between speed gained & tire life was linear (HARD: Slow / Durable, SOFT: Fast / Fragile) we might see either a more equal representation of each tire (ie they all balance out in the end) or a global trend towards just one type of tire, above all else. Probably MEDIUM in that case, as a best-of-both-worlds option.

Because we *don't* see that, it's clear the relationship is not so linear and the tradeoffs between compound usage are likely decided more by an individual's strategy than the hardware itself. We explore this relationship further in specific races below.

Insights and Analysis - Global Analysis - Tire Compound Choice vs Lap Time (R1)

Task: Investigate how different tire compounds (e.g., Soft, Medium, Hard) correlate with lap times throughout the race.

Objective: Identify which tire compounds lead to faster lap times and whether this varies depending on the stint or race phase.



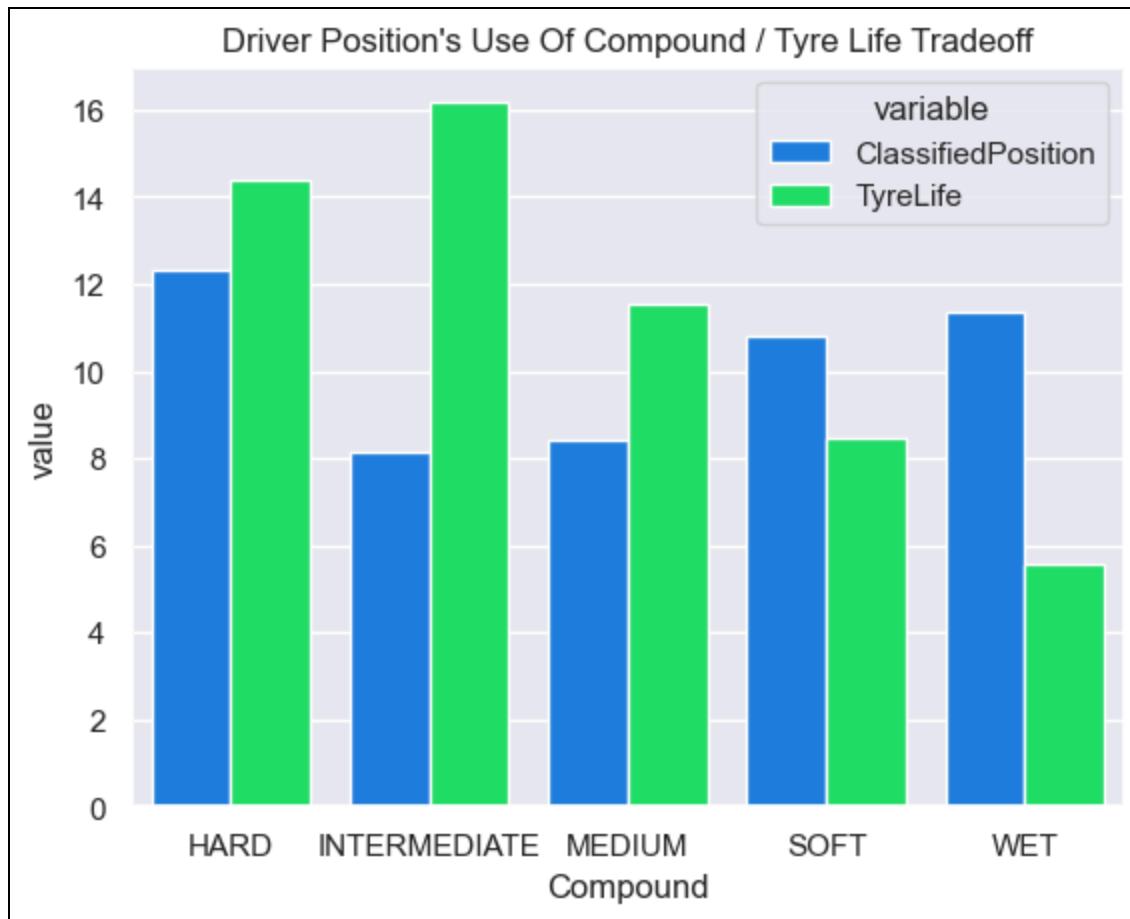
Insights

- Stint 4 and 5 are under-represented in this dataset. Most drivers have 3 stints.
- HARD tires on the first stint overwhelmingly lose time based on any other compound in any other stint
 - **Observation:** HARD tires are under-represented in the first stint. Most drivers do not use HARD tires at the start of the race
 - **Observation:** HARD tires benefit disproportionately from a worn-in track, rubbered-in track, and tire warming
- As races progress, we generally see an increase in HARD tire usage
 - **Observation:** After Stint 1, drivers are more likely to want to continue with their current position than risk losing spots from pit stops
- SOFT tires, regardless of Stint, see a fairly even representation of times compared to other compounds and have generally faster times
 - **Observation:** We see in specific races that this relationship is more complex; SOFT tires are usually used by those at the back of a race and MEDIUM tires see more popularity at the front
- INTERMEDIATE tires see an increase in lap times as races progress
 - This is mostly because races that use INTERMEDIATE tires tend to have fickle weather and INTERMEDIATE tires on those wet tracks tend not to be the best option for more than about 15 or 20 minutes as weather clears up
- WET tires are the second worst performing tire and see no representation in any other stint besides the first
- MEDIUM tires are far more popular than SOFT tires and see better performance after Stint 1
 - We explore this further in specific races, since this tends not to be true globally

Insights and Analysis - Global Analysis - Positional Use of Compounds / Tire Life Tradeoff (R2)

Task: Explore how starting the race on different tire compounds (Hard, Soft, Medium) impacts the final classification.

Objective: Understand whether the initial tire choice plays a significant role in determining race outcomes.



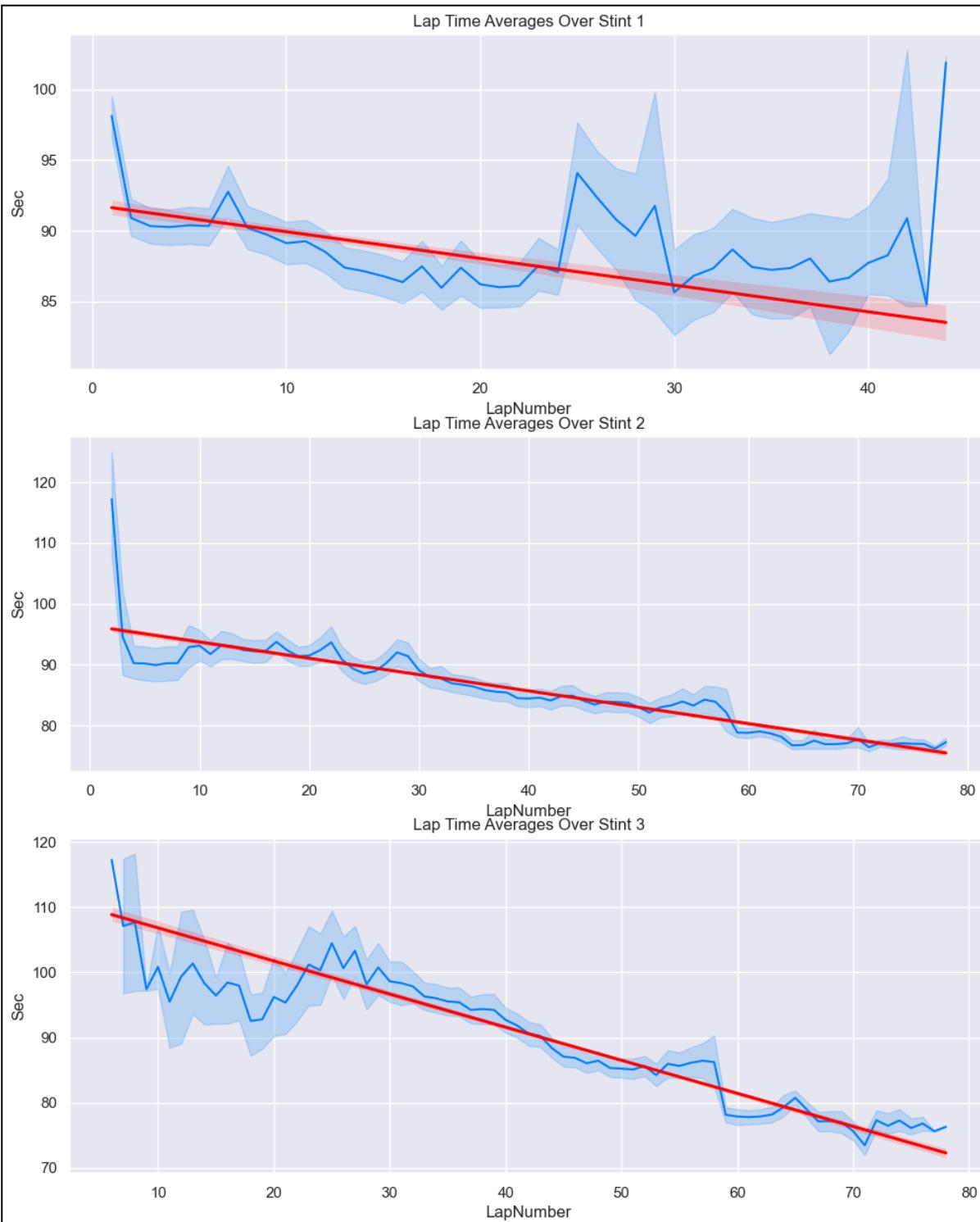
Insights

- We see higher use of MEDIUM compounds for drivers at the front of the race, and higher use of SOFT compounds for drivers at the back
- HARD tires are used by drivers at all positions in the race
- The tire life difference between HARD and MEDIUM is about 18%
- The tire life difference between MEDIUM and SOFT is also about 20%
- INTERMEDIATE and WET tire life is less important because when they are used, it is usually by necessity and not choice

At a glance, HARD tires see more popularity from rear drivers, and MEDIUM tires see more popularity from front drivers. This is too big of a generalization and is inconsistent with HARD tire usage in specific races, but it does suggest that **if a driver is ahead in the race, they tend to prefer a mix of speed and durability instead of relying on one or another completely.**

This makes sense if you consider tire durability a stronger factor in total lap time performance than speed. Later in this report, we identify that **compound differences tend to only make a 2-10 second difference within a single stint**. When compared to a 25 second pit stop, an (average) tire lifetime of 15 laps (HARD) is a much higher time-gainer than a faster compound with an average 40% decrease in durability (SOFT). This applies especially to races where stints are in the higher lap range.

Insights and Analysis - Global Analysis - Lap Times Over A Stint (R3.5)



Task: Explore lap times over a single stint

Objective: Identify trends in lap times and identify potential variables that bring this time down

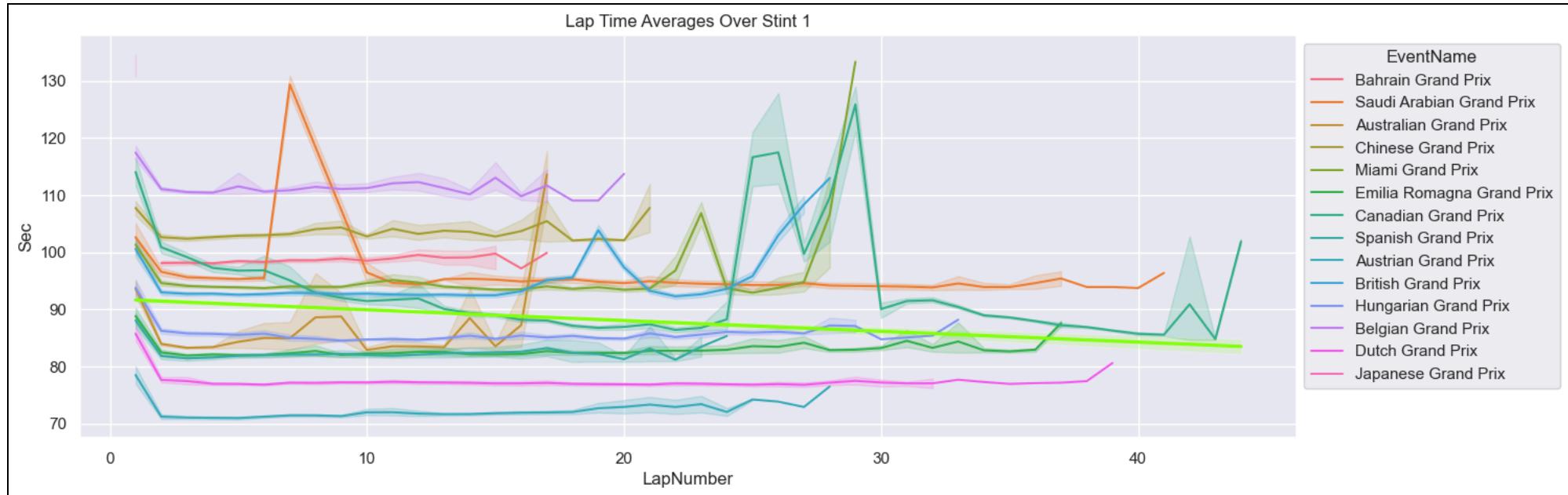
The global representation of this data is a little fuzzy, because it suggests that there are 1 or more stints containing 70 or more laps, which is not to be the case. The general trend still shows that over time, lap times decrease within a stint.

This is actually a **bad visualization** because none of the data here is normalized - tracks each have their own average lap times and lengths which make a "global trend" kind of meaningless. It's **more accurate to represent each race individually** since the lap splits are dependent on so many variables, including weather, driver skill, or individual race strategy.

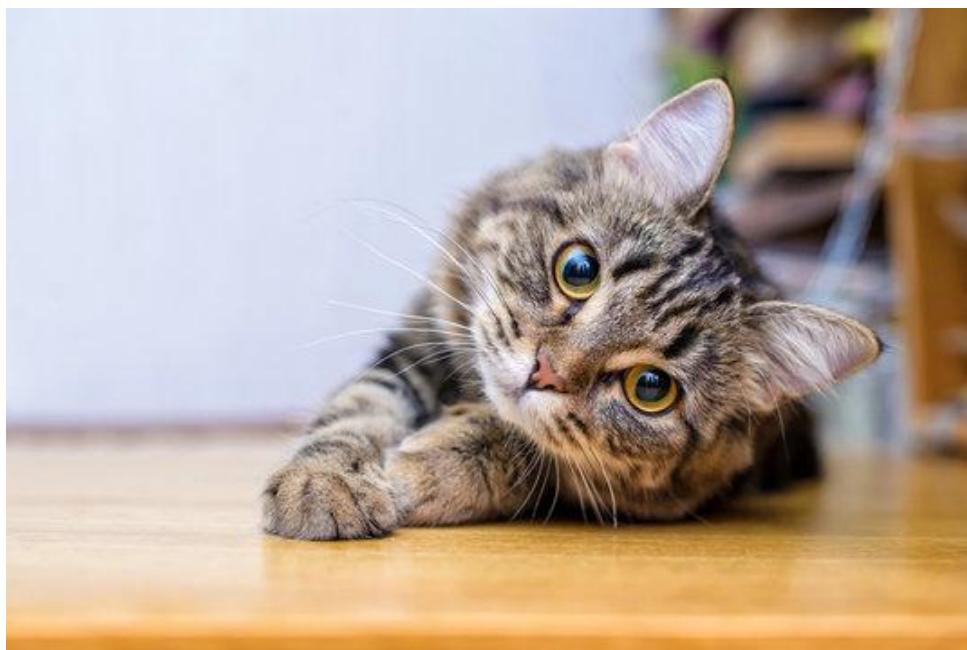
As such, you **can't conclude a global phenomenon of intra-stint lap times decreasing** just from this data alone

One thing we do often see is that the beginning of a race is very slow comparatively. Part of this is because of tire temp / the track being too fresh (non rubbered-in), but also because there are just a lot of cars adjacent to one another so they are forced to drive more slowly as passing and blocking become core strategies, until later in the race where maintaining speed and control becomes the core strategy. These generally lead to reduced times over the course of a race, independent of tire or track wear.

Insights and Analysis - Global Analysis - Lap Times Over A Stint (R3.5)



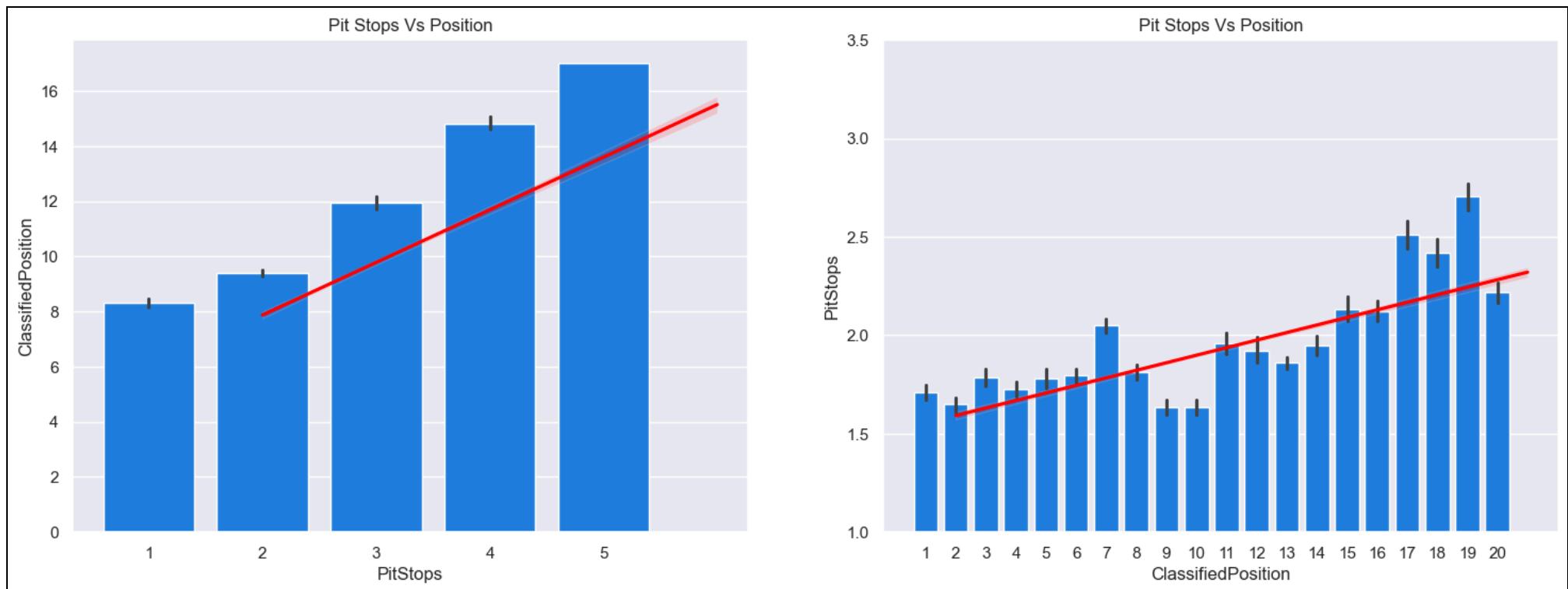
This is an example of the same analysis done but on a per-race basis. Most of the lines here are relatively flat (some actually increase) **suggesting both that lap times within a stint increase with time AND decrease with time...** but certain tracks bring this average way up or way down. So we'll explore these times per-race instead of as a global phenomenon.



Insights and Analysis - Global Analysis - Number of Stops vs Final Position (R4)

Task: Analyze the relationship between the number of pit stops a driver makes and their final position in the race.

Objective: Understand how the frequency of pit stops impacts race outcomes, particularly whether fewer or more stops lead to better results.



Insights

- General trend: Fewer pitstops results in a better final position / winning drivers tend to pit stop less than losing drivers

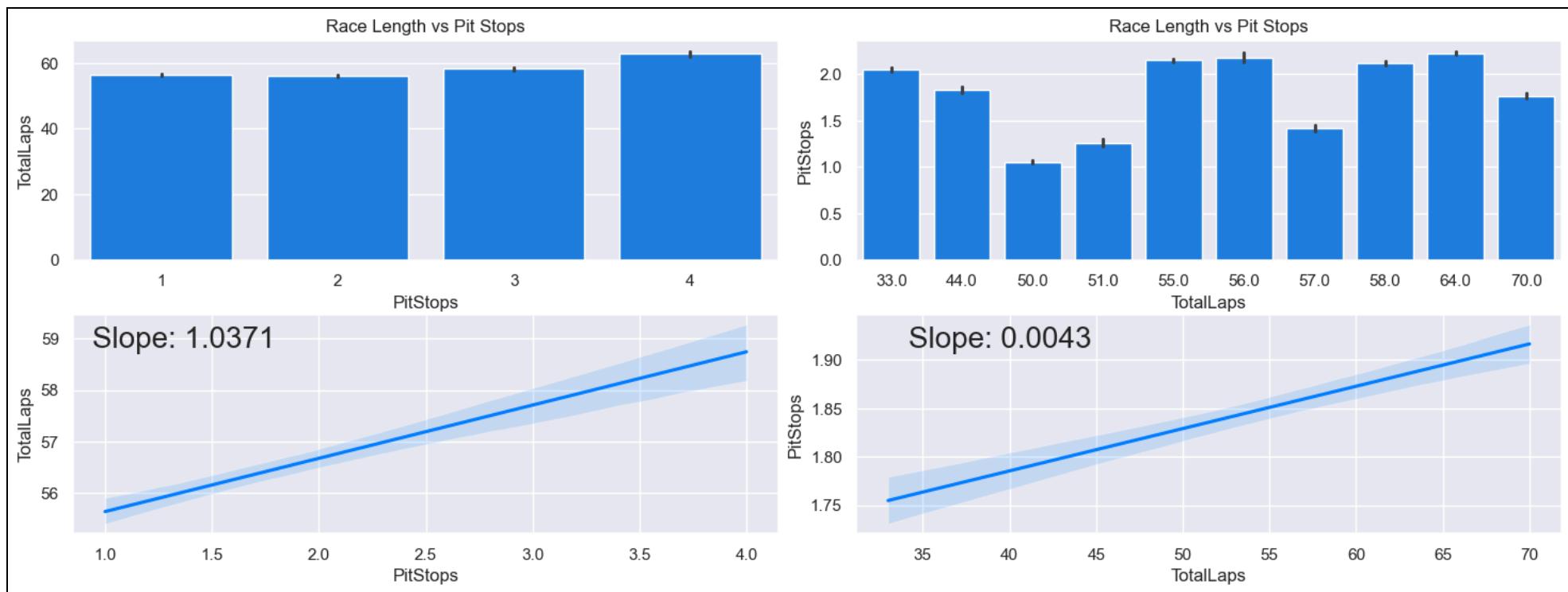
This follows the intuitive feeling that stopping less = more time saved. However most races tend to have an average of two pit stops, so these graphs once again have an over/under representation problem that favors outliers. It's a good tool to identify trends *in general* but not an adequate tool to draw more granular conclusions from.

We identify later in individual races that this behavior is not true for every race, suggesting that the deviation of strategy within single races and even single teams and drivers influence this metric significantly. **Most of the time, for individual races, there is no relationship here besides the general trend.**

Insights and Analysis - Global Analysis - Race Length vs Strategy (R5)

Task: Examine how the total number of laps in each race influenced the pit stop strategy and tire choices for teams and drivers.

Objective: Understand how race length affects strategic decisions, particularly in terms of the number of stops and tire choices.



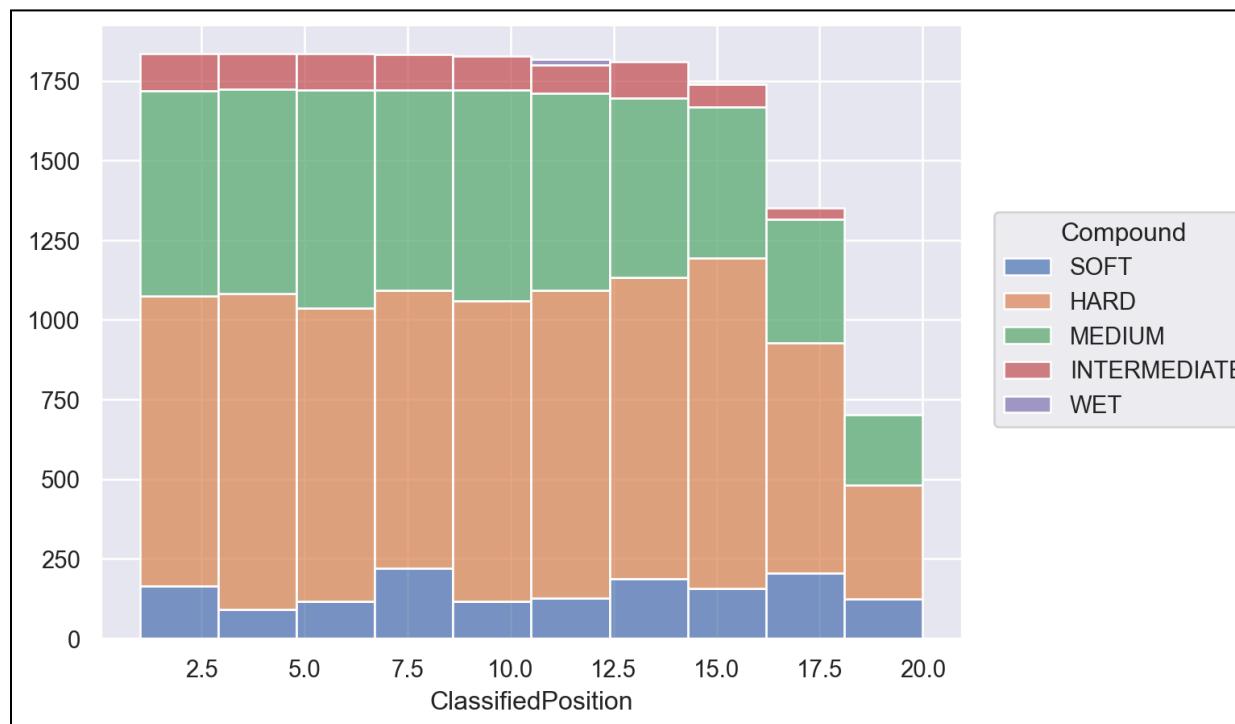
Insights

- The correlation between these two variables is **0.0674** (on a scale of $-1 > 1$), which means they are **not related to each other**
 - This is the *global* consideration, however this data is **best represented globally and not per-race**. If we analyze this data on individual races, we remove the TotalLaps variable (since each race has the same number of laps for each driver) and our relationship goes away because there's nothing to relate. Instead, we identify tire choices & pit stop strategy elsewhere in this report.
- The slope of each bar is very low, suggesting that the variables aren't related to each other almost at all
- We see more or less pit stops (on average) between all lengths of races, suggesting **pit stop strategy is independent of race length** and **more dependent on the individual race itself**
 - This is understandable if we consider that races have variable turns, hills, straightaways, weather, etc. And normally tire compound strategy is more centered around individual position in the race & stint, than the total number of laps.

Insights and Analysis - Global Analysis - What compounds do certain positions tend to use? (Bonus)

Task: Identify compound usage based on where a driver finishes in the race

Objective: Draw conclusions between compound usage and strategy effectiveness



Insights

- Front, middle, and back positions see an increased use of SOFT tires. Less in between
 - Perhaps these positions have an increased appetite for trying to gain place
- As positions decrease (losing), we see a gradual taper of MEDIUM tires and a gradual increase in HARD tires
 - Front positions may rely more heavily on MEDIUM tires and less on HARD tires, proportionally
 - Front positions still use HARD tires more than any other compound

- SOFT tires are used disproportionately more by drivers in the back of the race, between 2x and 3x
 - You might expect SOFT tires to see popularity in all positions, but this data is consistent with all races I evaluated; SOFT tires are almost exclusively used by those in positions behind 5th place and we don't often see SOFT compounds being used by leading drivers
- Later positions tend to fall off because they have completed fewer laps
 - This is likely due to over/under representation of these position types. DNF and DQ positions are not represented in this graph and likely make up the remainder of the missing space on the right side of the graph.
 - Proportionally, the last positions use far more SOFT tires than any other position in the race. If we scale the bar at the 18 mark to be the same height as the others, SOFT compounds see a huge rise relative to other positions

Insights and Analysis - Per Race

Bahrain Grand Prix - Base Statistics

Teams

Alpine	GAS, OCO
Aston Martin	STR, ALO
Ferrari	SAI, LEC
Haas F1 Team	MAG, HUL
Kick Sauber	BOT, ZHO
McLaren	NOR, PIA
Mercedes	RUS, HAM
RB	RIC, TSU
Red Bull Racing	VER, PER
Williams	ALB, SAR

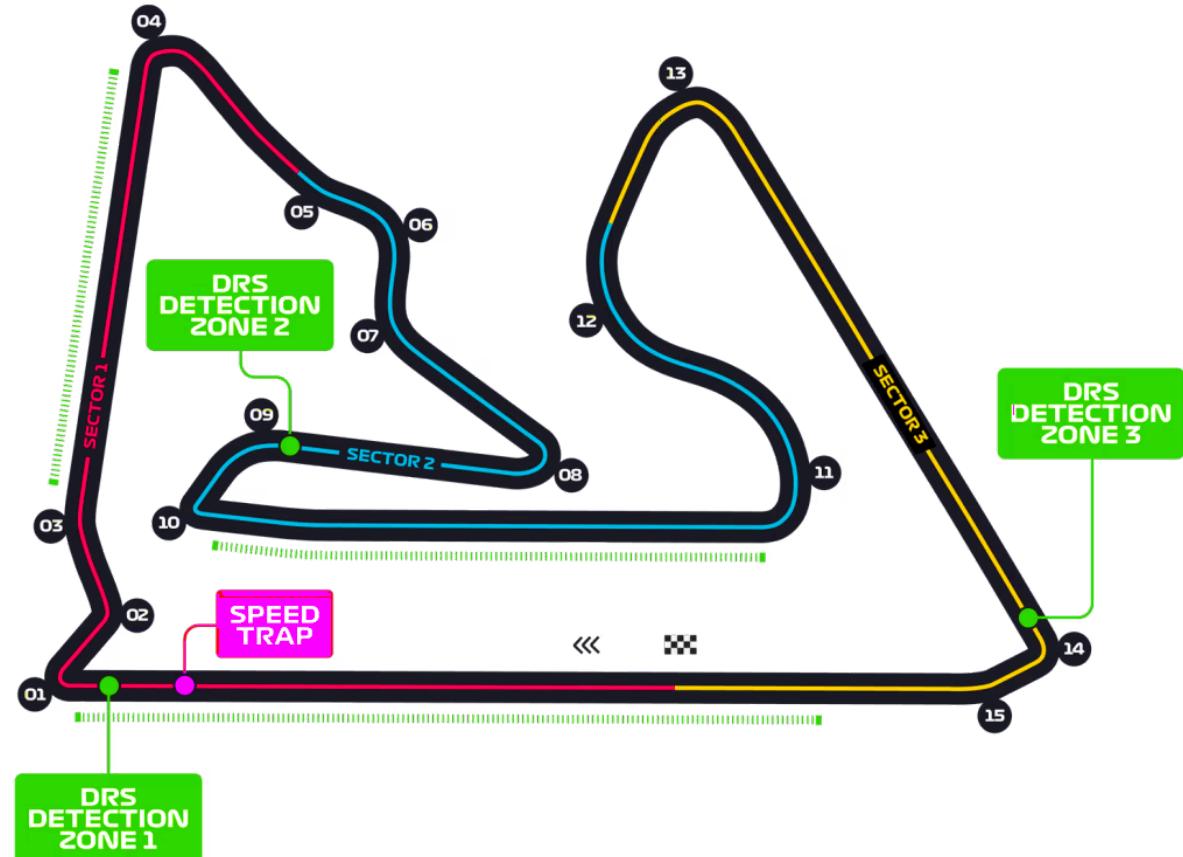
Total Statistics

Pit Stops	43
Pit Time	0:19:05
Laps Completed	1129
Lap Time	1 days 06:40:50
Race Laps	57
Compounds	[SOFT, HARD]

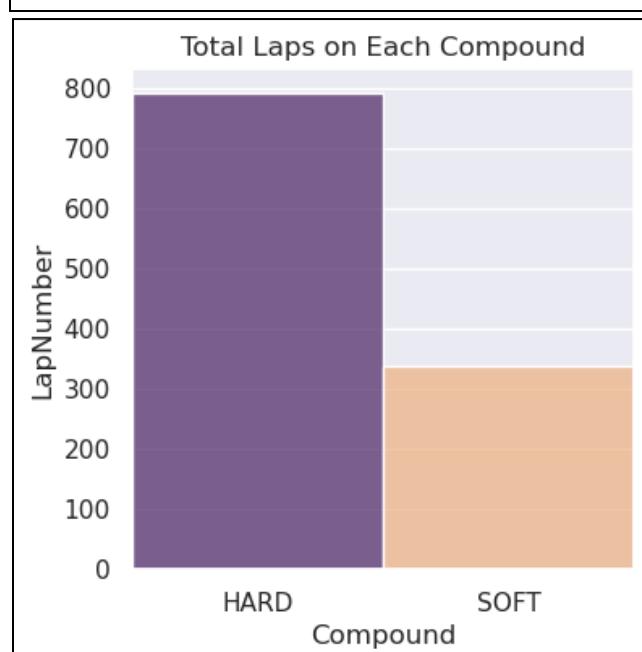
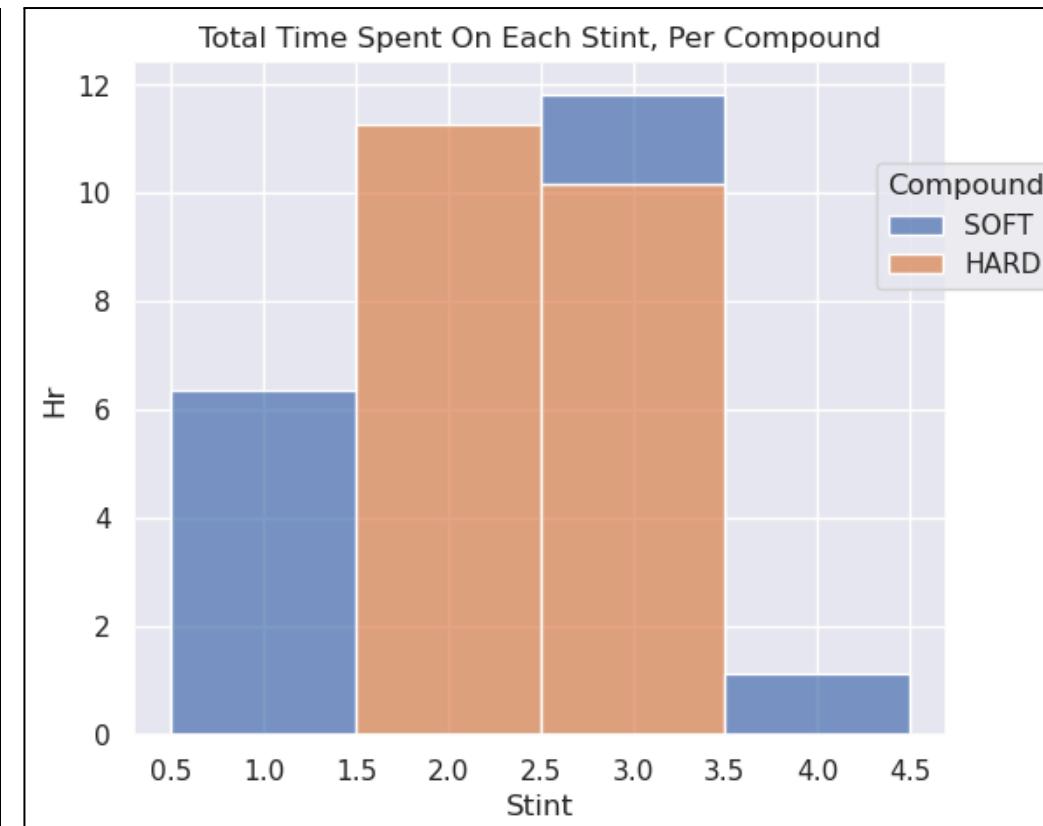
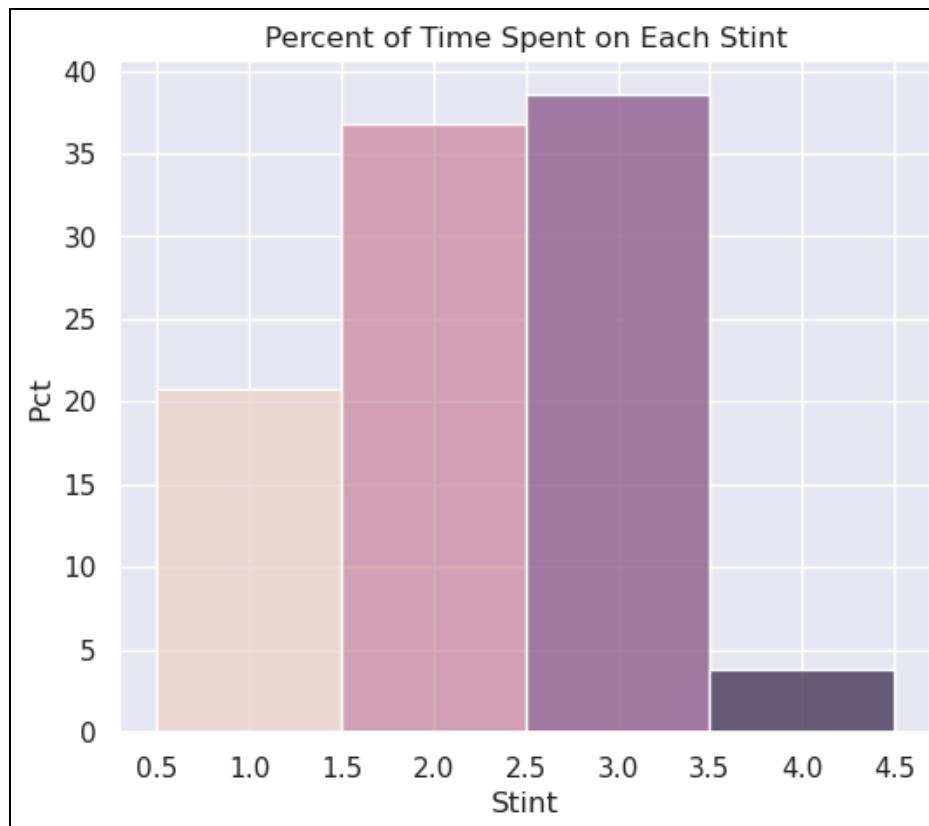
Average Statistics

Pit Stops	2.15
Pit Time	0:00:27
Laps Completed	57.2676
Lap Time	0:01:38

[Bahrain Circuit Link](#)



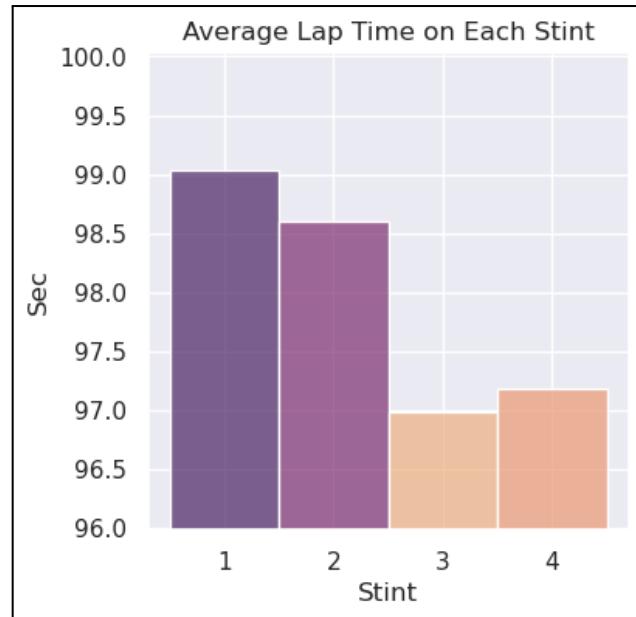
Bahrain Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

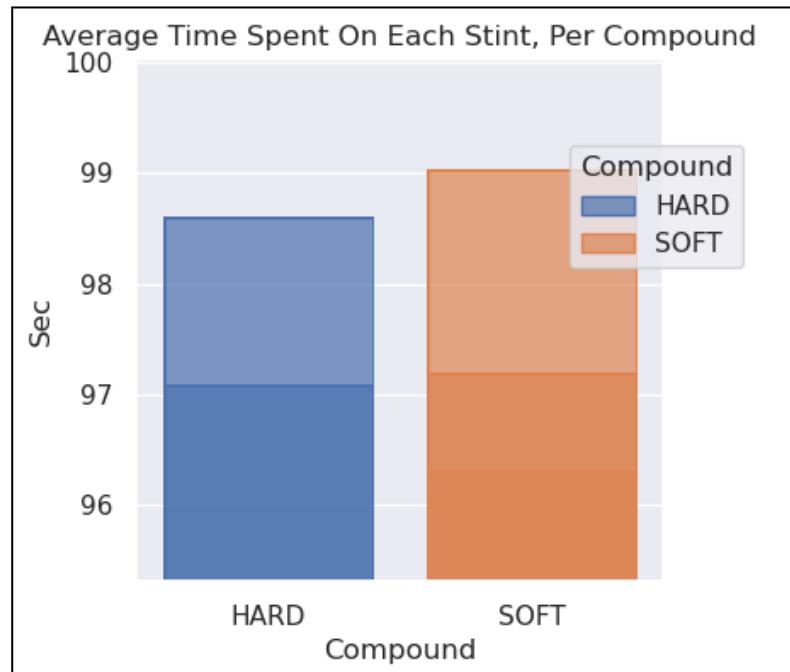
- This race only represents two compounds: SOFT / HARD
- Stint 1 sees exclusive use of SOFT tires, suggesting a more aggressive strategy by default
 - **Observation:** SOFT compounds see ~40% reduction in tire life compared to HARD tires, consistent with the global observation
 - **Observation:** Time spent on HARD tires is also about ~40% higher than SOFT tires, reducing pit stop frequency
- Stints 2 and 3 see almost exclusive use of HARD tires, and some of SOFT
 - **Observation:** Stint 2 strategy reflects a **strong desire to maintain pace** and longevity once the Stint 1 sprint has concluded
 - **Observation:** Stint 3 strategy reflects a **strong desire to maintain pace**, with some use of SOFT compounds, perhaps to eek out a little bit more position before the race ends
- Stint 4, if driven, uses exclusively SOFT tires, probably because **durability becomes less of a factor at the end of a race**

Bahrain Grand Prix - Average Lap Time Per Stint / Per Compound (Relationship 1)



Insights

- Stint 1 is the highest-time stint on average, likely because cars must accelerate at the beginning of a race and so naturally will be slower than at full speed
 - **Observation:** Stint 1 compounds are probably SOFT to gain this time back
- We see a **downward trend in lap times** (around 1-2 seconds on avg) as stints progress. This is a good example of it, because between stints 2 and 3, the compound is the same, so the only changing variable is the track itself and/or driver expertise
- Stint 3, despite having HARD tires, has the smallest average lap time
 - **Observation:** HARD tires benefit significantly from a worn-in track
- Stint 4, despite having SOFT tires, underperforms compared to the HARD tires in Stint 3
 - **Observation:** This is probably from stint 4 being under represented in this track, not because this is generally a true metric



Insights

- On average, HARD tires beat out SOFT tires on this track
 - **Observation:** This is probably from SOFT tires being skewed time-wise since they are seen primarily in the first stint, and seldom any other times
 - **Observation:** Tire strategy is influenced strongly by the first stint
 - **Observation:** Adjacent vehicles in the first stint might make the choice of one compound or another more attractive, based on a driver's starting position on the track and how many vehicles they need to get ahead of throughout the first stint

Bahrain Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
VER	2	49.306	57	1:31:45	0:01:37	1	ZHO	2	50.124	56	1:31:52	0:01:38	11
PER	2	48.916	57	1:32:07	0:01:37	2	MAG	2	50.454	56	1:31:53	0:01:38	12
SAI	2	48.466	57	1:32:10	0:01:37	3	RIC	2	49.36	56	1:31:54	0:01:38	13
LEC	2	48.129	57	1:32:24	0:01:37	4	TSU	2	49.271	56	1:31:54	0:01:38	14
RUS	2	49.716	57	1:32:32	0:01:37	5	ALB	2	49.461	56	1:31:57	0:01:39	15
NOR	2	48.91	57	1:32:33	0:01:37	6	HUL	3	85.509	56	1:32:02	0:01:39	16
HAM	2	49.183	57	1:32:35	0:01:37	7	OCO	2	49.821	56	1:32:16	0:01:39	17
PIA	2	50.21	57	1:32:41	0:01:38	8	GAS	3	81.445	56	1:32:17	0:01:39	18
ALO	2	49.923	57	1:33:00	0:01:38	9	BOT	2	101.517	56	1:30:18	0:01:39	19
STR	2	48.774	57	1:33:18	0:01:38	10	SAR	3	86.297	55	1:29:24	0:01:39	20

Insights

- Top drivers' pit stops and pit time are all relatively consistent (2 stops, ~49-50s pit time)
 - Until 15th place, pit time is about consistent for all drivers
 - In some cases (16th place vs 17th place), a full 36 second difference was still not enough for OCO to place 16th and instead took 17th
 - **Observation:** Pit time optimization is not where the main time savers are for this track
- Total lap time is not as equal, with a lap time difference of 27 seconds between first and second place
 - **Observation:** Skill becomes a much larger factor between each position, knocking off fractions of a second on a per-track basis
- **Observation:** Total Time Driven is not an accurate metric for measuring placement in a race
 - This is likely because the points system that F1 scores by is not only related to total time driven. Points are earned in various ways.

Bahrain Grand Prix - Driver Data



Insights

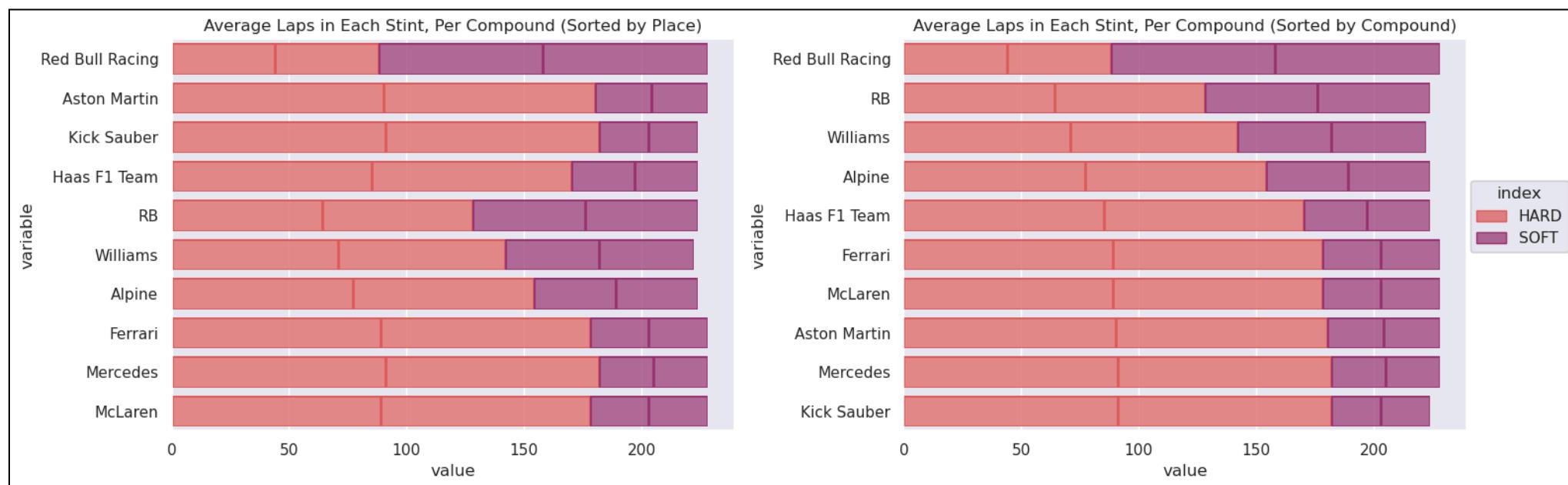
- Observation:** First place (VER) used SOFT tires for longer than HARD tires
- Observation:** Generally, SOFT tire and HARD tire usage varies with regard to position, although there's a general trend for higher SOFT tire usage to correlate with higher position
 - This isn't always true - third and fourth place predominantly used HARD tires, suggesting their strategy was very different from VER, but almost as effective. RIC also used SOFT tires like VER and PER, it just wasn't as effective
 - It's possible they decided to use HARD tires because they had points in other areas, and could afford to just be consistent - hence their high HARD tire use throughout the race

Bahrain Grand Prix - Team Data

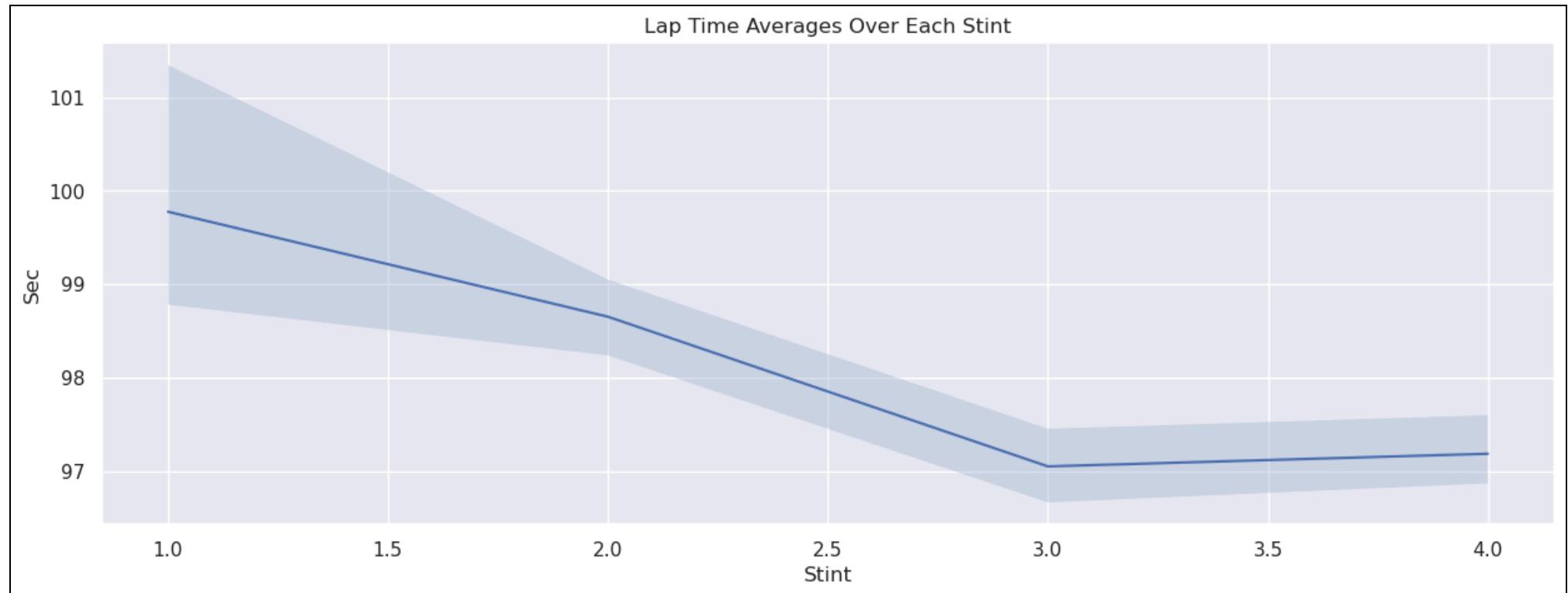
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Williams	2	5	0:02:16	55	3:01:20	0:01:39
Kick Sauber	2	4	0:02:32	56	3:02:09	0:01:38
RB	2	4	0:01:39	56	3:03:48	0:01:38
Red Bull Racing	2	4	0:01:38	57	3:03:52	0:01:37
Haas F1 Team	2	5	0:02:16	56	3:03:55	0:01:39
Alpine	2	5	0:02:11	56	3:04:33	0:01:39
Ferrari	2	4	0:01:37	57	3:04:34	0:01:37
Mercedes	2	4	0:01:39	57	3:05:07	0:01:37
McLaren	2	4	0:01:39	57	3:05:14	0:01:37
Aston Martin	2	4	0:01:39	57	3:06:18	0:01:38

Insights

- **Observation:** Red bull used mostly SOFT compounds this race and seemed to pull ahead because of it
- **Observation:** The other team/driver usages of HARD/SOFT compounds are fairly equally represented across the board, suggesting individual strategy is more important
- **Observation:** Perhaps increased use of SOFT tires on this track would make drivers place higher, on average



Bahrain Grand Prix - Lap Time Averages



Insights

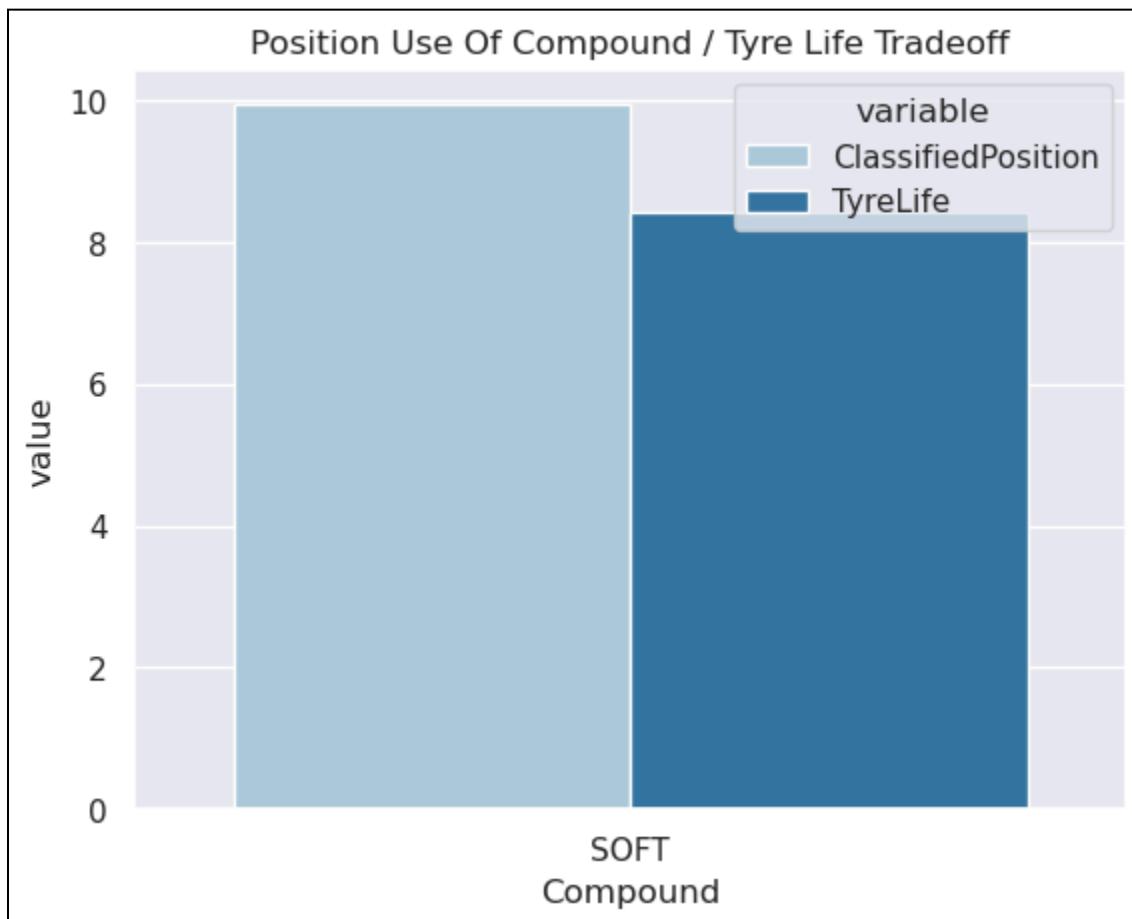
- Lap times decrease over time, as expected
- Lap time increases slightly at stint 4, probably because of under-representation
- Lap time variability within the first stint is quite high but as the race continues, driver times converge

Bahrain Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

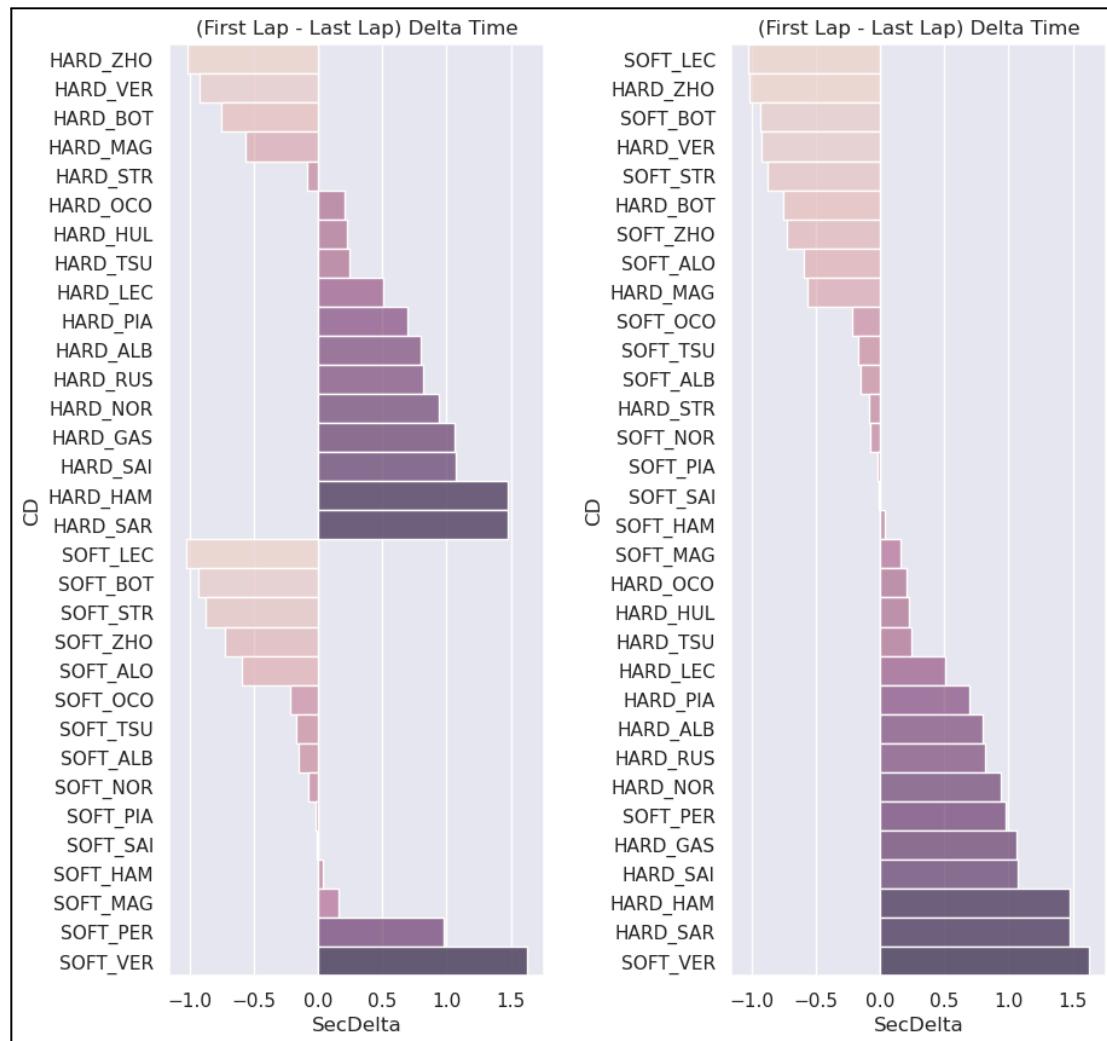
Compound	Position	ClassifiedPosition	TyreLife
SOFT	9.1974	9.9399	8.4292

Insights

- Positions that start with SOFT tires tend to end ~0.9 positions behind
- This is a bad metric for this race because the starting tire type for all drivers was SOFT, so it's a bit meaningless
 - In other graphs in other races, we'll see comparisons between different compounds and see how they affect final position



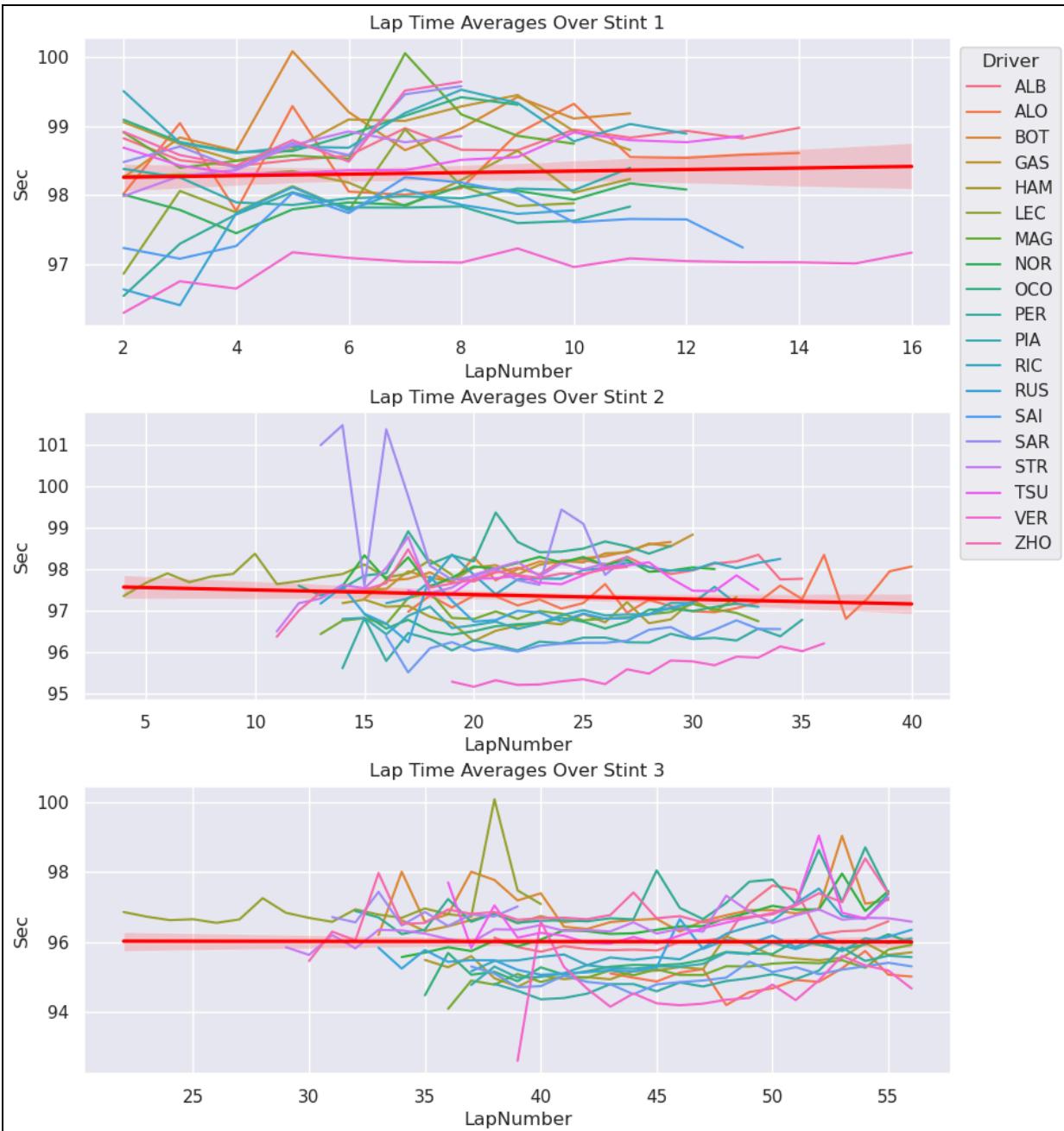
Bahrain Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- The delta time across the board is fairly evenly represented
- We see more positive lap splits with HARD tires than we do with SOFT tires
 - In fact, PER and VER are the only ones who maintained a negative split with SOFT tires, everyone else gained time with their SOFT tire usage
- SOFT tire usage in general saw a positive lap split (slower)
- HARD tire usage in general saw a negative lap split (faster)

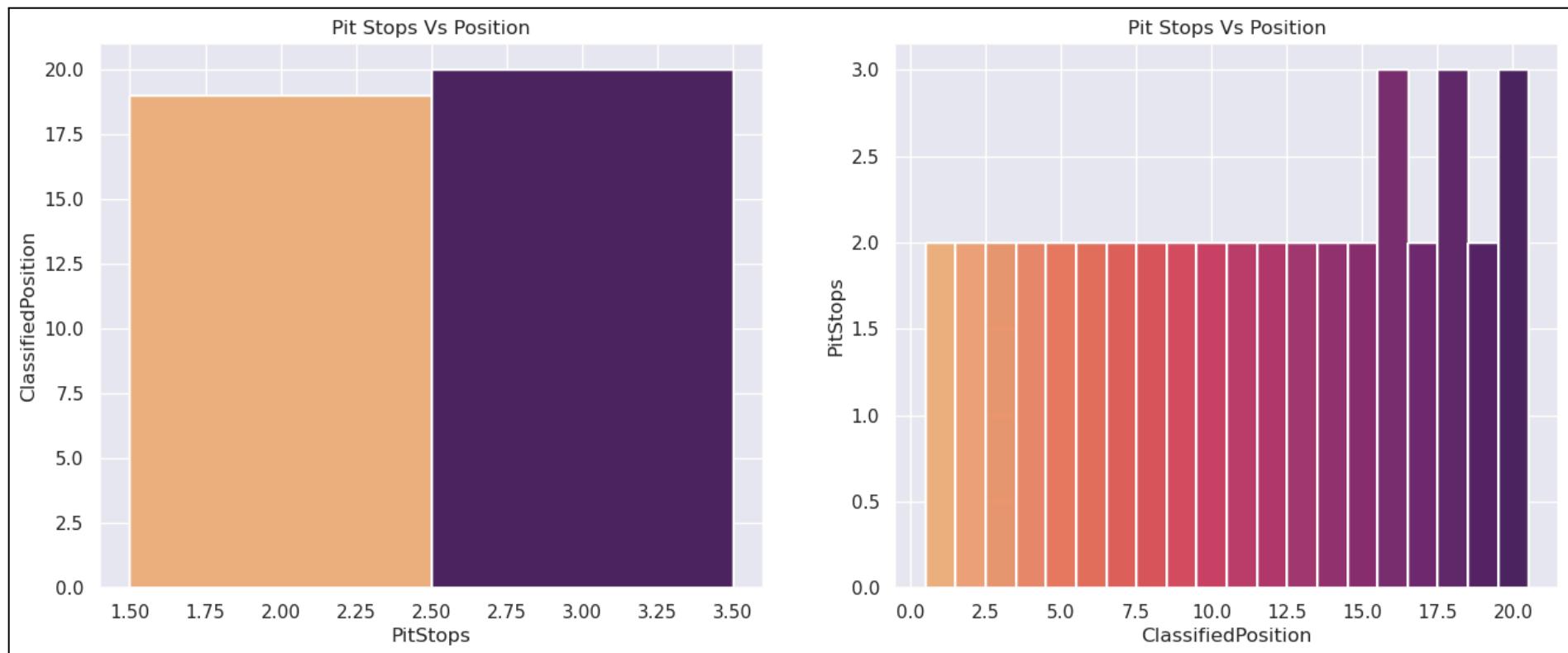
Bahrain Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Stint 1 sees a **general increase in times** over the duration of the stint, possibly due to a combination of non-worn-in tracks and longer use of SOFT tires for the first stint
- Stint 2 and 3, which saw mostly HARD tire usage, maintain a **slightly negative and neutral lap time respectively**
- For many of the individual drivers, we see lap times increase throughout each stint, where the **average is brought down by one or two drivers**
- **Observation:** Consistent lap averages are greatly affected by pit stop efficiency and other errors, even a 0.5s difference will affect this graph a lot

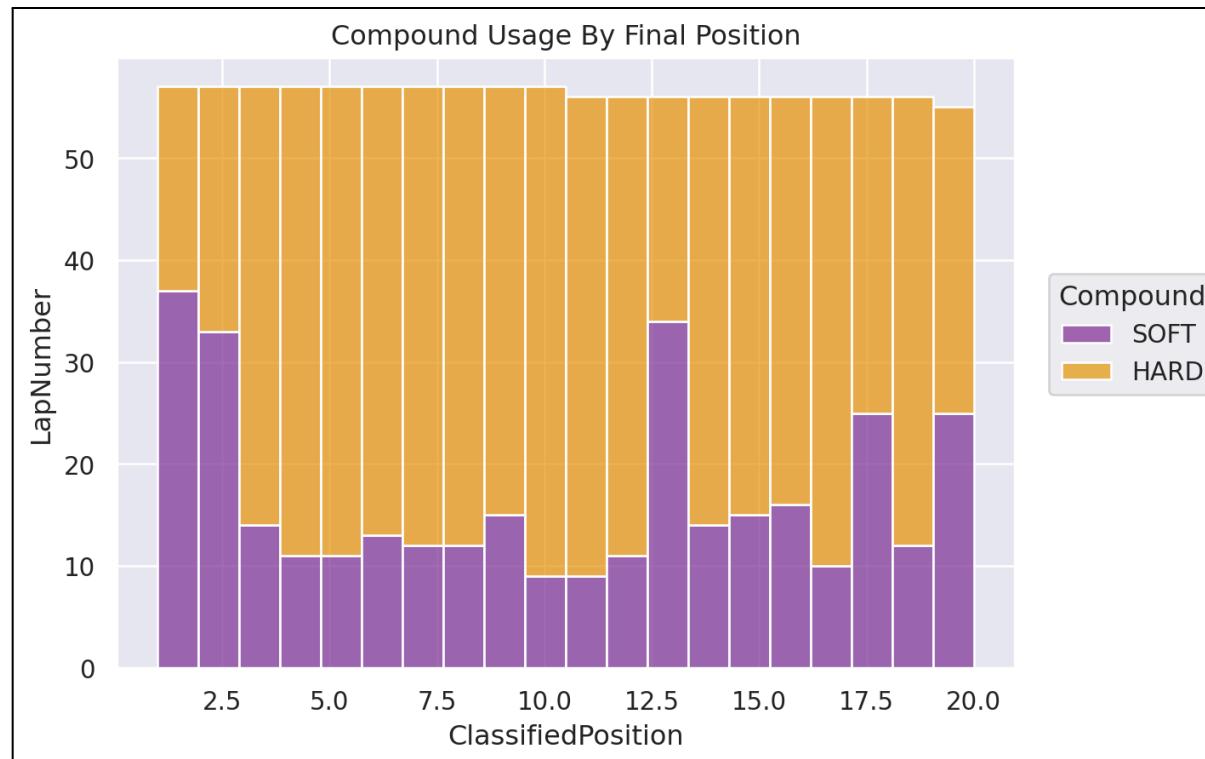
Bahrain Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Pit stops and positions don't see a very high correlation... mostly because just about everyone chose to do 2 pit stops for this race
- Those who did choose to do 3 pit stops see a worse performance

Bahrain Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- First and second place use **SOFT** tires disproportionately more than the rest of the drivers
- Among all drivers, **HARD tires are by far the most popular** for this race
- Tire compound usage is actually pretty consistent between drivers in this race, suggesting that a **general tire strategy is one of several factors** playing into how drivers are determining their winning strategy
 - **Observation:** Tires may not be as important a decision for this race, or a ratio of around 5 HARD / 1 SOFT is adequate enough for a consistent strategy

Saudi Arabian Grand Prix - Base Statistics

Teams

Alpine	GAS, OCO
Aston Martin	ALO, STR
Ferrari	LEC, BEA
Haas F1 Team	MAG, HUL
Kick Sauber	BOT, ZHO
McLaren	PIA, NOR
Mercedes	RUS, HAM
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	SAR, ALB

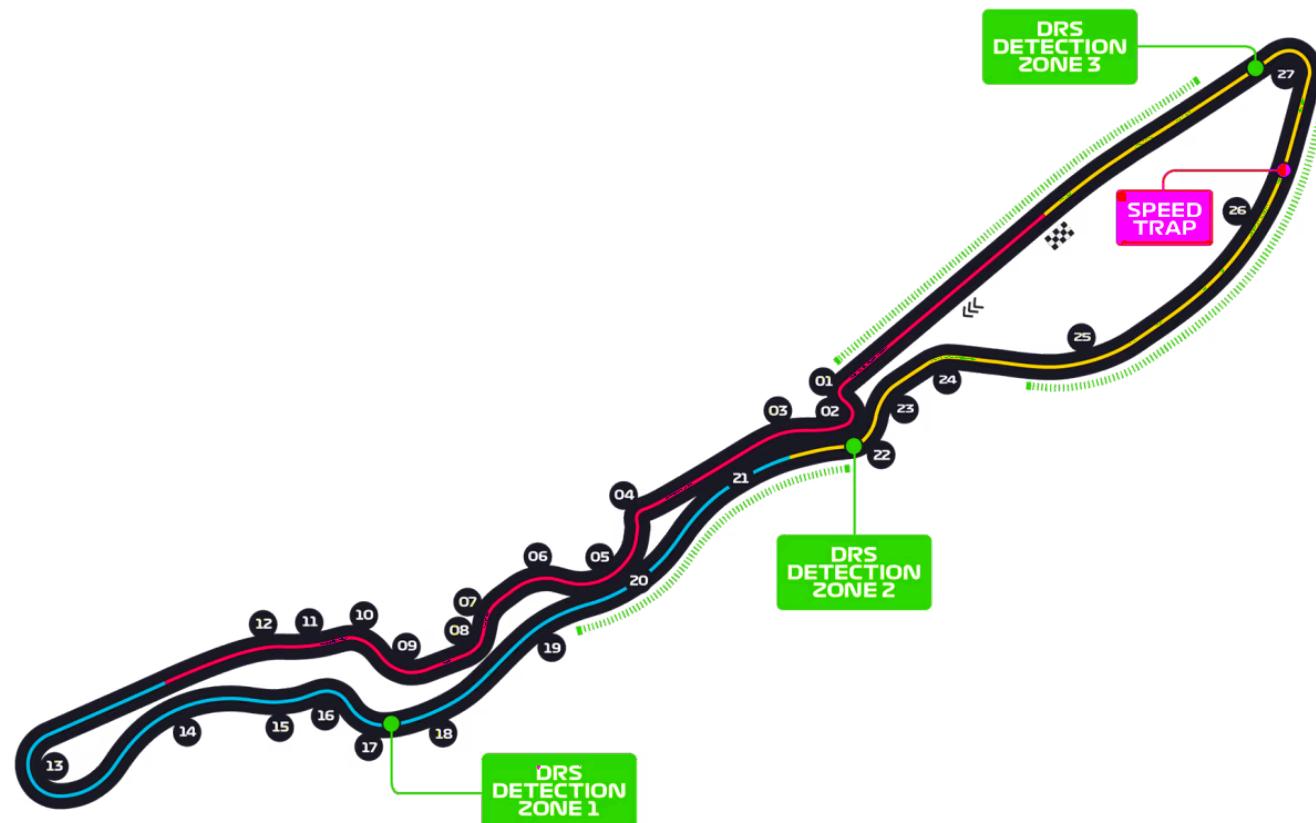
Total Statistics

Pit Stops	19
Pit Time	00:08:03
Laps Completed	901
Lap Time	0 days 23:15:37
Race Laps	50
Compounds	[MEDIUM, HARD, SOFT]

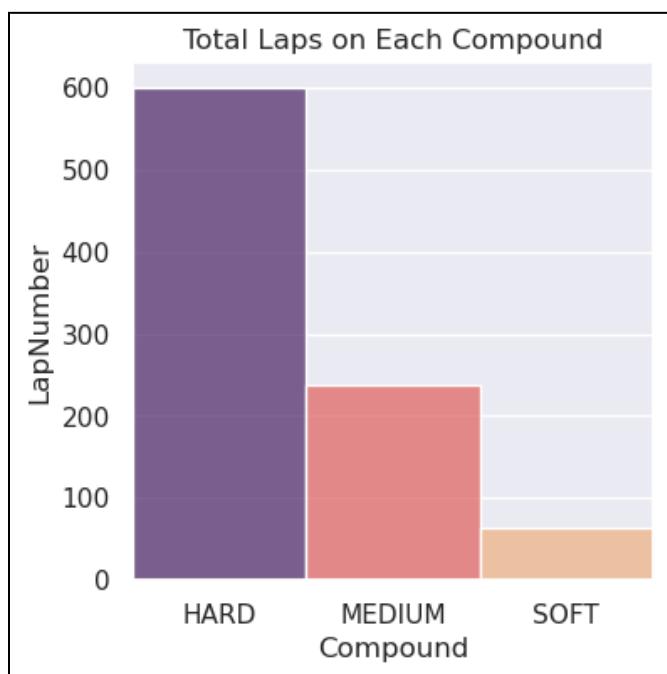
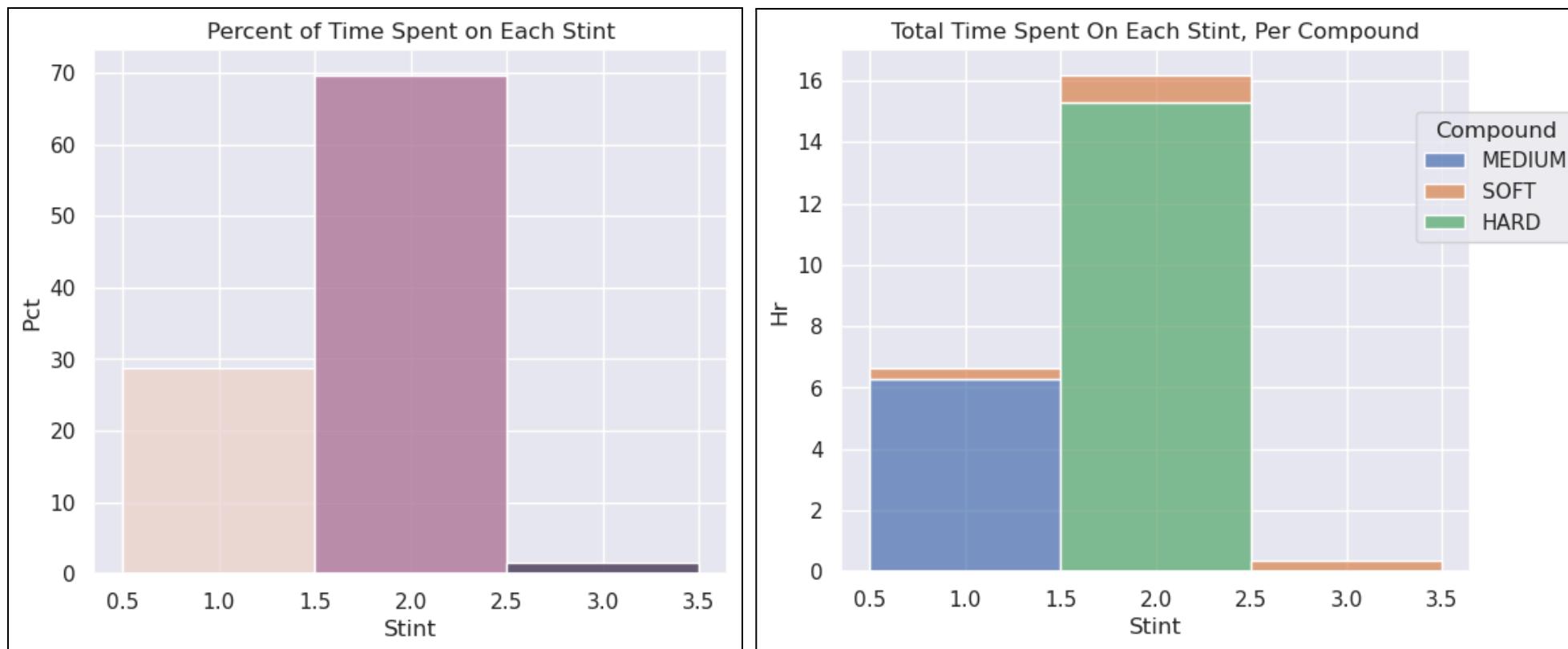
Average Statistics

Pit Stops	1.0556
Pit Time	0:00:25
Laps Completed	45
Lap Time	0:01:36

[Saudi Grand Prix Link](#)



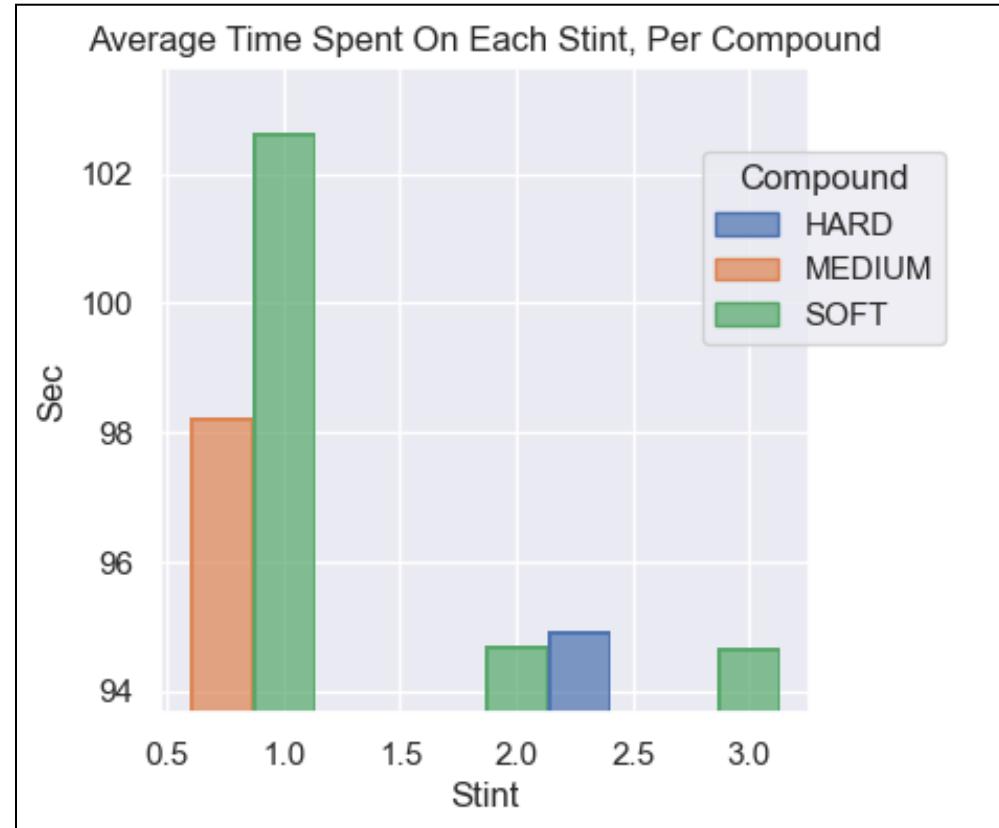
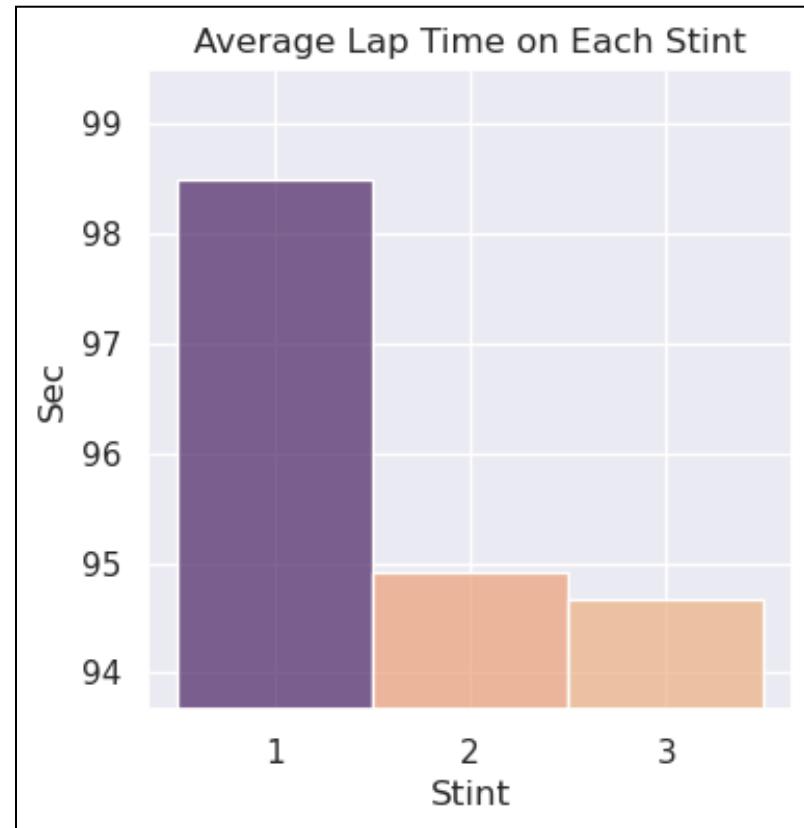
Saudi Arabian Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- MEDIUM tires see a majority popularity in the first stint, likely due to a combination of slight turns and long straightaways requiring a higher durability for consistency
- Stint 2 sees mostly HARD tires similar to the last race, where **consistency on the long track is key**
- SOFT & MEDIUM tires account for around a third of the laps driven on this course, suggesting a general strategy of **$\frac{1}{3}$ SOFT and $\frac{2}{3}$ HARD tire usage**
- A majority of the time was spent in Stint 2 for most drivers (nearly 70%) suggesting a desire to **race towards a consistent position in Stint 1 and maintain it in Stint 2**

Saudi Arabian Grand Prix - Average Lap Time Per Stint / Per Compound



Insights

- The lap time on Stint 1 will always be a little higher due to the drivers being adjacent to each other and needing to accelerate / dodge other drivers
- The HARD / MEDIUM / SOFT lap times seem backwards, with HARD tires being fastest and MEDIUM / SOFT tires being slowest
 - This is a combined result of being on Stint 1, and this race's chaos in the start of the race when everyone went to the pit at the same time
- Observation:** Stint 2 HARD tires benefit greatly from a worn-in track caused by the SOFT tire usage in stint 1
- On Stint 2, SOFT and HARD tires saw nearly identical lap times**, suggesting that HARD tires are the better option because of their durability being higher, and speed being about the same, on average

Saudi Arabian Grand Prix - Driver Data

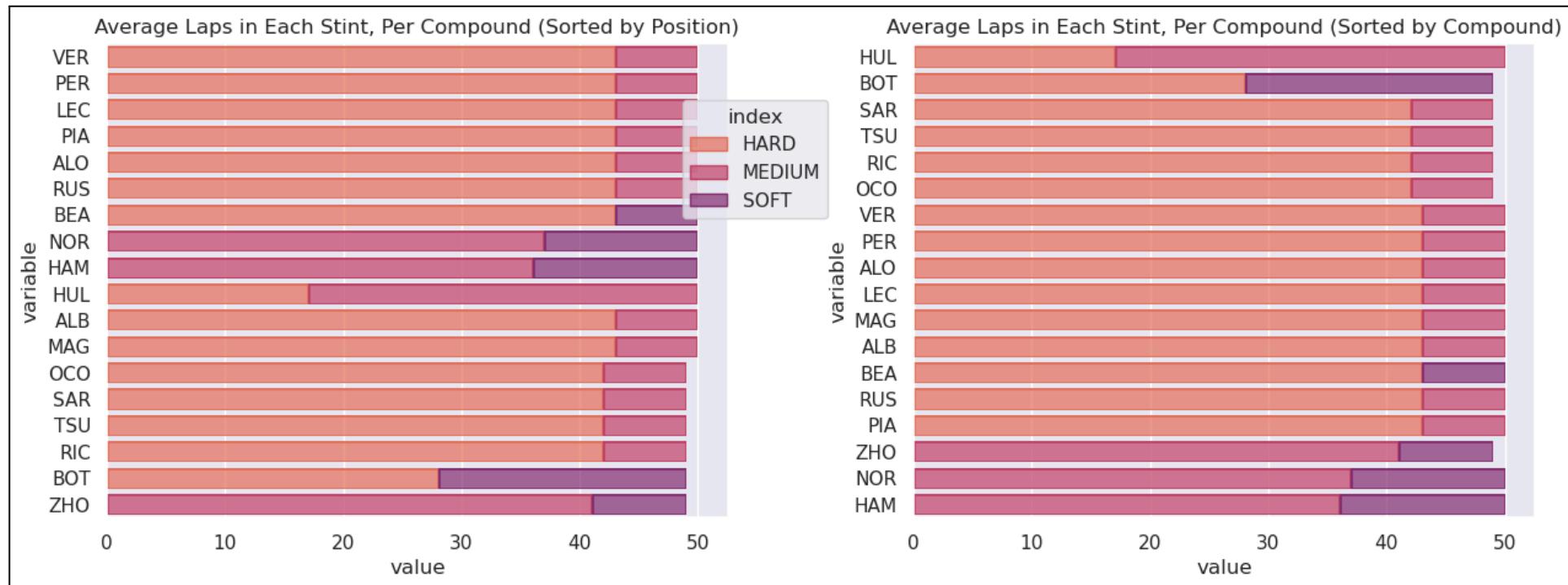
Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
VER	1	20.668	50	1:14:53	0:01:34	1	ALB	1	21.633	50	1:19:12	0:01:37	11
PER	1	22.243	50	1:15:06	0:01:34	2	MAG	1	21.46	50	1:19:09	0:01:37	12
LEC	1	23.374	50	1:15:17	0:01:34	3	OCO	1	22.525	49	1:17:51	0:01:37	13
PIA	1	21.379	50	1:15:35	0:01:34	4	SAR	1	23.717	49	1:17:53	0:01:37	14
ALO	1	22.24	50	1:15:39	0:01:35	5	TSU	1	21.74	49	1:17:49	0:01:37	15
RUS	1	21.004	50	1:15:48	0:01:35	6	RIC	1	63.418	49	1:17:50	0:01:37	16
BEA	1	22.453	50	1:18:26	0:01:36	7	BOT	2	22.682	49	1:18:09	0:01:38	17
NOR	1	22.266	50	1:15:53	0:01:35	8	ZHO	1	46.349	49	1:18:26	0:01:38	18
HAM	1	20.236	50	1:15:58	0:01:35	9	GAS	0	99	1	0:02:01	0:02:01	99
HUL	1	21.107	50	1:16:37	0:01:36	10	STR	0	99	6	0:08:06	0:01:37	99

Note: Due to changes in code, some times are now in seconds instead of HH:MM:SS moving forward

Insights

- Lance Stroll crashed out on Lap 6, resulting in a DNF
- Pierre Gasly [had an issue](#) with his gearbox after the Lap 1 resulting in a DNF
- Pit time for RIC and ZHO was 2x - 3x higher than average
- We see that total lap time is not necessarily the only factor that decides who places in a race, since some faster positions placed lower in the race
 - This data seems inconsistent with lap times found online - likely this is a data discrepancy because of the Lap 6 safety car for this race. It's unclear how this data was calculated during this lap
 - There were a LOT of pit stops during this period of time and several penalties were handed out, skewing the pit times further than normal
- The lap time delta between first and last place is around 3-4s

Saudi Arabian Grand Prix - Driver Data



Insights

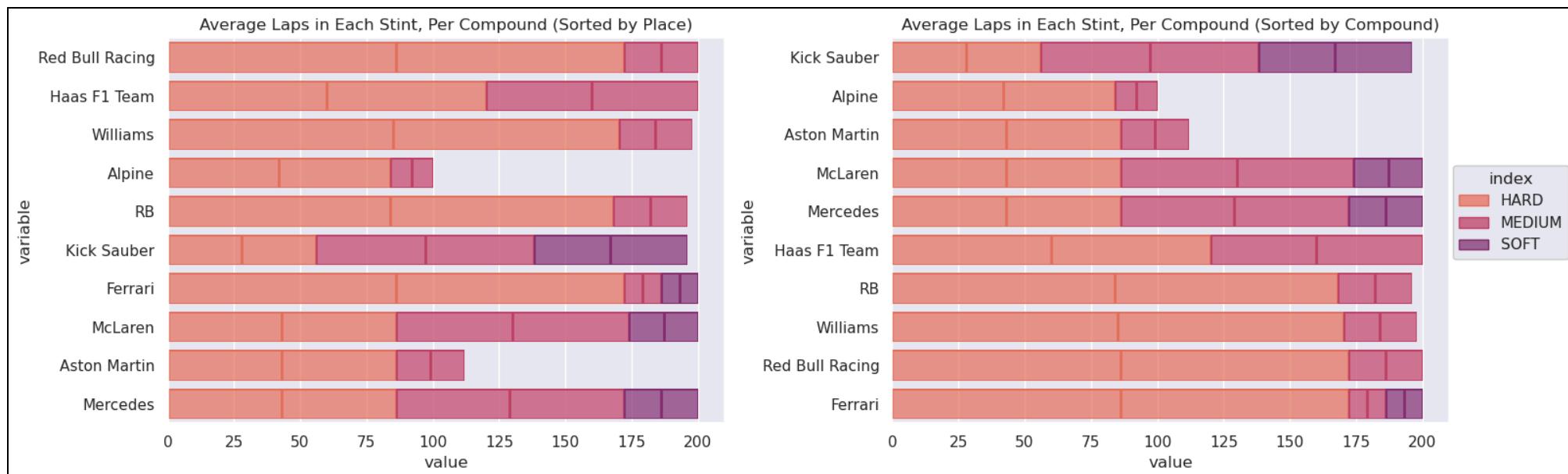
- Almost all of the strategies were the same, using MEDIUM tires to begin with and HARD tires for the rest of the stints after the first
 - HUL and BOT are the only two that continued to use SOFT/MEDIUM tires longer than anyone else did
- The winning strategies seemed to use primarily MEDIUM tires in the first stint and HARD tires for the duration of the race

Saudi Arabian Grand Prix - Team Data

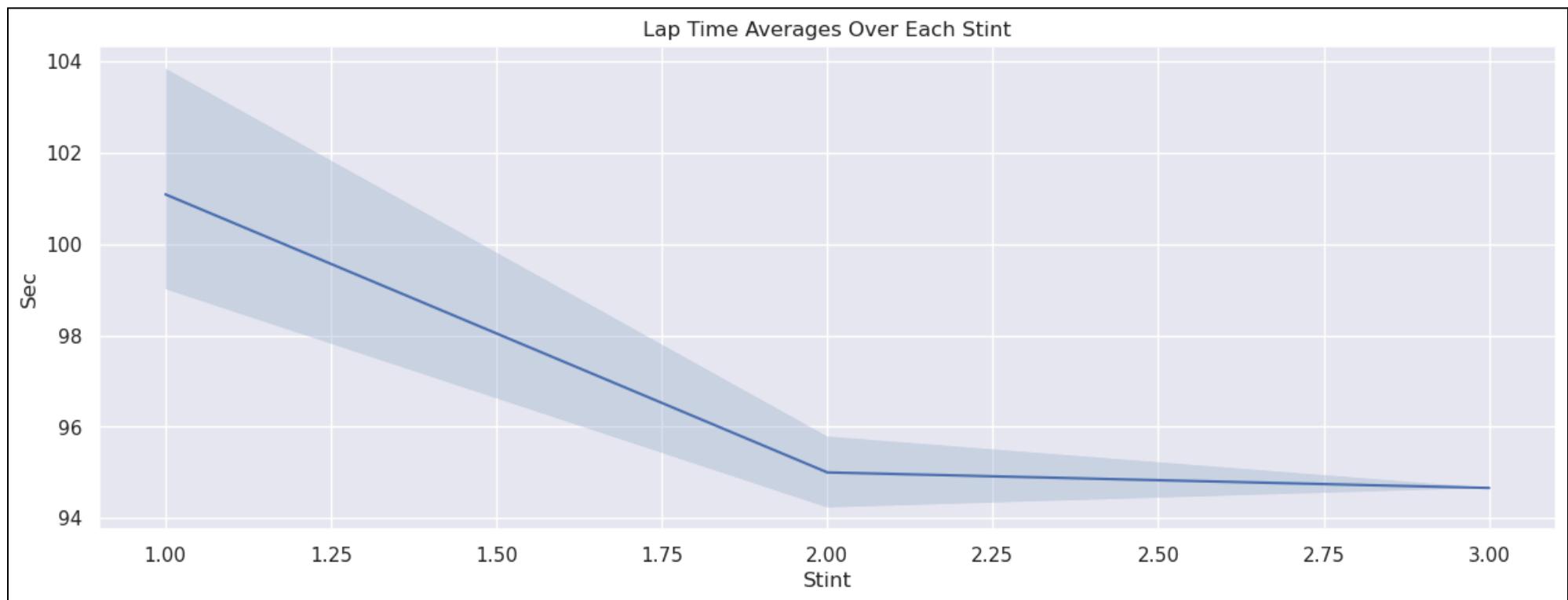
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Alpine	2	1	22.525	49	1:19:52	0:01:38
Aston Martin	2	1	22.24	6	1:23:44	0:01:35
Red Bull Racing	2	2	42.911	50	2:29:59	0:01:34
McLaren	2	2	43.645	50	2:31:28	0:01:35
Mercedes	2	2	41.24	50	2:31:46	0:01:35
Ferrari	2	2	45.827	50	2:33:43	0:01:35
RB	2	2	85.158	49	2:35:40	0:01:37
Haas F1 Team	2	2	42.567	50	2:35:46	0:01:36
Kick Sauber	2	3	92.293	49	2:36:35	0:01:38
Williams	2	2	45.35	50	2:37:04	0:01:37

Insights

- Alpine and Aston Martin both lost 1 driver to DNF
- Mercedes had the lowest pit time
- Red bull had the lowest Avg Lap Time
- Despite the variable usage of MEDIUM / HARD tires, it's clear that the winning strategy was to use HARD tires for the majority of the race
- MEDIUM tires seemed to be a better tire compound to use this race than SOFT tires



Saudi Arabian Grand Prix - Lap Time Averages



Insights

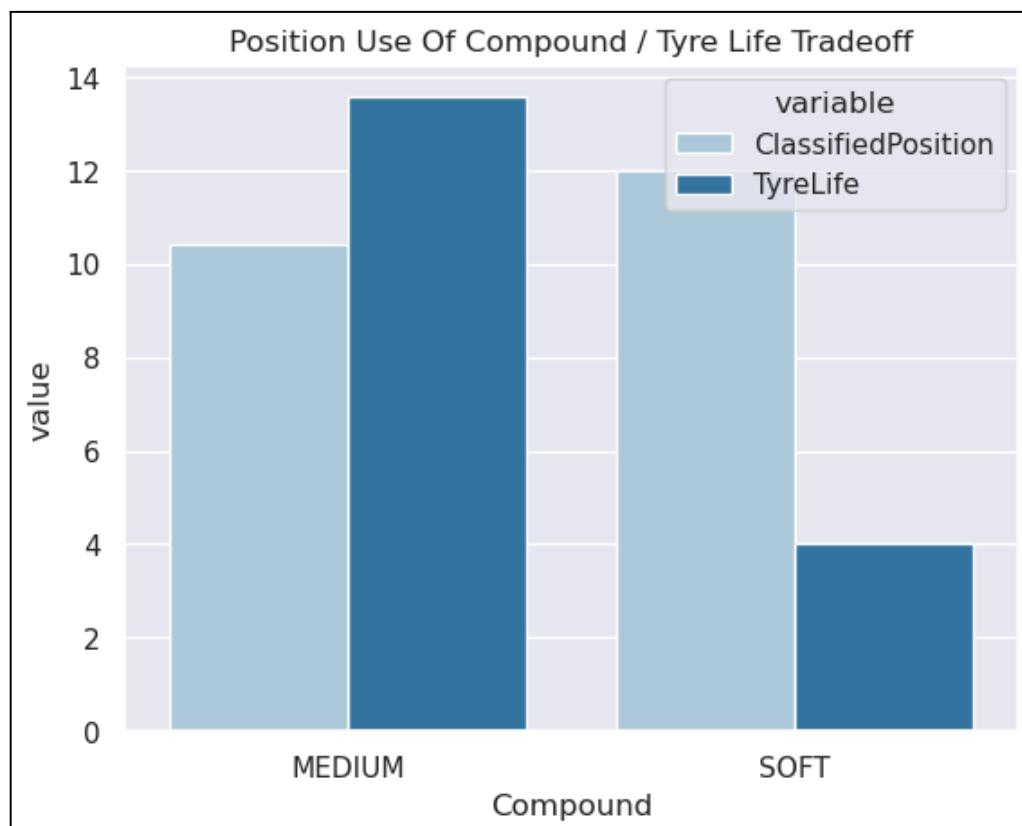
- As expected, lap averages decrease steadily and then converge as the race progresses
- Lap time variability within the first stint is quite high but as the race continues, driver times converge

Saudi Arabian Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

Compound	Position	ClassifiedPosition	TyreLife
MEDIUM	8.1255	10.3983	13.5671
SOFT	13.7143	12	4

Insights

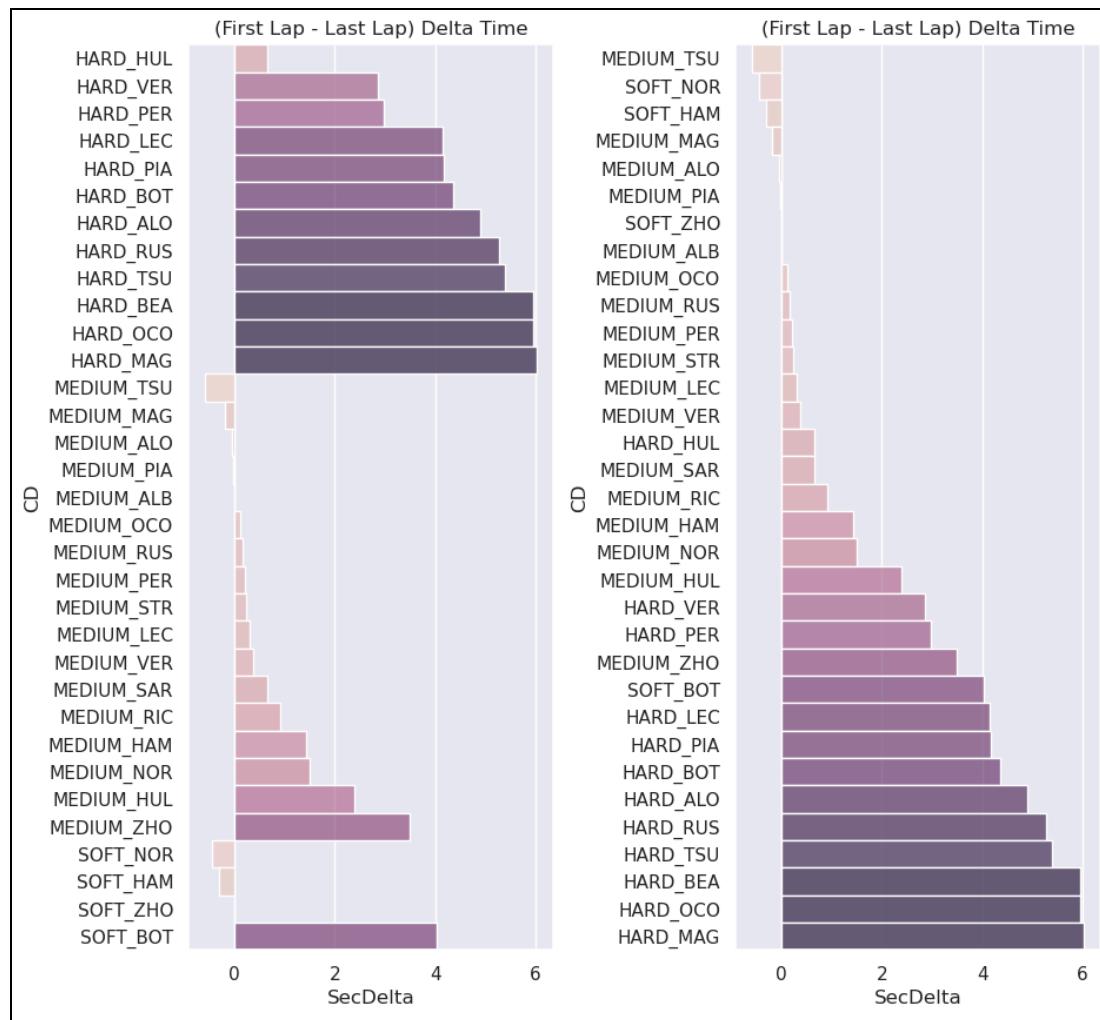
- Drivers who started with MEDIUM tires tended to find themselves lose two positions, on average
 - This goes against the strategy identified within this race, and is likely due to even representation of MEDIUM tires across the race among all drivers
- Drivers who started with SOFT tires generally saw their positions increase by 1.7
- MEDIUM tires still provided the best absolute positional gain ahead of SOFT tires



Insights

- The positional difference between SOFT and MEDIUM tires as a starting compound in this race wasn't very significant and was impacted more by the crash in Lap 6
- It probably would have benefited everyone to use SOFT tires to begin with, but since they couldn't have anticipated the crash, they chose MEDIUM tires instead

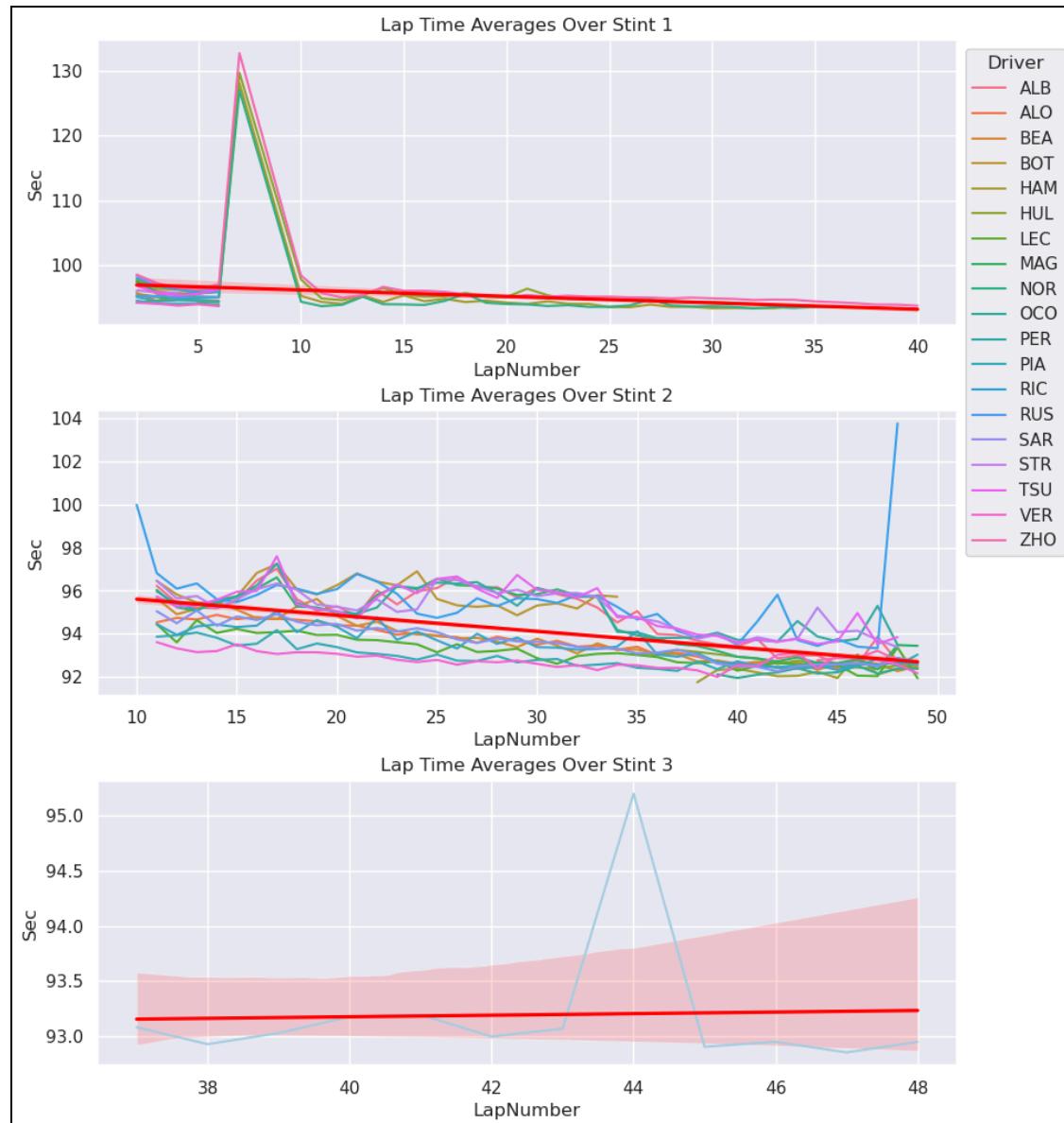
Saudi Arabian Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- HARD compounds found an average lap split of 3 seconds faster over the course of their stints
- MEDIUM tires found an average split of 1.5 seconds faster
- SOFT tires were under represented, but found a generally slower lap time split except for BOT, who went 4 seconds faster within their stint

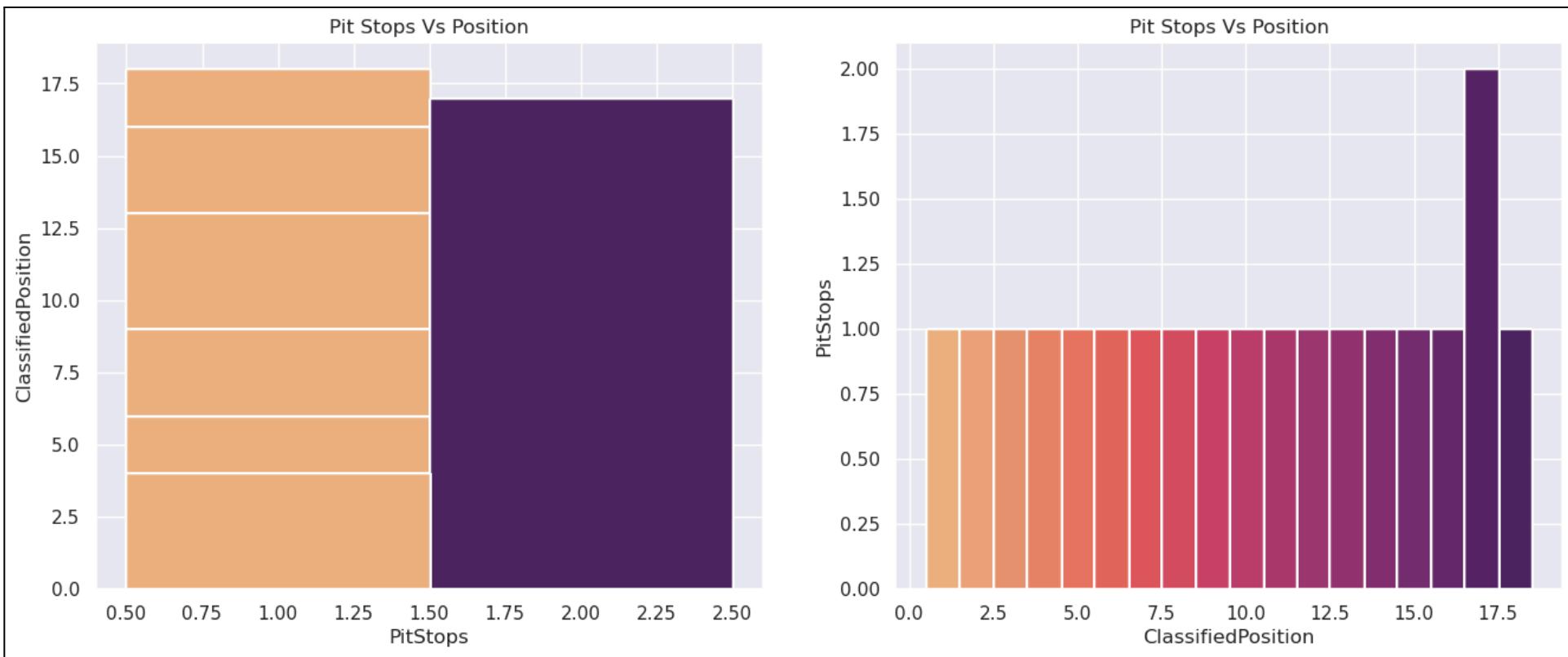
Saudi Arabian Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Lap times were very consistent in Stint 1 because of the safety car after the crash
- Stint 2 times saw splits decrease across the board, likely because of the heavy amount of straightaways
- Stint 3 is under represented and only had one driver

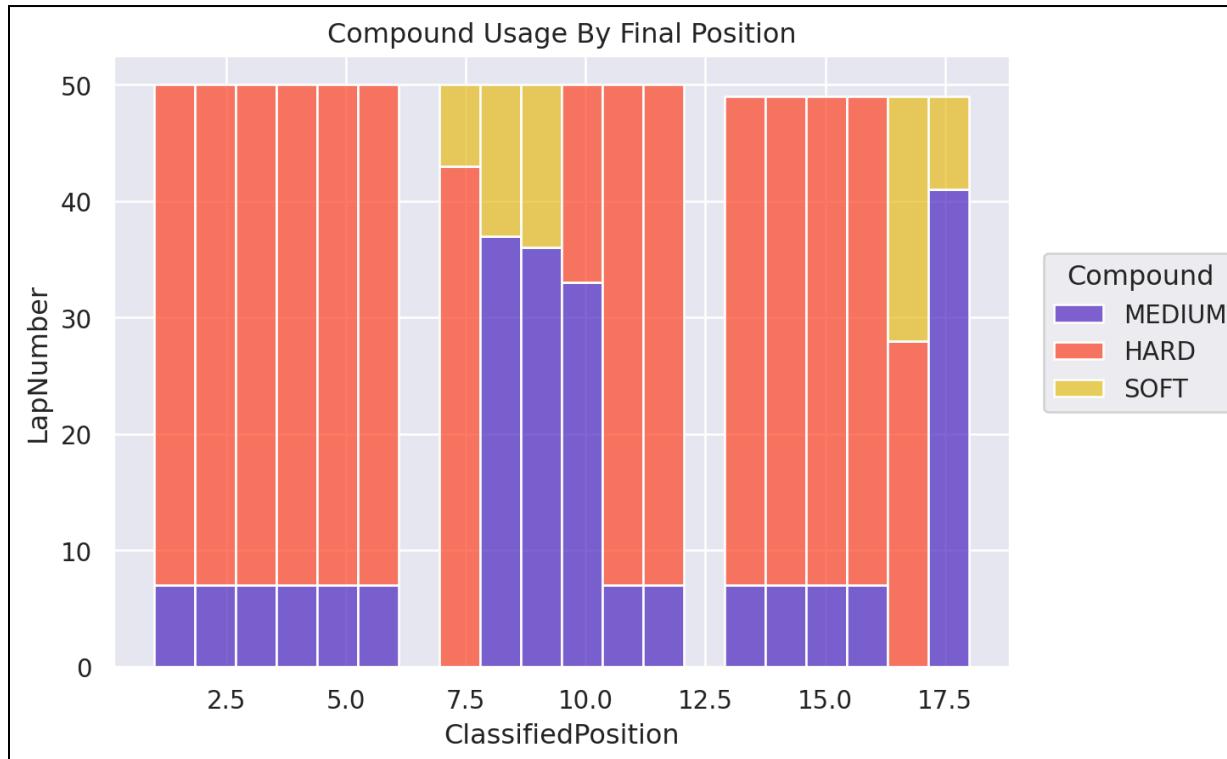
Saudi Arabian Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Pit stops did not correlate strongly with performance in this race, except to say that most drivers chose to do 2 pit stops instead of 3

Saudi Arabian Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- As shown previously, higher scoring drivers used a consistent tire strategy - that being MEDIUM tires in the beginning, and HARD tires throughout the race
- Drivers with different strategies had lower scores, in general
- The consistent use of tire compounds across many of the positions is likely due to the crash at the beginning of the race, where everyone changed tires around the same time

Australian Grand Prix - Base Statistics

Teams

Alpine	GAS, OCO
Aston Martin	ALO, STR
Ferrari	SAI, LEC
Haas F1 Team	MAG, HUL
Kick Sauber	ZHO, BOT
McLaren	NOR, PIA
Mercedes	HAM, RUS
RB	TSU, RIC
Red Bull Racing	PER, VER
Williams	ALB

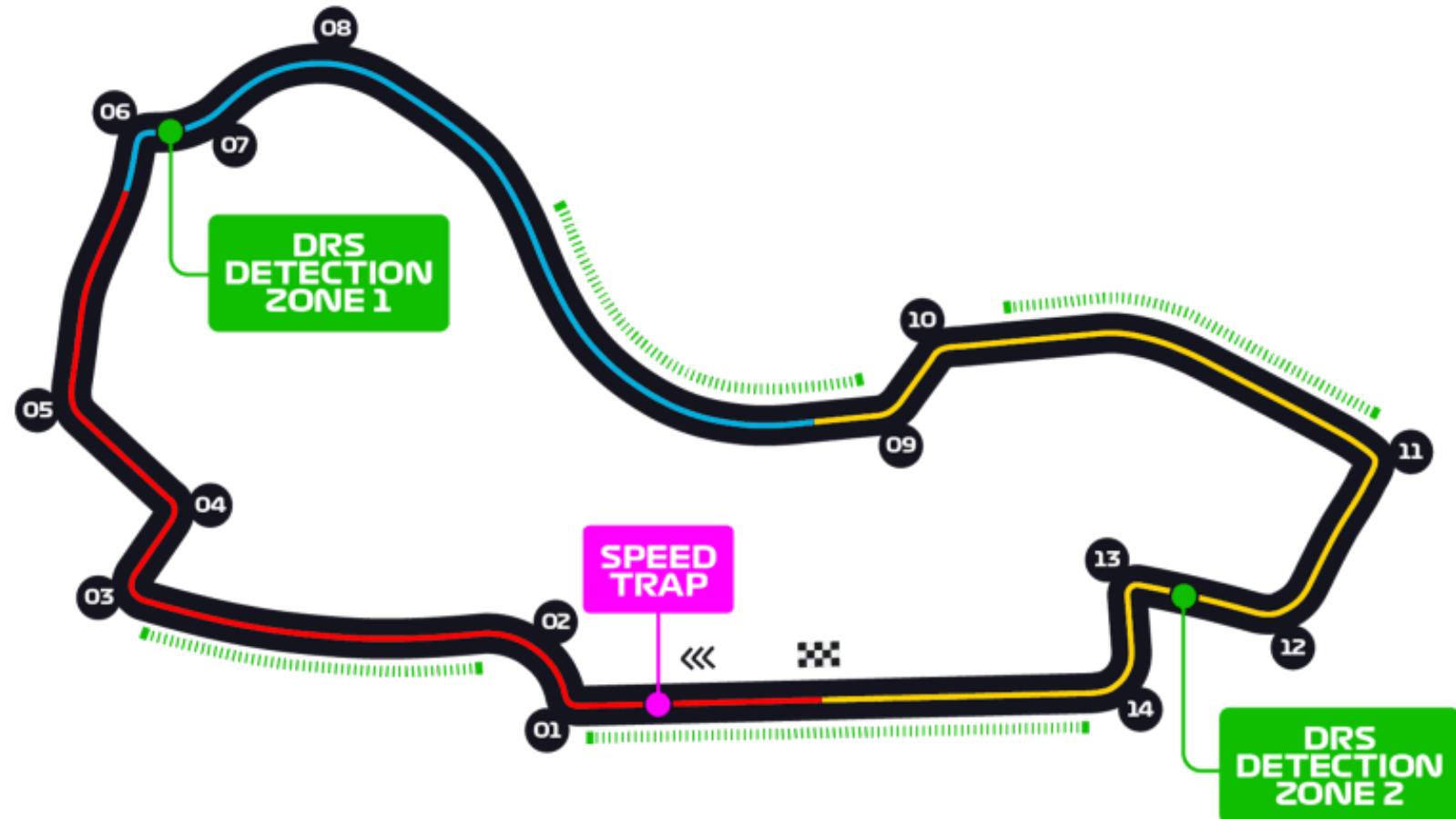
Total Statistics

Pit Stops	37
Pit Time	00:11:46
Laps Completed	998
Lap Time	0 days 23:21:59
Race Laps	58
Compounds	[MEDIUM, HARD, SOFT]

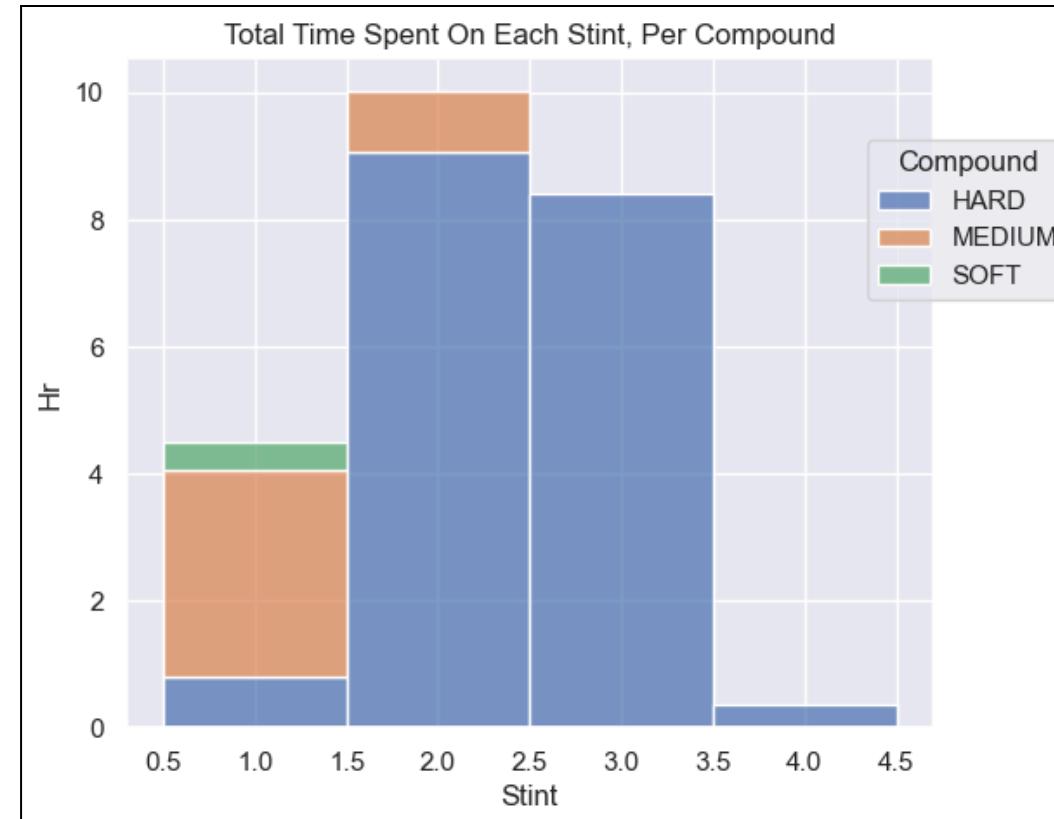
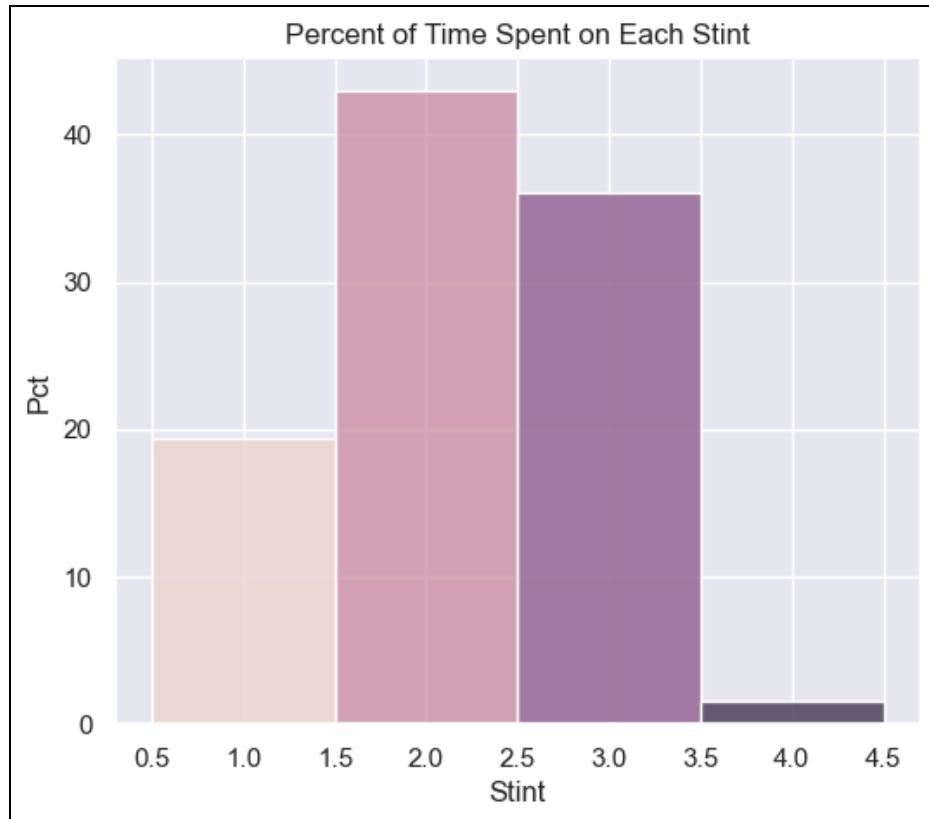
Average Statistics

Pit Stops	2.0556
Pit Time	19.6143
Laps Completed	52.5263
Lap Time	0:01:25

[Australian Grand Prix Link](#)



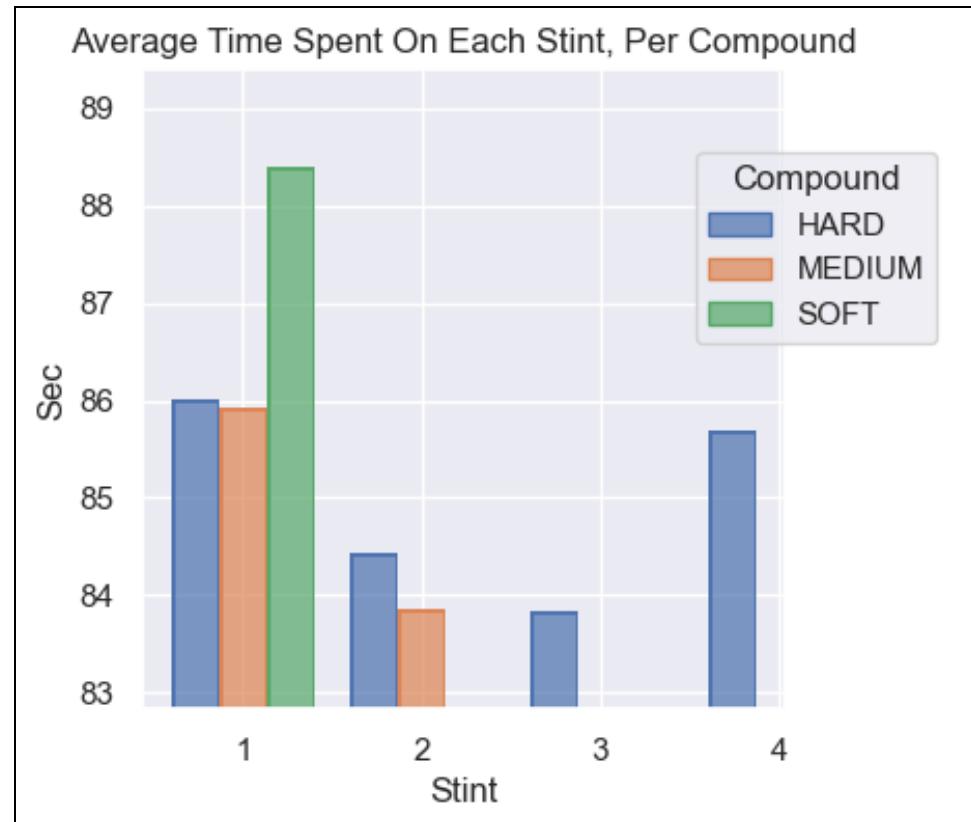
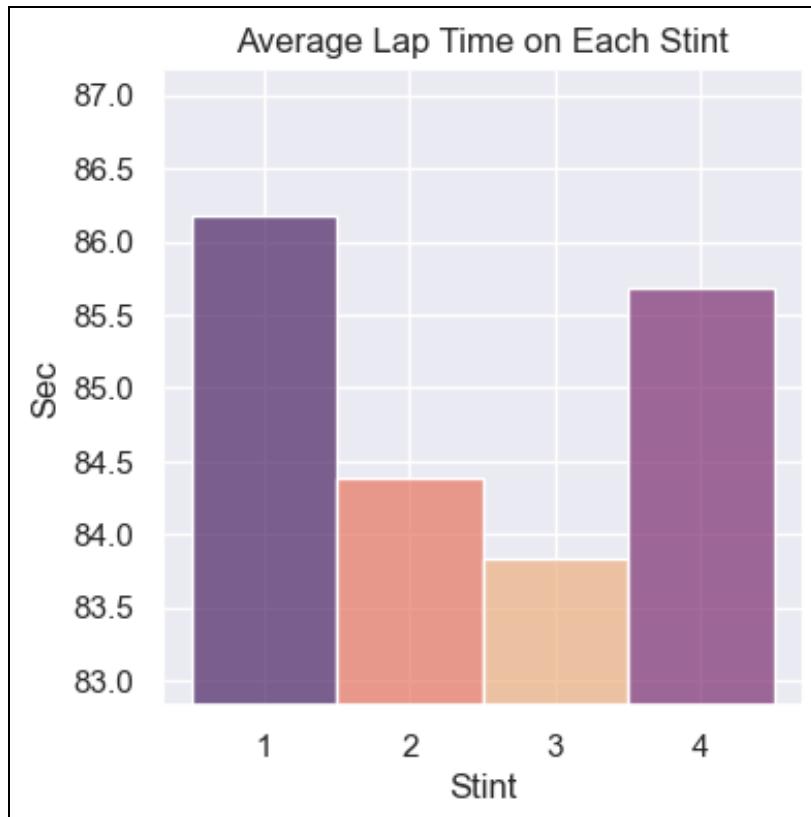
Australian Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stint 1 saw more representation of SOFT and HARD compounds than in other races we've seen previously, but MEDIUM tires still were the most popular option
- Stint 2 saw mostly HARD tire usage and some small MEDIUM tire usage
- Stint 3 saw only HARD tires, consistent with the general strategy we've seen so far of HARD tires being used more at the middle and end of a race to maintain position and increase durability to prevent more pit stops
- Stints 2 and 3 saw the highest lap time sum, consistent with our previous observations that the first stint is often the sprint-stint and the follow on stints are typically more maintenance / consistency focused

Australian Grand Prix - Average Lap Time Per Stint / Per Compound



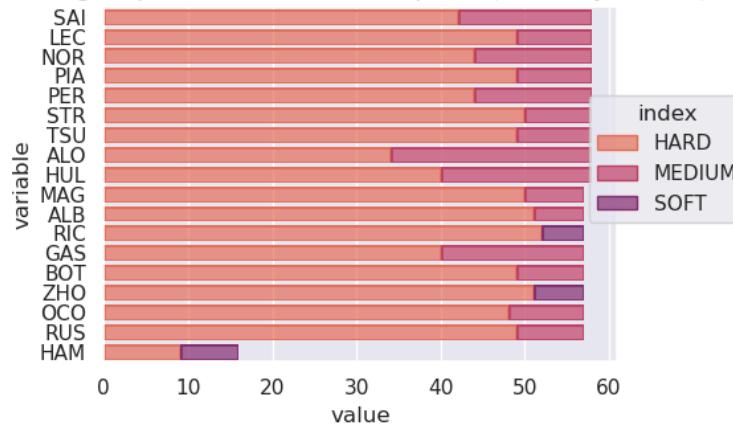
Insights

- Stint 1 sees the highest time despite overwhelmingly using soft and medium tires, likely because of driver adjacency in the start of the race and the general nature of needing to accelerate and brake a lot because of this clumping of cars
- Stint 2 and 3 see the lowest times in general, because of track wear and cars being less close to one another, allowing for drivers to focus on control and lap performance more than collisions
- In this race, SOFT tires only saw use in the first stint, MEDIUM was seen in mostly stint 1 and some of Stint 2 (about 5%) but HARD tires dominated after Stint 1
 - This might suggest that drivers were quickly able to get out of the sprint phase in this race and transition to their maintenance phase rather quick

Australian Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
SAI	2	35.224	58	1:20:27	0:01:23	1	ALB	2	35.187	57	1:20:32	0:01:25	11
LEC	2	34.387	58	1:20:29	0:01:23	2	RIC	2	35.742	57	1:20:38	0:01:25	12
NOR	2	35.443	58	1:20:33	0:01:23	3	GAS	2	37.82	57	1:21:03	0:01:25	13
PIA	2	35.7	58	1:21:03	0:01:24	4	BOT	2	65.788	57	1:21:09	0:01:25	14
PER	2	35.15	58	1:21:23	0:01:24	5	ZHO	3	55.641	57	1:21:11	0:01:25	15
STR	2	35.58	58	1:22:00	0:01:25	6	OCO	3	66.615	57	1:21:21	0:01:26	16
TSU	2	36.003	58	1:22:02	0:01:25	7	RUS	2	35.738	57	1:18:05	0:01:24	17
ALO	2	35.957	58	1:21:48	0:01:25	8	HAM	1	17.543	16	0:21:18	0:01:25	99
HUL	2	36.32	58	1:22:11	0:01:25	9	VER	0	0	4	0:04:15	0:01:25	99
MAG	2	36.291	57	1:20:31	0:01:25	10							

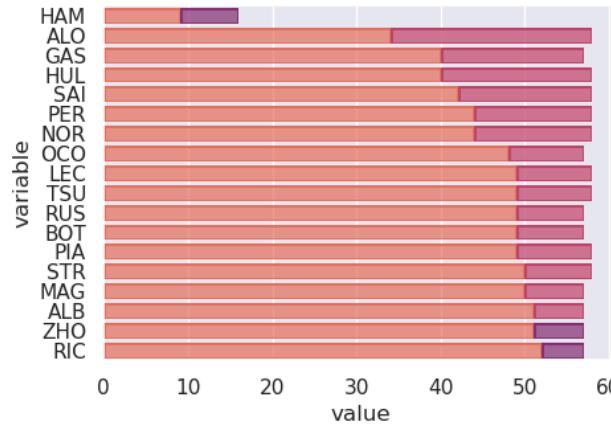
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- VER DNF this race because of car issues on lap 4
- HAM also had car issues which caused him to DNF at lap 16
- RUS crashed out on his last lap although was able to place in this race at 17th position
- Laps driven is inconsistent for some drivers, between 57 and 58 total laps driven - this is likely due to a difference in pit stop times or however the sensors on each vehicle track laps completed.
- Compound popularity has pretty even representation across all drivers in this race, most having the same HARD:MEDIUM proportions throughout the race, aided by the crash which triggered the safety car
 - ALO and HUL, which used much more MEDIUM compound, saw themselves placed last

Average Laps in Each Stint, Per Compound (Sorted by Compound)



Australian Grand Prix - Team Data

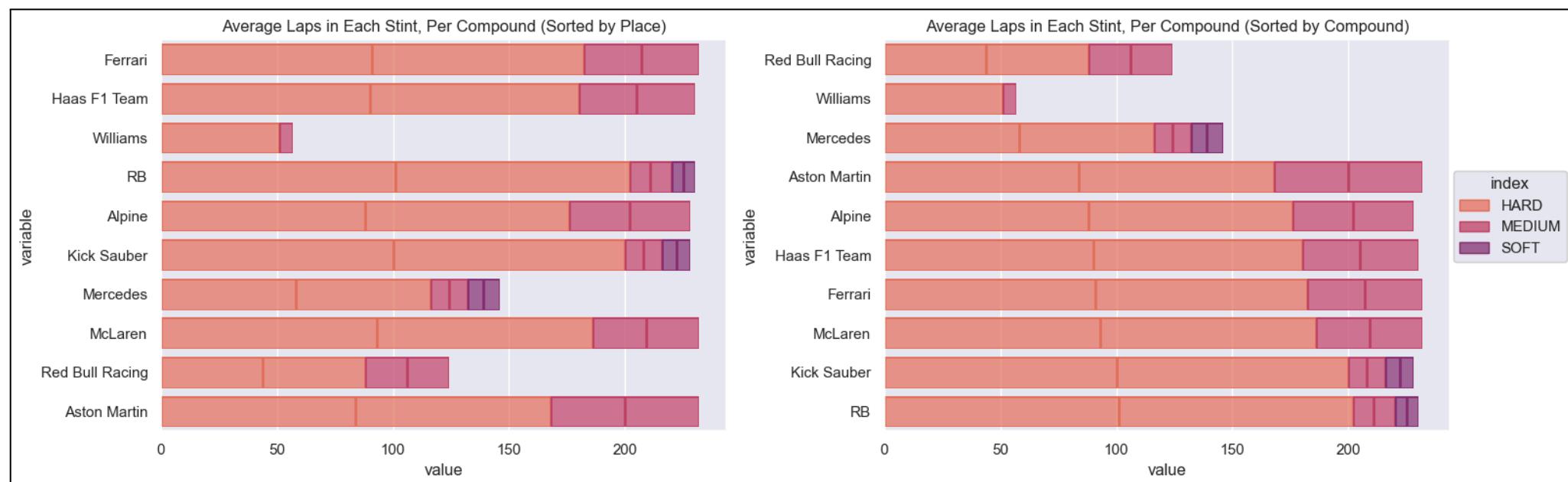
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Williams	1	2	35.187	57	1:20:32	0:01:25
Red Bull Racing	2	2	35.15	58	1:25:38	0:01:24
Mercedes	2	3	53.281	57	1:39:23	0:01:24
Ferrari	2	4	69.611	58	2:40:56	0:01:23
McLaren	2	4	71.143	58	2:41:35	0:01:24
Kick Sauber	2	5	121.429	57	2:42:20	0:01:25
Alpine	2	5	104.435	57	2:42:24	0:01:25
RB	2	4	71.745	57	2:42:41	0:01:25
Haas F1 Team	2	4	72.611	58	2:42:42	0:01:25
Aston Martin	2	4	71.537	58	2:43:48	0:01:25

Insights

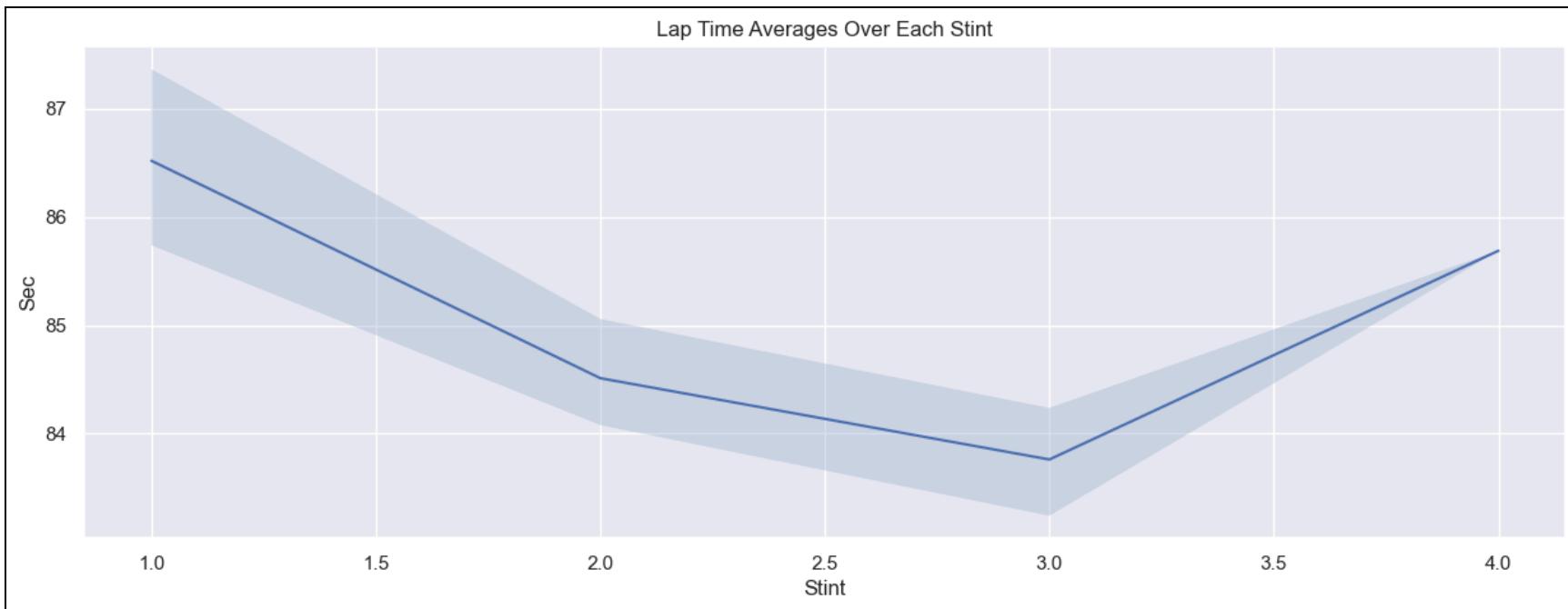
- Kick Sauber and Alpine had much higher Pit Times than other teams in this race due to their additional pit stops
- Red Bull had VER DNF - hence Red Bull's small Pit Time. Their scores are representative of PER's scores for this race
- Despite the many pit stop discrepancies, average lap time remained very consistent over all teams in this race
- Williams, Red Bull, and Mercedes had fewer drivers than the normal 2 per team, often due to DNFs or in Williams' case, just one driver to start with

Insights

- Of those teams that had all of their players for the whole race, increased MEDIUM compound usage over HARD seemed to aid team positional strategy
- There's a fairly linear usage of compounds for most teams as they gradually increase their usage of MEDIUM tires over HARD tires



Australian Grand Prix - Lap Time Averages

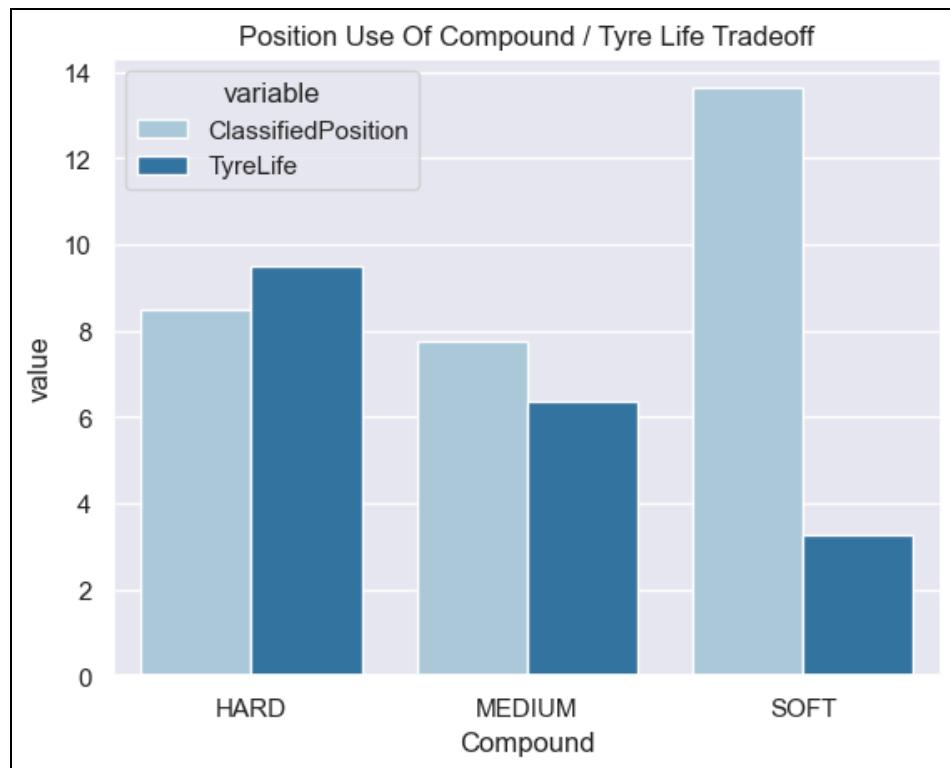


Insights

- We see a more gradual decline in lap times instead of a very sharp drop during Stint 1, like we do in some other races
 - It's likely the track allows for more flexibility / is bigger so car adjacency isn't as big of a problem
- There are no huge jumps in lap time from anyone during the race - everyone is within a few seconds of each other, on average, every stint
- Stint 4 is under represented and was only driven by two drivers, ZHO & OCO, who placed near the end of the trial

Australian Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

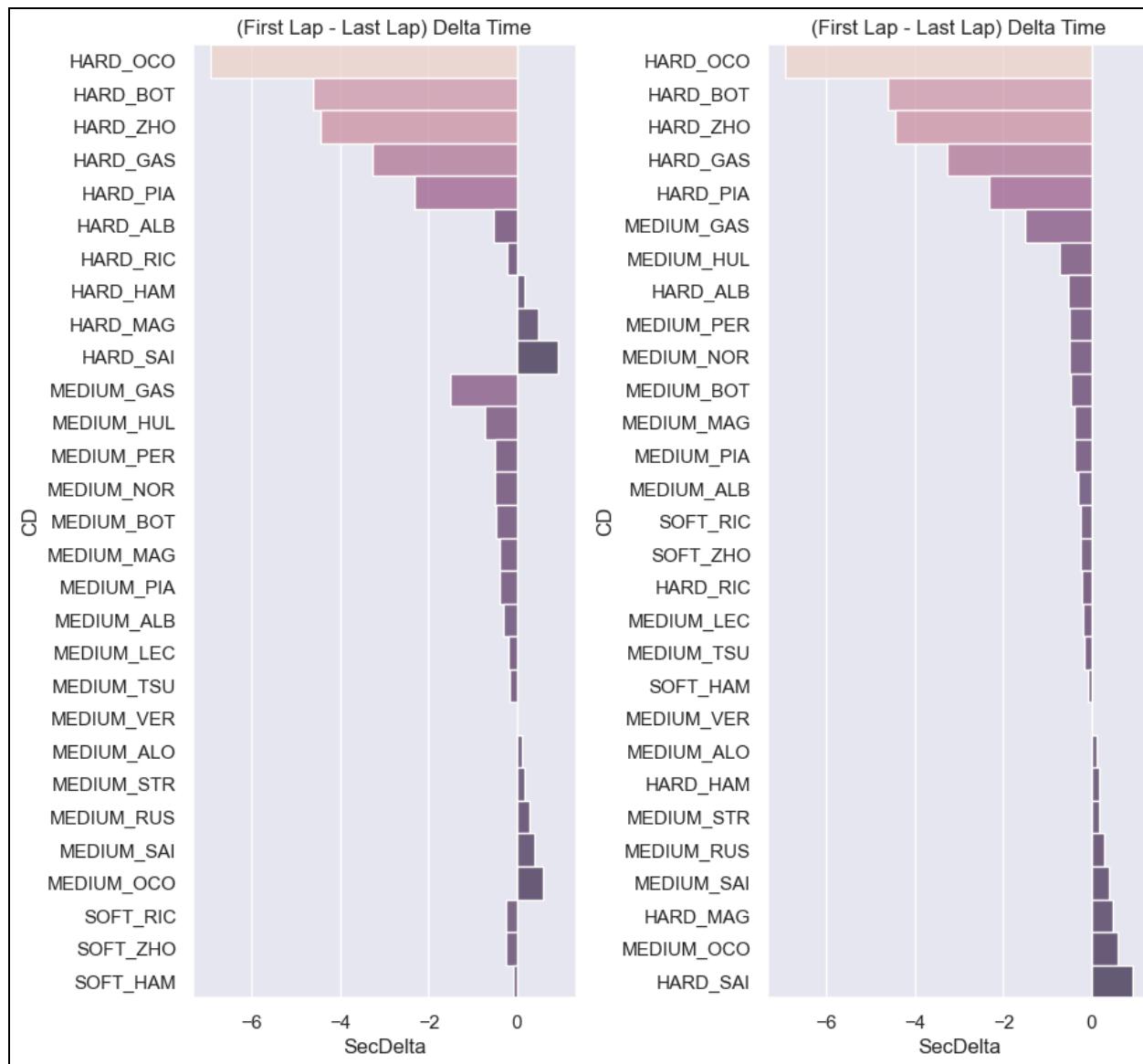
Compound	Position	ClassifiedPosition	TyreLife
HARD	8.3824	8.5	9.5
MEDIUM	7.2015	7.7761	6.3582
SOFT	18	13.6364	3.2727



Insights

- Generally, the starting tire type does not play a huge role in this race because the representation of tires is fairly segregated per-stint
- HARD tires see a slight decrease (0.2) in positions as the race goes on, which is **very good** for this race as the tradeoff for tire life is not that big of a deal
 - Observation:** HARD tires are good for this race
- MEDIUM tires see a similar relationship as HARD tires
- SOFT tires see a significant increase in position, although SOFT tires are also under-represented for this race and were only used by ZHO, RIC, and HAM

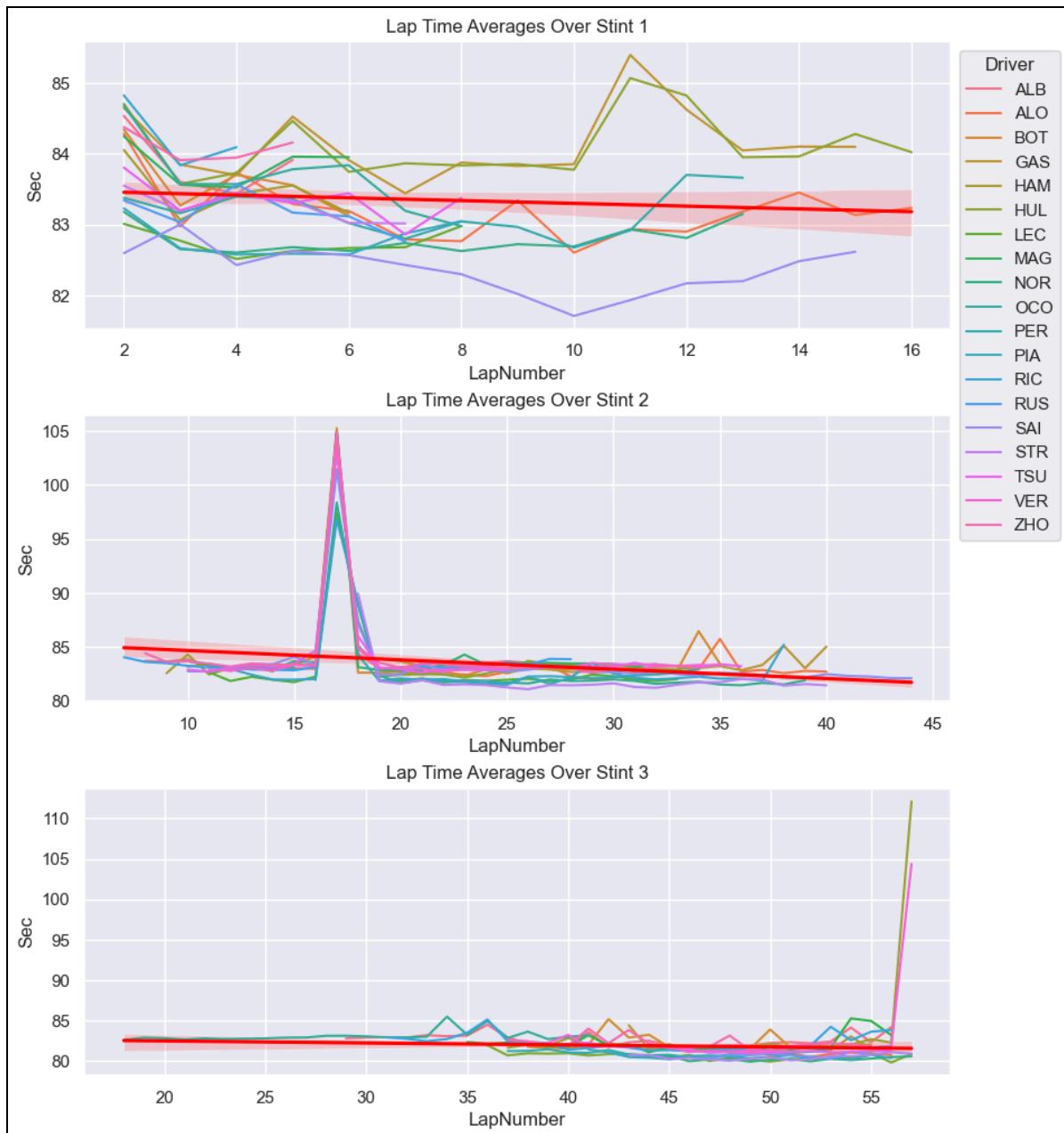
Australian Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- Despite the fact that HARD tires have seen a lot of popularity in this race, the lap split has been otherwise negative and split times slower on the HARD compound
- Split times for the whole race were quite negative in general, mostly because of the safety car
 - As such this data is a bit skewed for this race and even with superb driving performance, there would still be a generally negative split

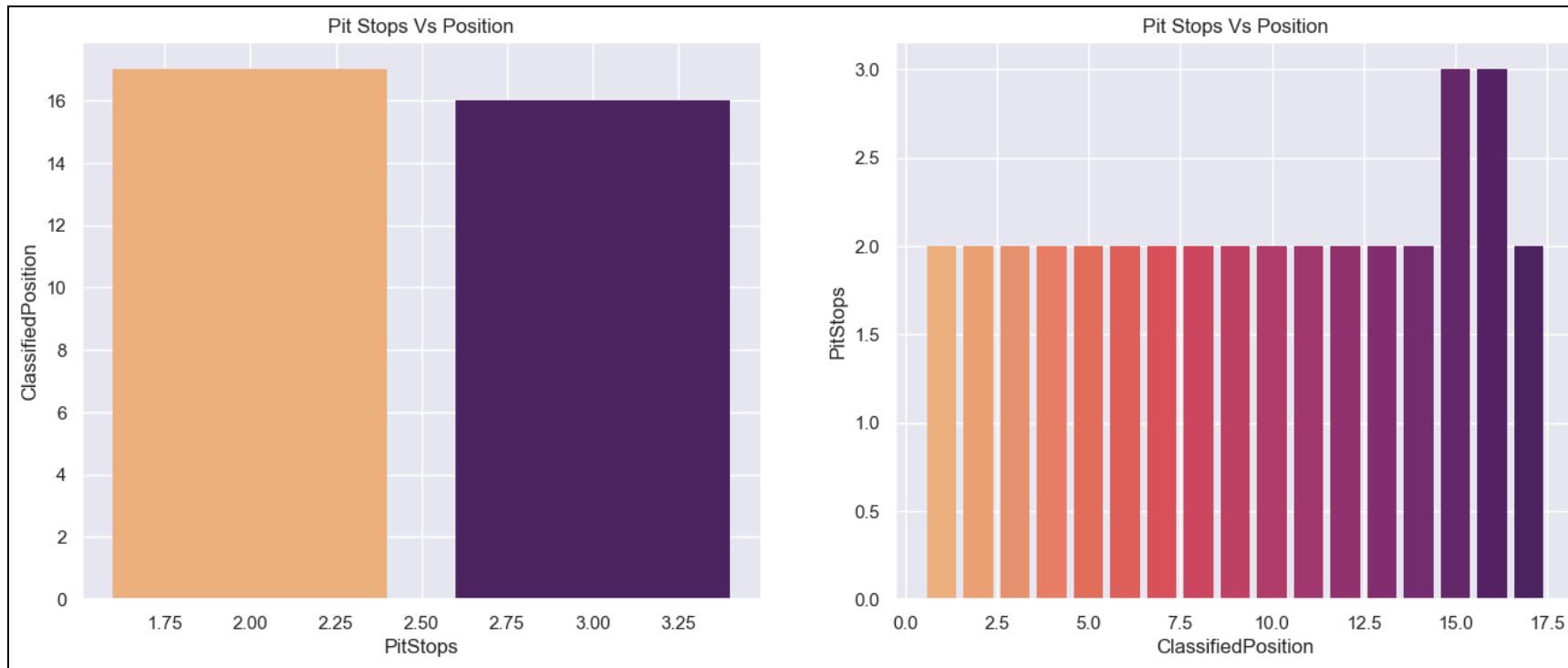
Australian Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Lap times were all over the place on this one
- For Stint 1, some of the crashes and safety car issues led to a general lack of usable data - averages were very up and down
- For Stint 2, the safety car was still in play for most players and we saw an obvious stop-gap for driver times. However, we still see a **downward trend in times**.
- Stint 3 was still affected by the safety car until around lap 30

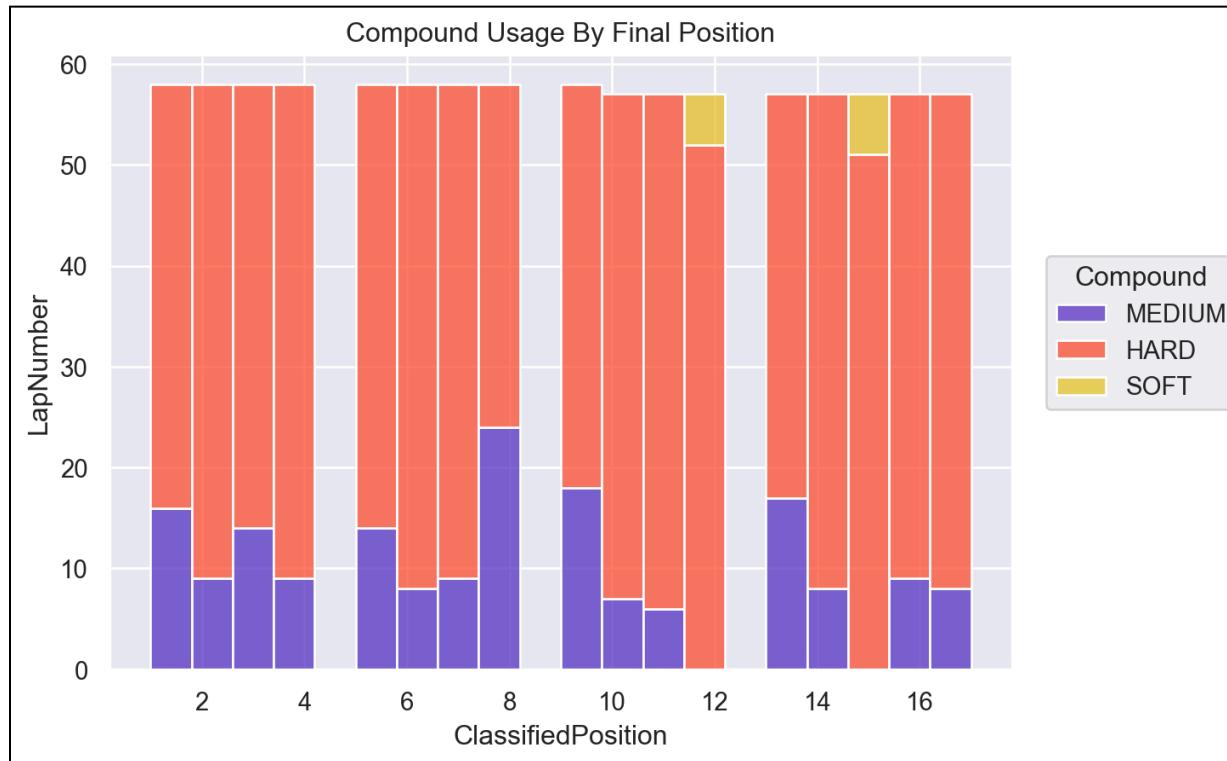
Australian Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- As with many other races, the number of pit stops generally has a minimal correlation with the final position, although in general more pit stops is associated with a worse position

Australian Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- We see a general trend for higher positions to use *slightly* less HARD compounds over the course of the race
 - That said, the distribution of MEDIUM / HARD compounds is still pretty even and this difference is more than likely down to specific driver skill instead of tire strategy
- SOFT compound usage was associated with worse performance throughout this race

Japanese Grand Prix - Base Statistics

Teams

Alpine	OCO, GAS
Aston Martin	ALO, STR
Ferrari	SAI, LEC
Haas F1 Team	HUL, MAG
Kick Sauber	ZHO, BOT
McLaren	NOR, PIA
Mercedes	RUS, HAM
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	SAR, ALB

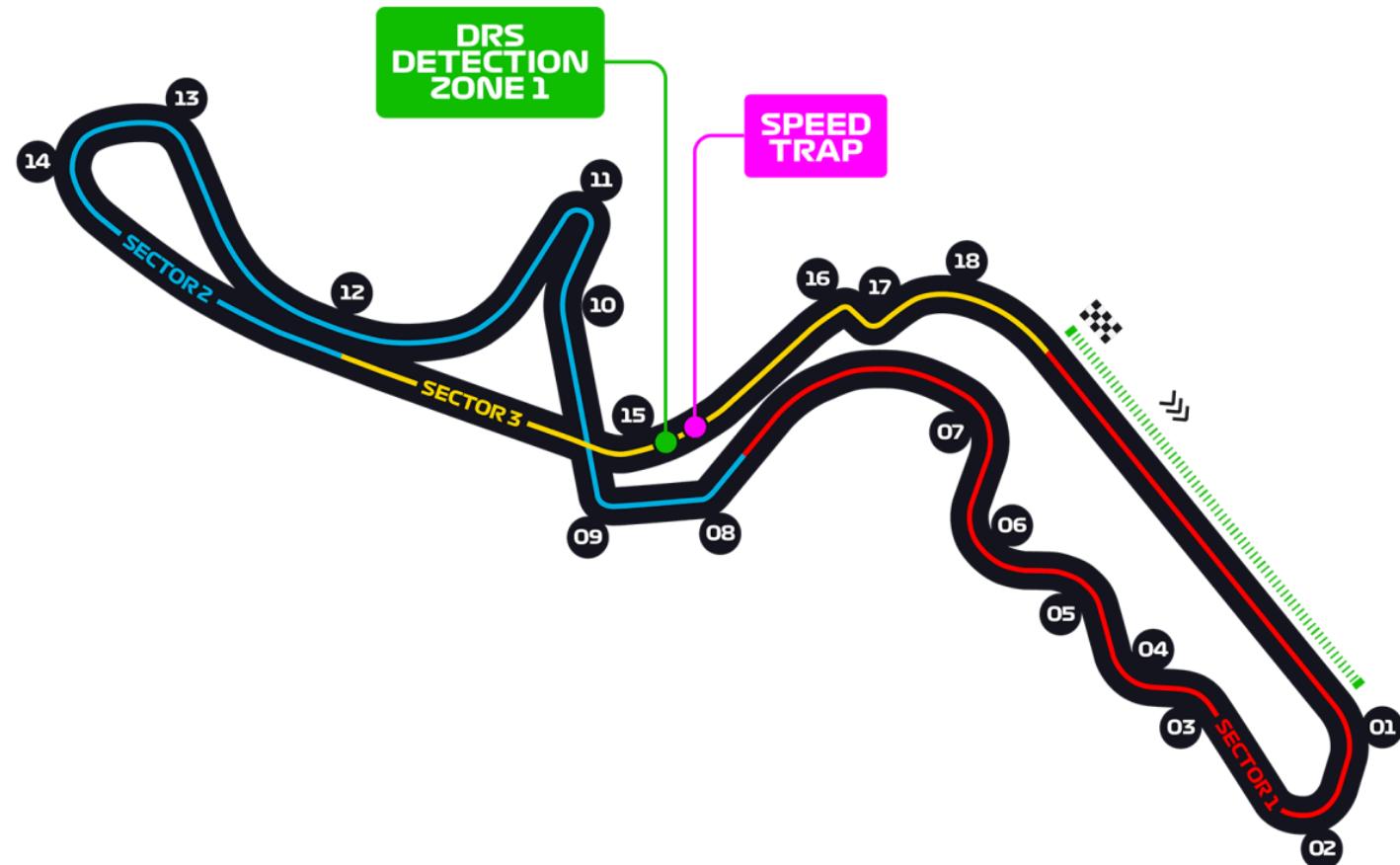
Total Statistics

Pit Stops	54
Pit Time	08:08:21
Laps Completed	907
Lap Time	1 days 00:20:13
Race Laps	53
Compounds	[MEDIUM, HARD, SOFT]

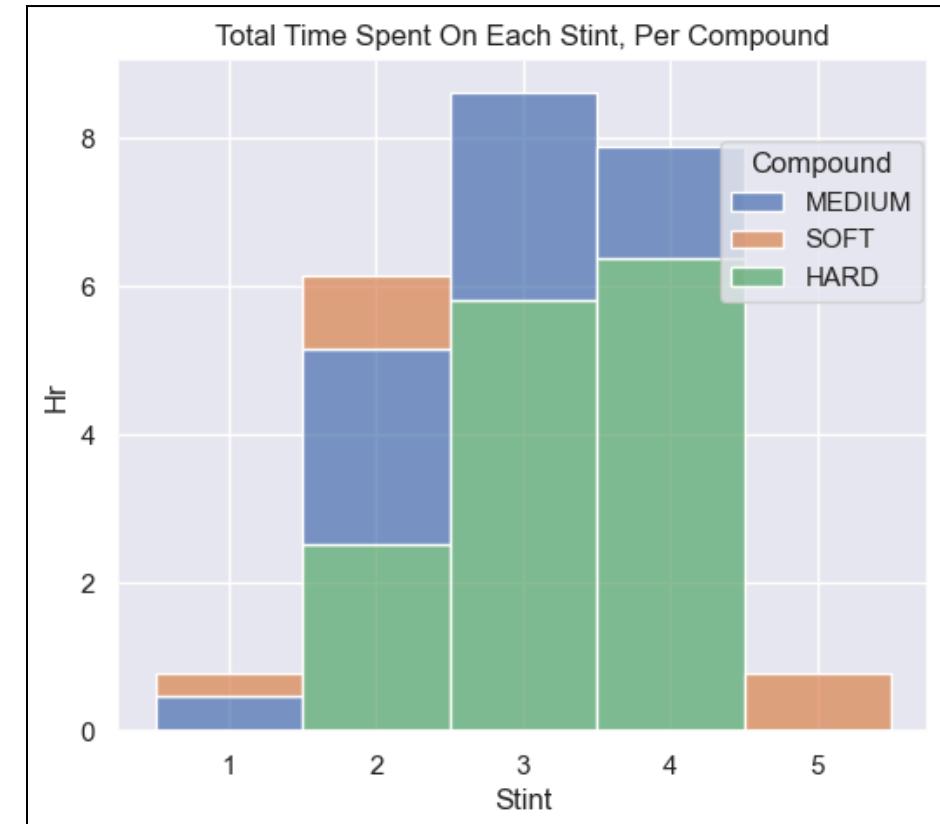
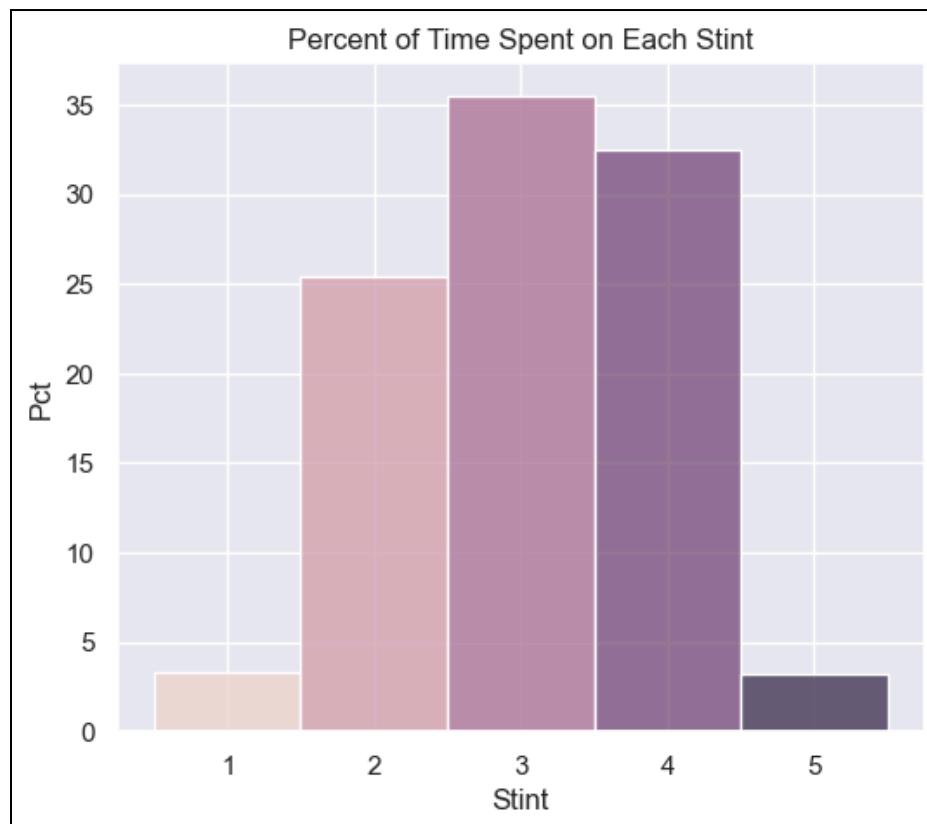
Average Statistics

Pit Stops	2
Pit Time	23.562
Laps Completed	45.3
Lap Time	0:01:40

[Japanese Grand Prix Link](#)



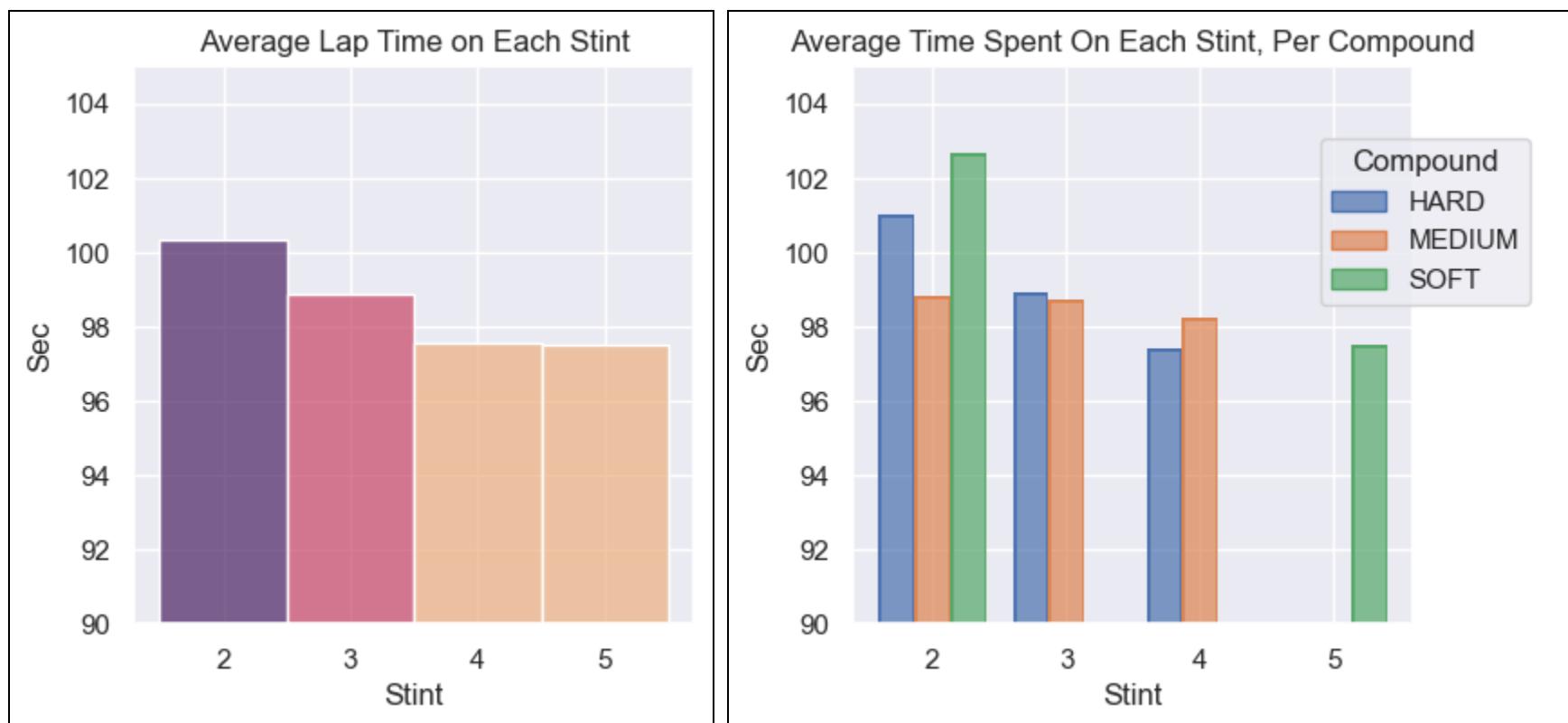
Japanese Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stint 1 was uncharacteristically short, and the compound representation was about 50/50 on SOFT and MEDIUM tires with MEDIUM being slightly more popular
 - For all intents and purposes, Stint 2 is Stint 1 for this race, since there was a crash that required lap repairs and a position reset
- Stint 2 an even use of HARD and MEDIUM tires with some SOFT tire representation
 - The compound usage is interesting for this race - **you see some drivers electing to use HARD tires on what is essentially the first stint**. What changed between these two stints to make these drivers change their strategy? It could be that **they were respecting their tire strategy** (switching from SOFT/MEDIUM to MEDIUM/HARD) while **other drivers instead recognized Stint 2 was still a sprint-round** and treated the tires as such, using SOFT and MEDIUM compounds.
- Stints 3 and 4 have about equal representation of MEDIUM and HARD compounds, with more MEDIUM representation than we might otherwise normally see. This is likely because of the **significant turns and twists in this track**, which MEDIUM tires strike a good balance on versus tire durability
- Predictably, on Stint 5 we see SOFT tires being used, likely because there are so few laps left and SOFT tires offer the best speed performance

Japanese Grand Prix - Average Lap Time Per Stint / Per Compound



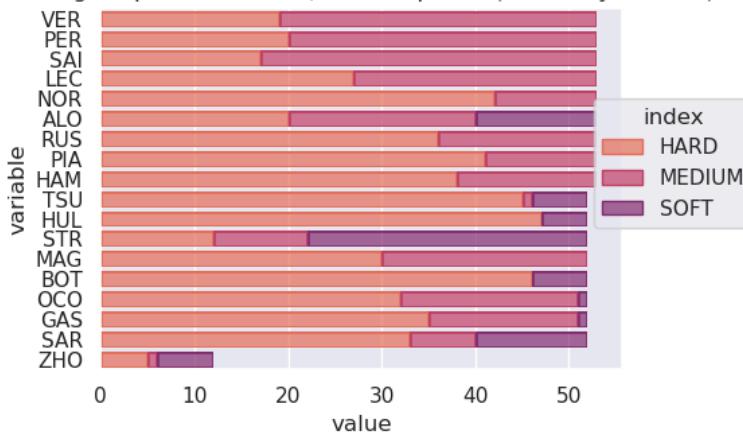
Insights

- Stint 2 sees MEDIUM tires being faster than HARD tires, being faster than SOFT tires
 - We might instead expect SOFT faster than MEDIUM faster than HARD, but the (almost) opposite is true
- Stint 3 sees MEDIUM and HARD tires have about the same performance, on average
- Stint 4 sees the same data as in Stint 3, but with a slightly more favorable approach to the HARD tires
 - **Observation:** We see a pattern in this race and others that HARD tires benefit disproportionately more from a worn-in track than other compounds

Japanese Grand Prix - Driver Data

Driver	Pit Stops	PitTime	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	PitTime	Laps Driven	TotalTime	Avg Time	Pos
VER	2	21.75	53	1:23:00	0:01:38	1	HUL	2	28.628	52	1:23:29	0:01:40	11
PER	2	23.397	53	1:23:13	0:01:38	2	STR	3	54.888	52	1:26:06	0:01:41	12
SAI	2	26.631	53	1:23:25	0:01:38	3	MAG	1	10.52	52	1:26:16	0:01:41	13
LEC	1	6.494	53	1:23:45	0:01:39	4	BOT	2	32.798	52	1:26:14	0:01:41	14
NOR	2	26.367	53	1:23:31	0:01:38	5	OCO	2	33.213	52	1:26:33	0:01:42	15
ALO	2	27.024	53	1:23:51	0:01:39	6	GAS	2	33.472	52	1:26:47	0:01:42	16
RUS	2	27.566	53	1:24:08	0:01:39	7	SAR	3	57.266	52	1:27:12	0:01:43	17
PIA	2	26.328	53	1:23:57	0:01:39	8	ZHO	2	6.087	12	0:21:09	0:01:55	99
HAM	2	27.961	53	1:24:05	0:01:39	9	RIC	0	99	1			99
TSU	2	30.616	52	1:23:32	0:01:40	10	ALB	0	99	1			99

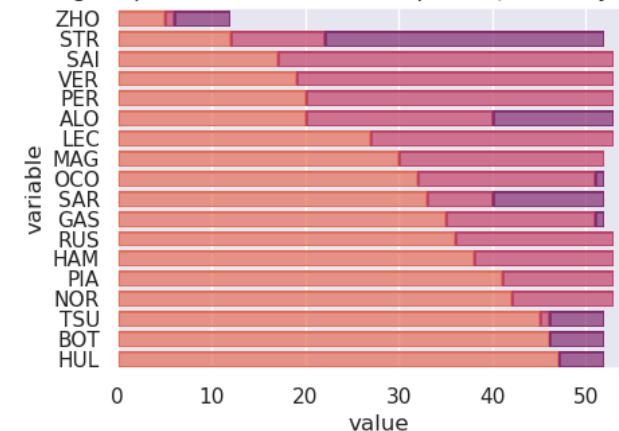
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- STR & SAR had three pit stops
- The pit stops for this race are skewed because of the crash that occurred at the beginning of the race. As such all of the pit times were technically about 25 minutes - I've standardized the times (-1600 seconds each) so these are relative to their end pit time from the first stint
- LEC used a one-stop strategy during this race and took fourth place
- ZHO, RIC, and ALB were all DNF
- Observation:** Generally, increased MEDIUM compound usage resulted in higher performance on this track, and lower positions have decreased MEDIUM tire usage or increased SOFT tire usage
 - Observation:** We see a pattern emerging in many races where MEDIUM tires are preferable and SOFT tires are just not worth the durability loss in the beginning of a race

Average Laps in Each Stint, Per Compound (Sorted by Compound)

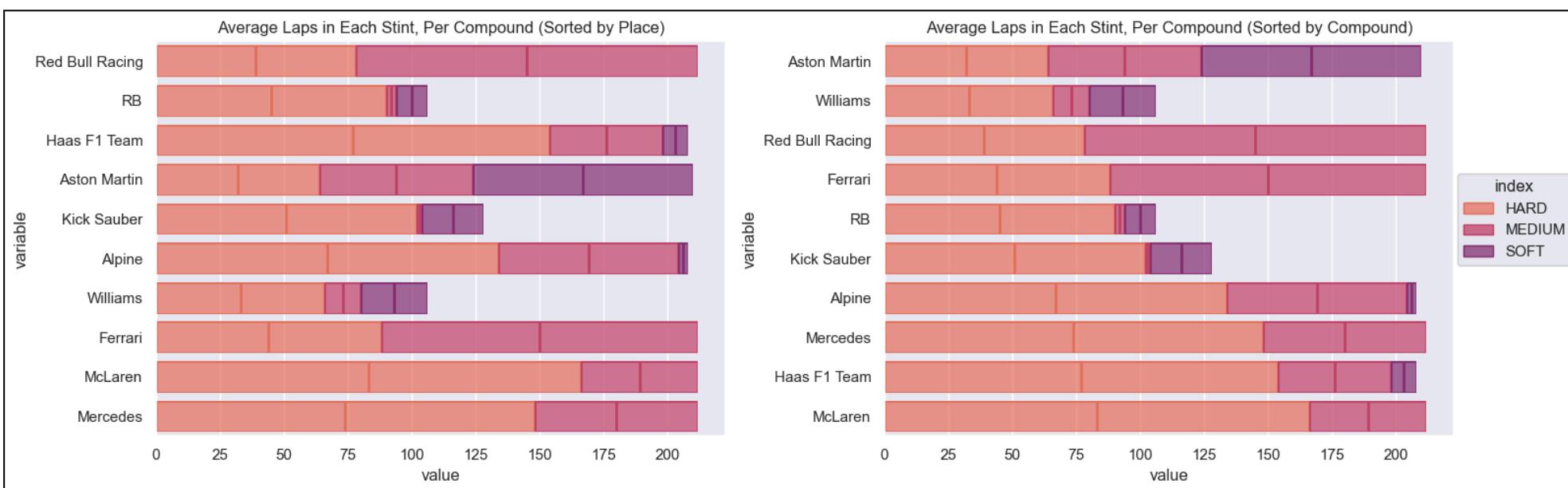


Japanese Grand Prix - Team Data

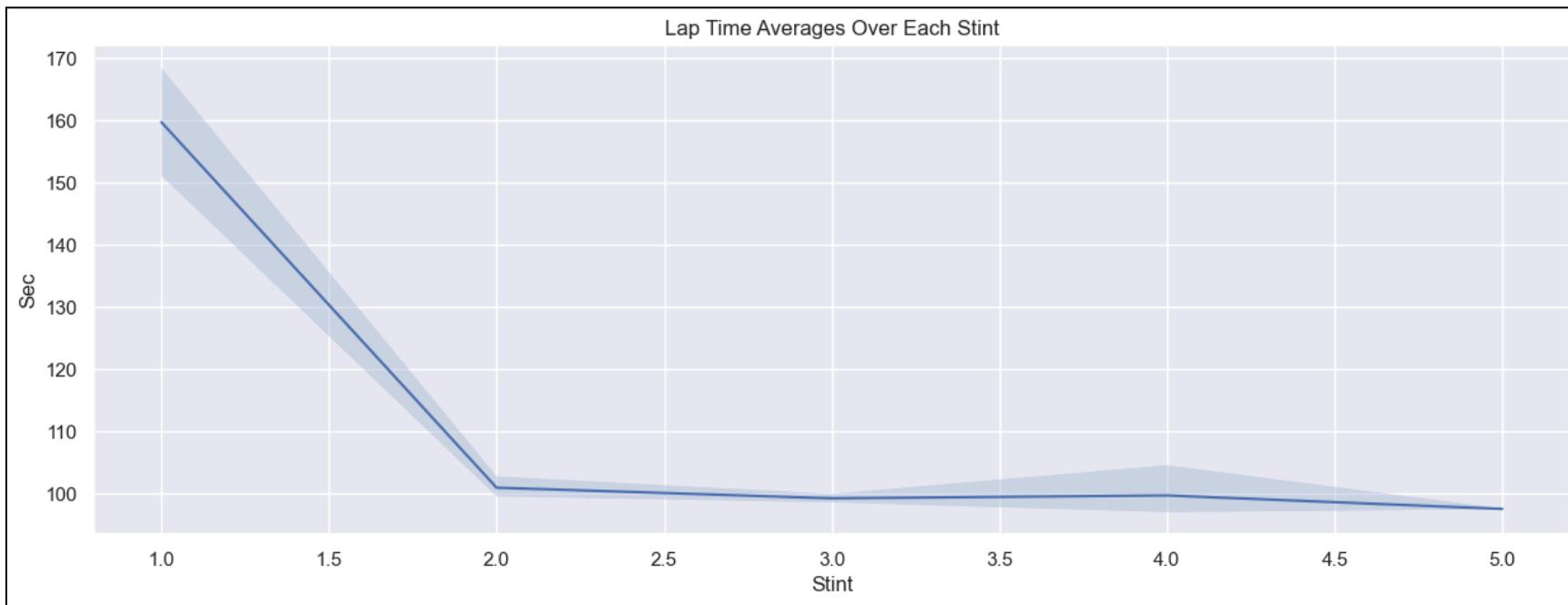
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
RB	2	2	46.552	1	1:23:32	0:01:40
Williams	2	3	72.636	1	1:27:12	0:01:43
Kick Sauber	2	4	50.544	12	1:47:23	0:01:44
Red Bull Racing	2	4	92.109	53	2:46:13	0:01:38
Ferrari	2	3	69.786	53	2:47:10	0:01:38
McLaren	2	4	92.351	53	2:47:28	0:01:39
Mercedes	2	4	93.523	53	2:48:13	0:01:39
Haas F1 Team	2	3	74.006	52	2:49:45	0:01:41
Aston Martin	2	5	115.505	52	2:49:57	0:01:40
Alpine	2	4	94.111	52	2:53:20	0:01:42

Insights

- Average time across all teams was +2s
- RB and Williams both had drivers that only drove one lap (the beginning crash), so they (as a team) did not complete the race
- Kick Sauber had the same situation, with 12 laps
- Generally, teams that used primarily MEDIUM compounds saw a greater performance than those that used more HARD compounds or any SOFT compounds



Japanese Grand Prix - Lap Time Averages

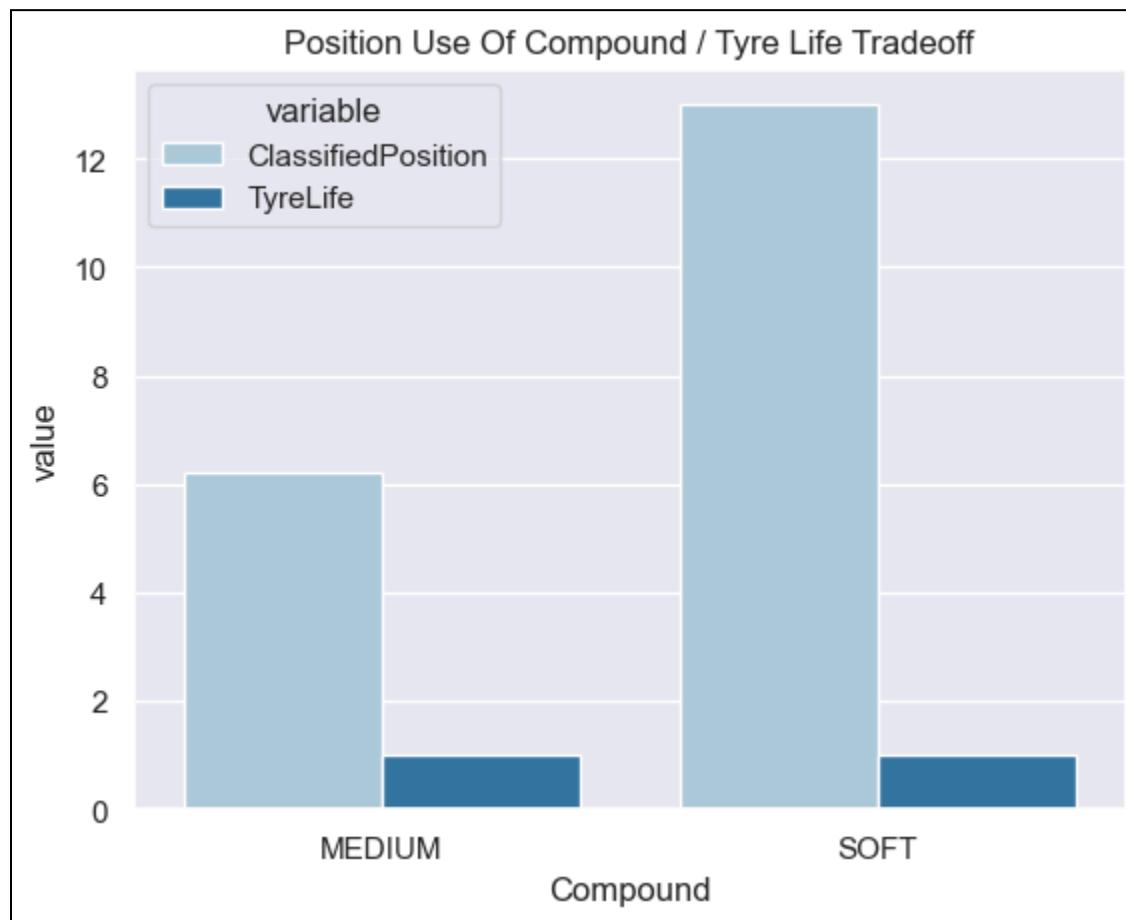


Insights

- This track has a large initial lap time average, likely caused by the initial crash
- For the most part, the rest of the times were pretty even, although we begin to see some more variation at Stint 5

Japanese Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

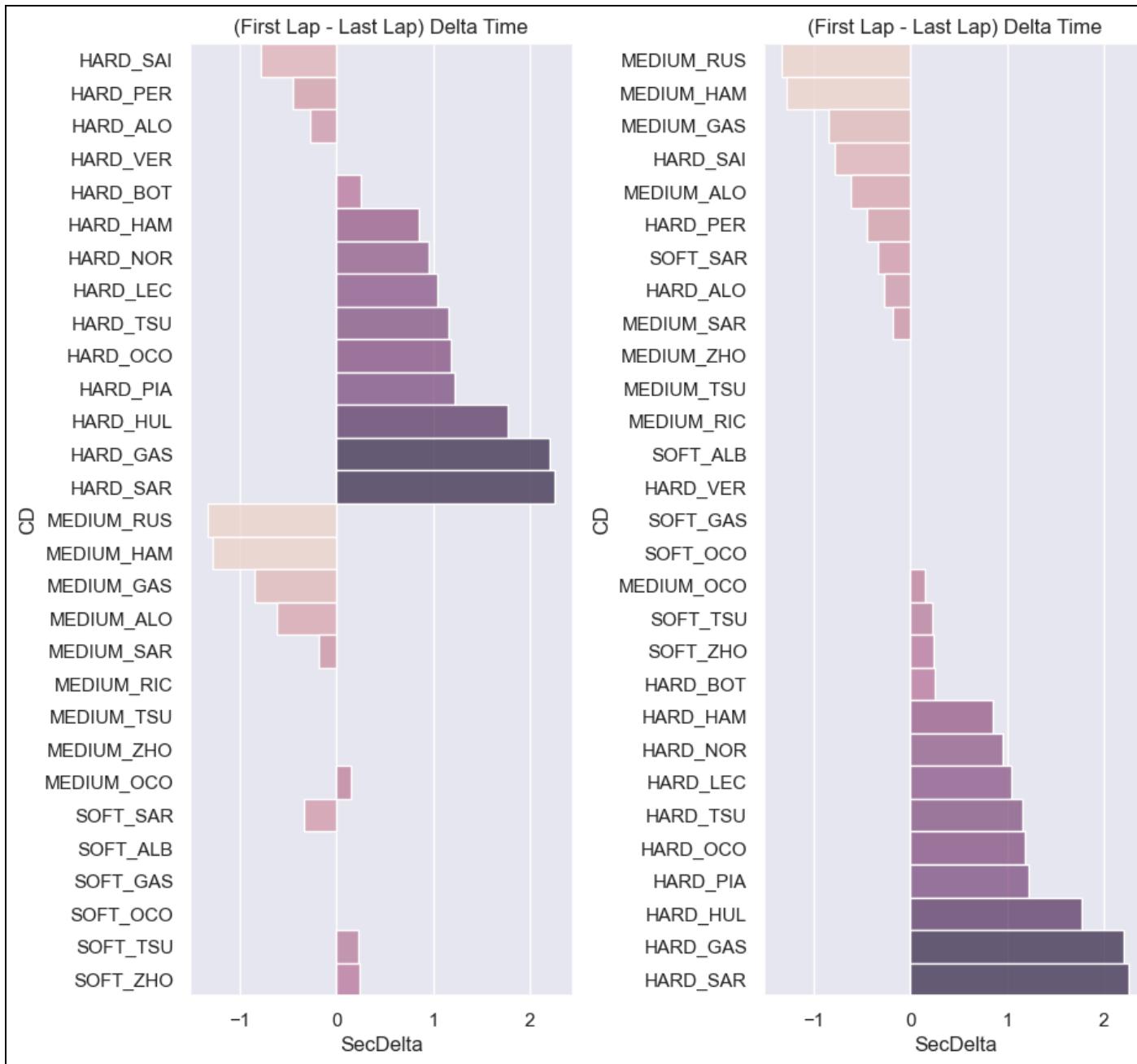
Compound	Position	ClassifiedPosition	TyreLife
MEDIUM	8.6	6.2	1
SOFT	14.1429	13	1



Insights

- Those that started with MEDIUM tires tended to see some increase in final position, +2.4 positions on average
 - Consistent with current observations
- Those that started with SOFT compounds also saw a +1.1 increase on average from start to end
 - Although it's a positive increase, the absolute number is quite low at 13
 - **Observation:** This may suggest that those who start further behind should use SOFT tires and those that start in the front use MEDIUM tires
 - Tire life for both of these compounds was very short, likely because of the crash in the first lap

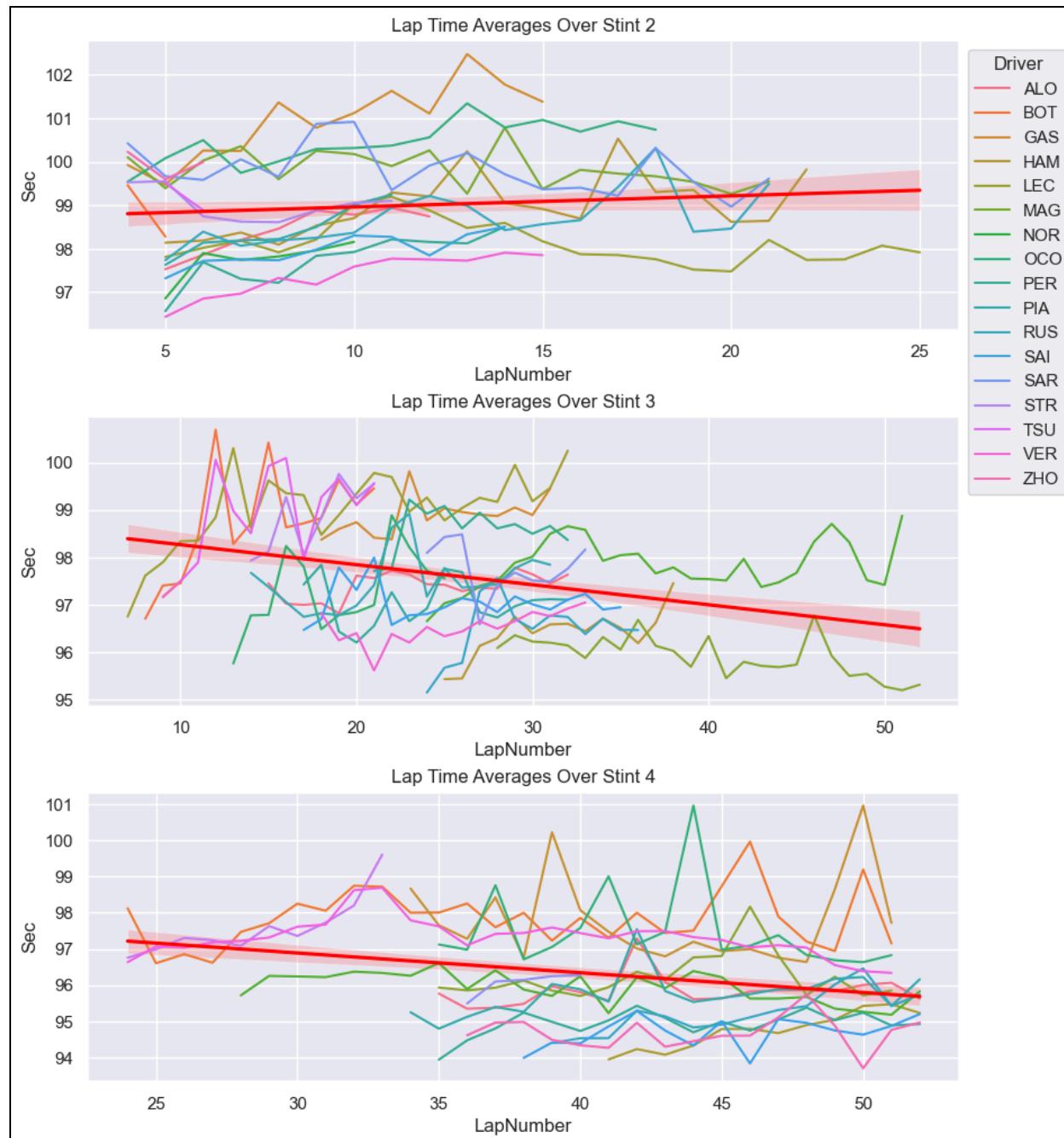
Japanese Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- HARD tires saw the best split time this race, with a max of -2.15 second split and around +0.8 second minimum split
- MEDIUM tires only saw only positive splits this race
- SOFT tires saw, generally, a small negative split except for SAR which saw a small positive split of around 0.3 seconds
- Observation:** It's clear on this race that HARD tires are the way to go based on split times
- Despite the high usage of MEDIUM tires, most of the MEDIUM tire users saw significant positive splits, suggesting they may not have been the best choice for this track

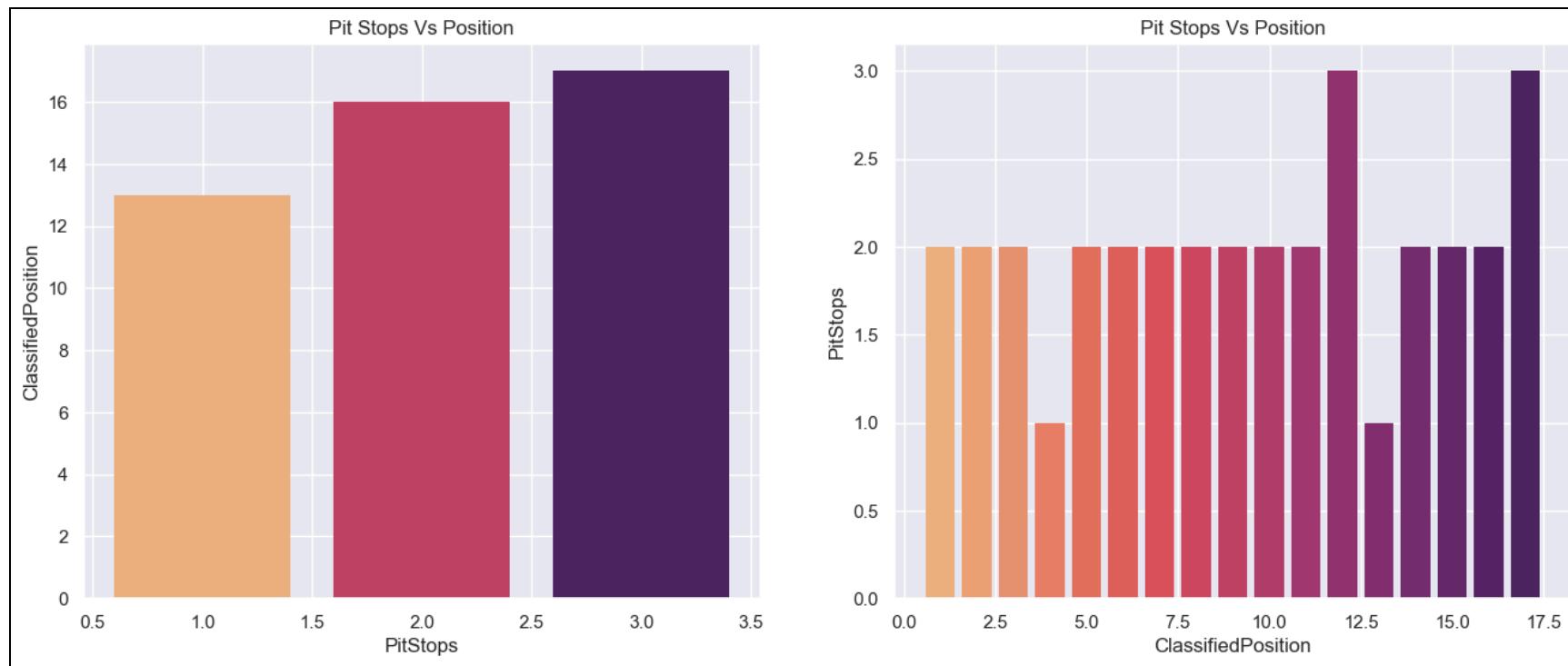
Japanese Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Lap times generally increased over stint 2, perhaps a combination of stint 2 being the "first stint" and cars still being very adjacent to one another
- Stint 3 sees a heavier downward slope in lap times, although we can see in the graph there are still plenty of drivers that had positive splits over the race and the average is brought down some by low-time drivers
- Stint 4 sees a less significant downward slope than Stint 3, likely due to drivers not being so clumped together and being able to focus on driving the track more than bumping into one another

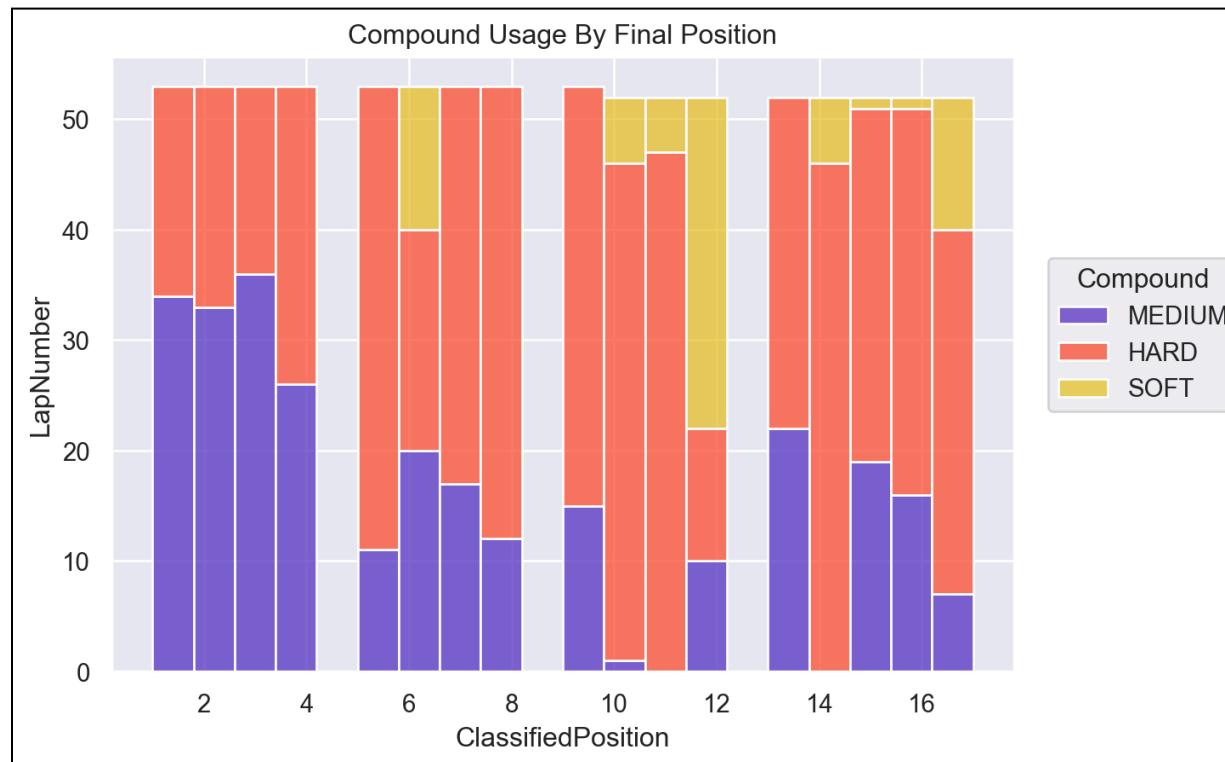
Japanese Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- LEC was the one of the only drivers who had one pit stop and it seems to have worked well for him, placing him at 4th place overall
- We see a typical trend of less pit stops leading to a better position in the race, but the correlation is not very strong, especially for this race

Japanese Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- The top 5 positions only used HARd and MEDIUM compounds, in mostly equal proportions
- SOFT compound usage is correlated with worse positions in this race
- Those who used less HARD compounds during the race saw a decreased final position

Chinese Grand Prix - Base Statistics

Teams

Alpine	GAS, OCO
Aston Martin	ALO, STR
Ferrari	LEC, SAI
Haas F1 Team	MAG, HUL
Kick Sauber	BOT, ZHO
McLaren	PIA, NOR
Mercedes	RUS, HAM
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	SAR, ALB

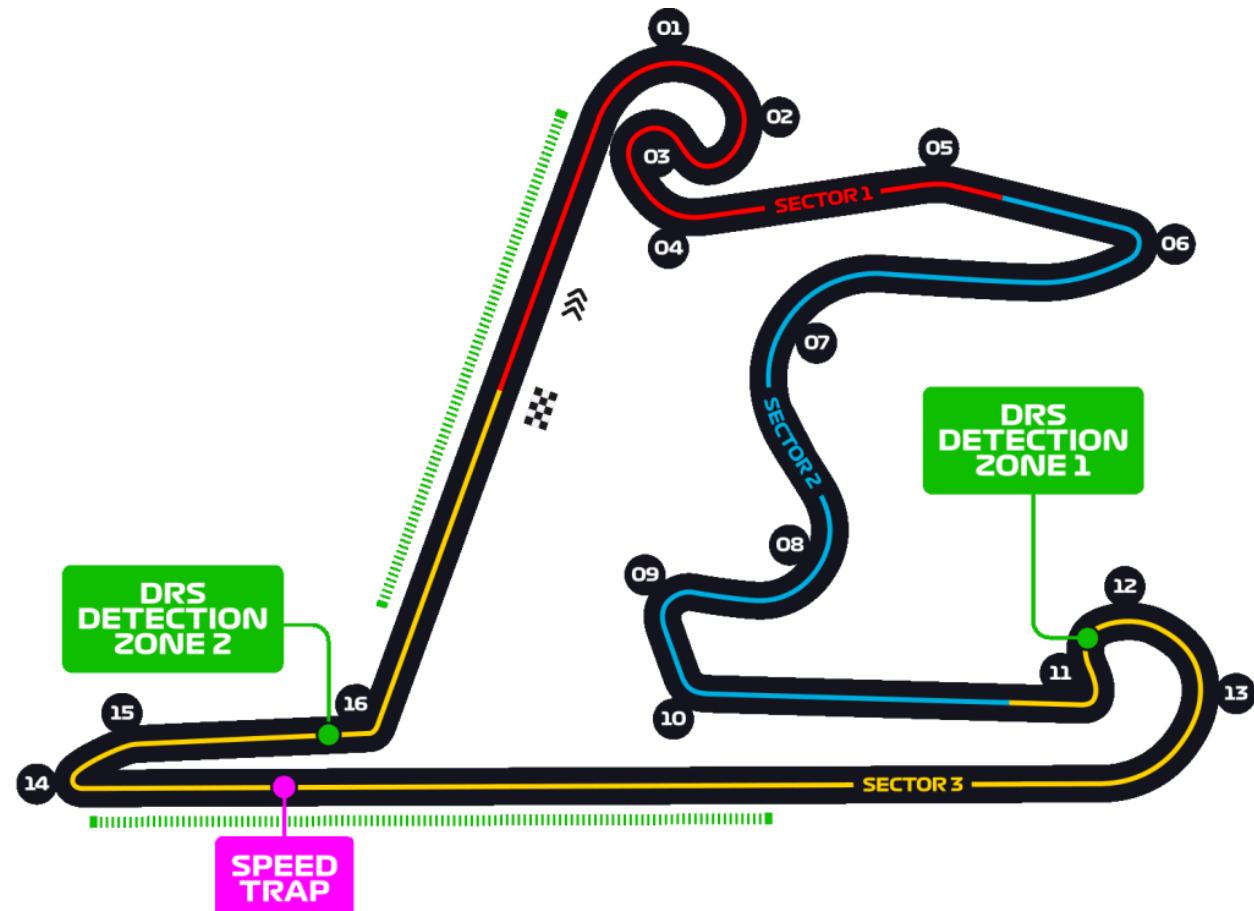
Total Statistics

Pit Stops	41
Pit Time	00:16:57
Laps Completed	1032
Lap Time	1 days 06:13:37
Race Laps	56
Compounds	[MEDIUM, HARD, SOFT]

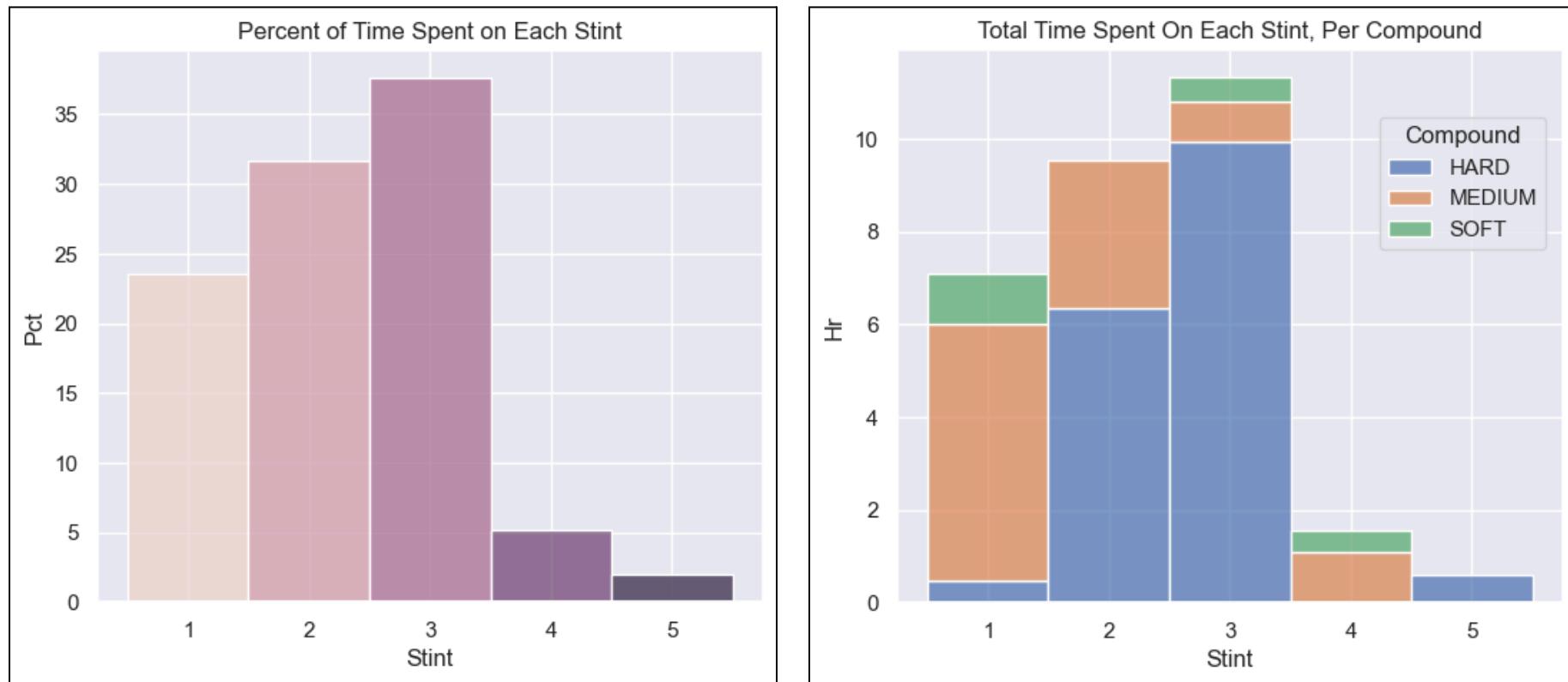
Average Statistics

Pit Stops	1.7368
Pit Time	25.442
Laps Completed	57.2676
Lap Time	0:01:48

[Chinese Grand Prix Link](#)



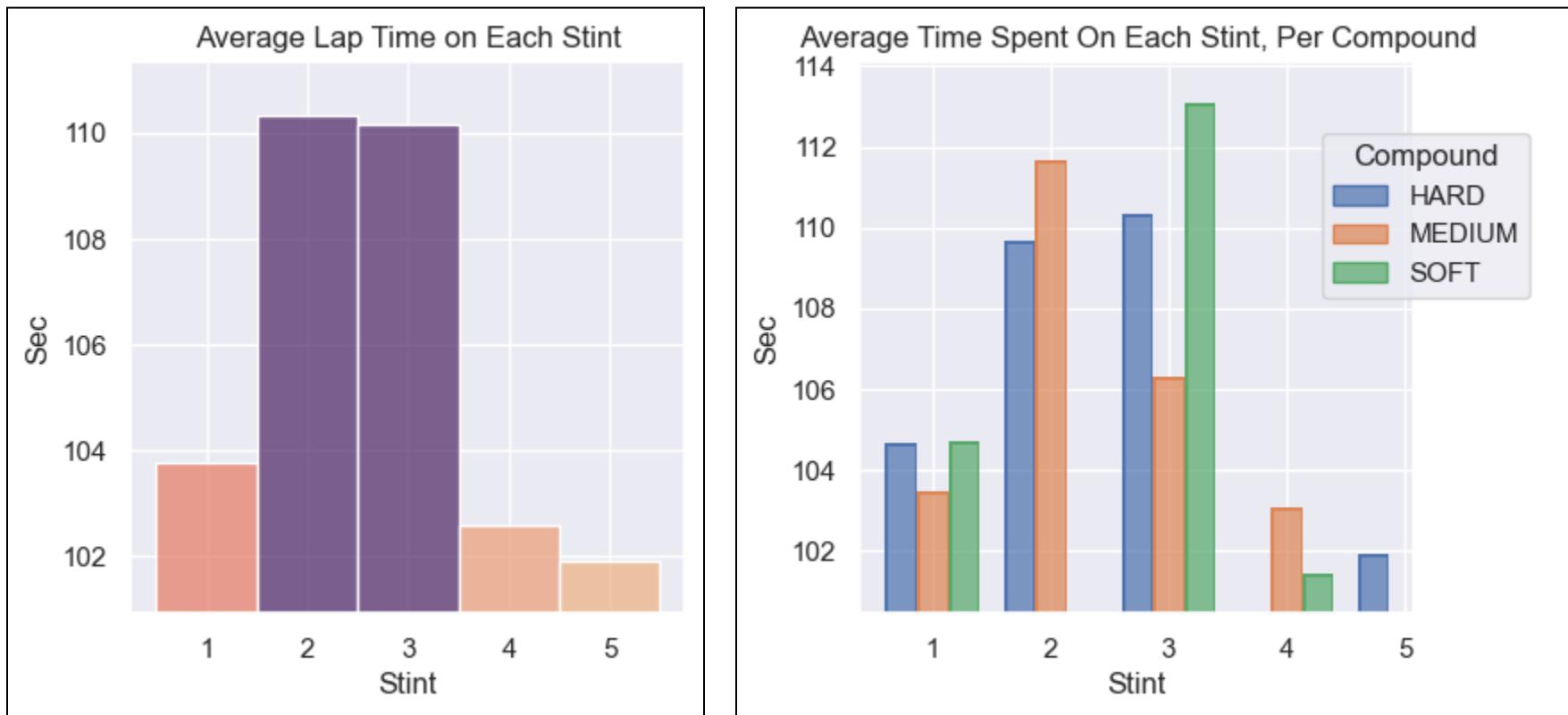
Chinese Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stints 1, 2, and 3 represent a majority of driver's stints in this race
- Stint 1 sees primarily MEDIUM tires with some use of SOFT and HARD
- Stint 2 sees about $\frac{2}{3}$ HARD tire usage and $\frac{1}{3}$ MEDIUM tire usage
 - This is different than what we've seen before, where stints after the first usually lean more heavily into HARD tires
 - **Observation:** The winding nature of this track allows for more MEDIUM tire usage, giving drivers more traction and greater acceleration potential coming out of tight curves
- Interestingly, we still see SOFT compound usage on the third and fourth stints
 - Likely because they are the last stints for their drivers, with some effort to gain position in the last part of the race
- Stints 4 and 5 are under represented
 - Interestingly, despite limited Stint 5 representation, the driver(s) still elected to use HARD tires there instead of SOFT or MEDIUM tires, like we often see in stints 4 and 5

Chinese Grand Prix - Average Lap Time Per Stint / Per Compound



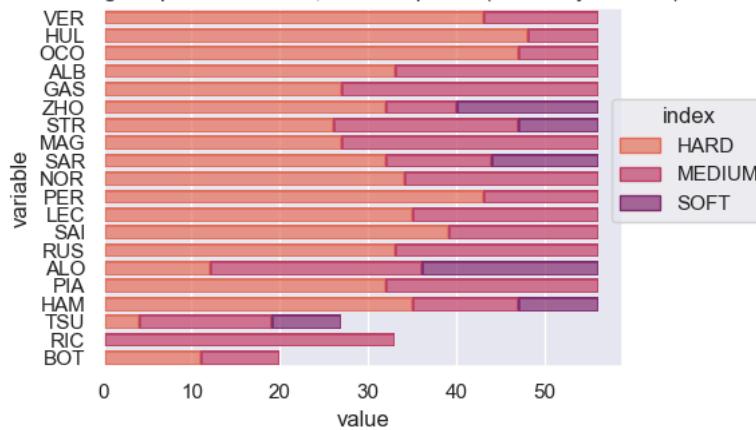
Insights

- Unlike previous races, we see stint 1 with a lap time much lower on average (about 6s) than other races
 - This is especially interesting because the first three stints have approximately equal representation, time wise. One stint is not much longer or shorter than another
- Stints 2 and 3, which make up the bulk of the race, see nearly identical lap times on average
 - This might suggest that drivers were content using the same compound between these stints and maintain their current strategy
- HARD / MEDIUM compounds saw approximately equal representation during this race
 - This is different than usual, where either MEDIUM or HARD compounds (when used together) tend to be faster than the other in the same race. Here, they are roughly equally represented
 - **Observation:** MEDIUM tires do not provide enough of a difference in split times to consider using them over HARD tires
- SOFT tires, when used, generally tended to perform the slowest of the represented tire compounds
 - This is likely due to under-representation because the top drivers in this race tended to stick with MEDIUM and HARD compounds

Chinese Grand Prix - Driver Data

Driver	PitStop s	Pit Time	LapsDrive n	TotalTime	AvgTime	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	AvgTime	Pos
VER	1	22.572	56	1:32:57	0:01:45	1	OCO	2	0	56	1:41:55	0:01:49	11
NOR	1	0	56	1:38:29	0:01:47	2	ALB	2	0	56	1:41:58	0:01:49	12
PER	1	0	56	1:33:33	0:01:46	3	GAS	3	0	56	1:42:02	0:01:49	13
LEC	1	22.21	56	1:33:39	0:01:46	4	ZHO	2	0	56	1:39:32	0:01:49	14
SAI	1	0	56	1:36:23	0:01:47	5	STR	2	23.783	56	1:33:28	0:01:46	15
RUS	2	0	56	1:38:59	0:01:48	6	MAG	2	22.913	56	1:39:29	0:01:49	16
ALO	3	22.927	56	1:36:34	0:01:47	7	SAR	3	23.225	56	1:42:18	0:01:50	17
PIA	2	0	56	1:39:18	0:01:48	8	TSU	2	99	27	0:48:07	0:01:51	99
HAM	2	0	56	1:41:51	0:01:49	9	BOT	1	99	20	0:32:59	0:01:44	99
HUL	1	22.995	56	1:39:23	0:01:48	10	RIC	1	99	33	1:00:45	0:01:54	99

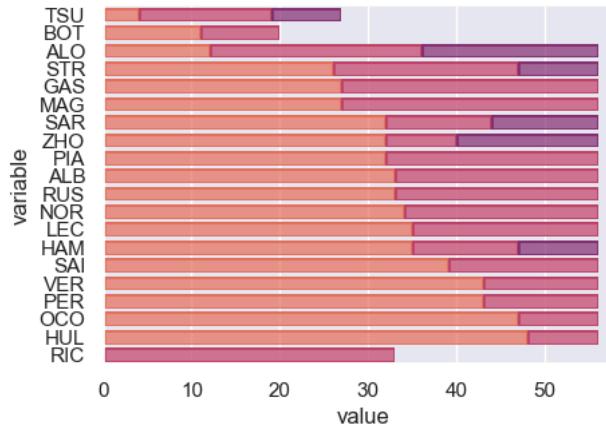
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- Pit times for drivers in this race were approximately equal
- Three drivers DNFd - TSU, BOT, RIC
- The average lap time saw a higher deviation than usual, with +5s instead of the usual +2s, which is still quite high for an average lap time difference
- Most drivers elected for just one pit stop, likely caused by the mechanical failure at the midway point for BOT, where the safety car was enabled
 - This is most likely the reason for the MEDIUM / HARD usage - some drivers determined they could do HARD tires for the remainder of the race (40ish laps) and others continued to push the MEDIUM tires
- **Observation:** Of the top racers, the top three used a higher HARD : MEDIUM proportion than anyone else in the race
- SOFT tires see some usage in places 6, 7, and 9, though SOFT tires are correlated with worse performance this race, in general
- Drivers after 3rd place have a roughly equivalent HARD / MEDIUM usage

Average Laps in Each Stint, Per Compound (Sorted by Compound)

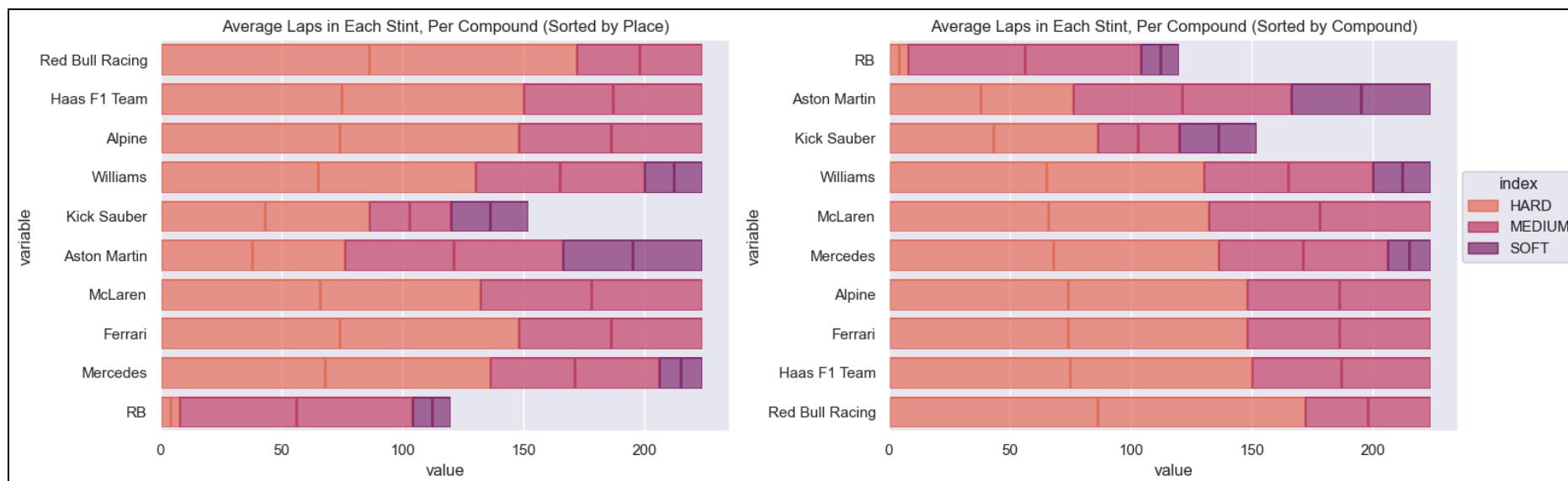


Chinese Grand Prix - Team Data

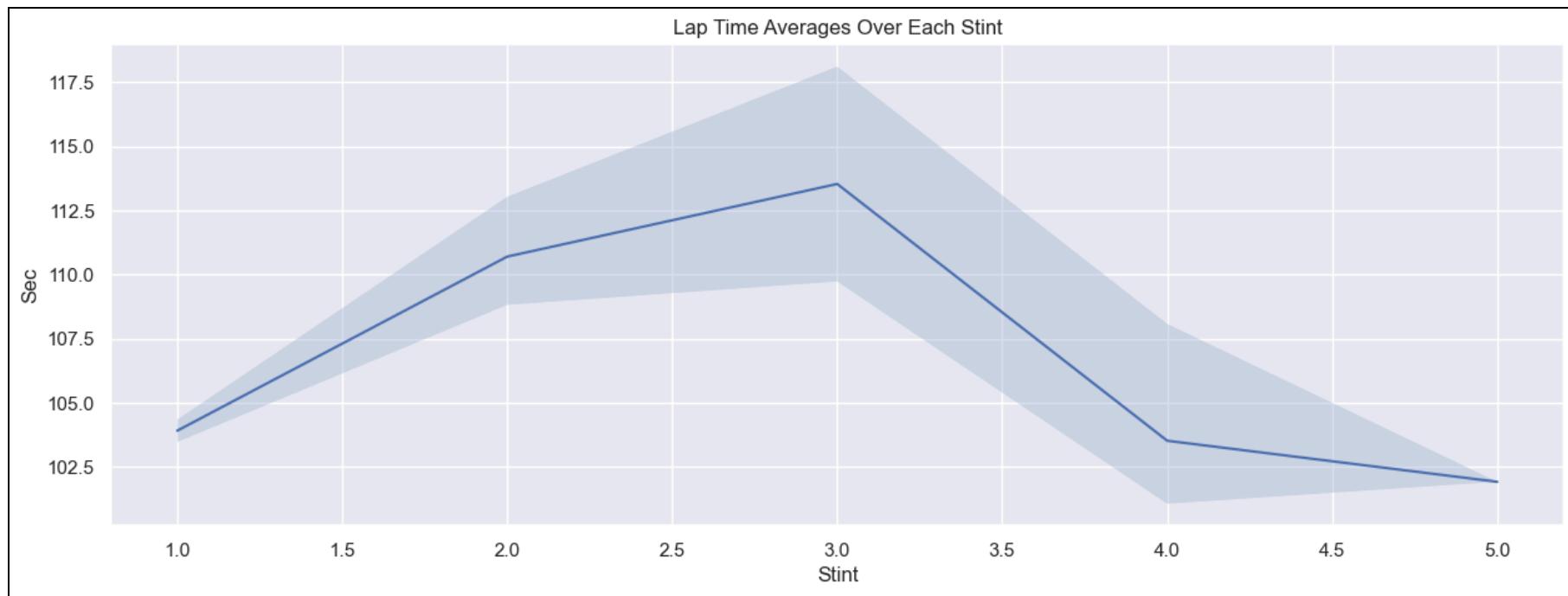
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
RB	2	3	0	33	1:48:52	0:01:53
Kick Sauber	2	3	23.285	20	2:12:30	0:01:47
Red Bull Racing	2	2	22.572	56	3:06:30	0:01:46
Ferrari	2	2	22.21	56	3:10:02	0:01:47
Aston Martin	2	5	92.49	56	3:10:02	0:01:47
McLaren	2	3	0	56	3:17:47	0:01:48
Haas F1 Team	2	3	45.908	56	3:18:52	0:01:48
Mercedes	2	4	0	56	3:20:50	0:01:49
Alpine	2	5	0	56	3:23:57	0:01:49
Williams	2	5	45.886	56	3:24:16	0:01:49

Insights

- Despite a high per-driver lap time variance, the team lap-time variance is smaller at +/- 2.5s
- Both RB and Kick Sauber had drivers DNF in this race, both having driven on average only half of the race
- Aston Martin had 5 pit stops this race, the most of any other team
- Ferrari and Aston Martin had the same total lap time
- Of the winning teams, the top scoring teams tended to use HARD compounds more than anything else, and did not use SOFT compounds
- SOFT compounds were generally associated with worse performance



Chinese Grand Prix - Lap Time Averages

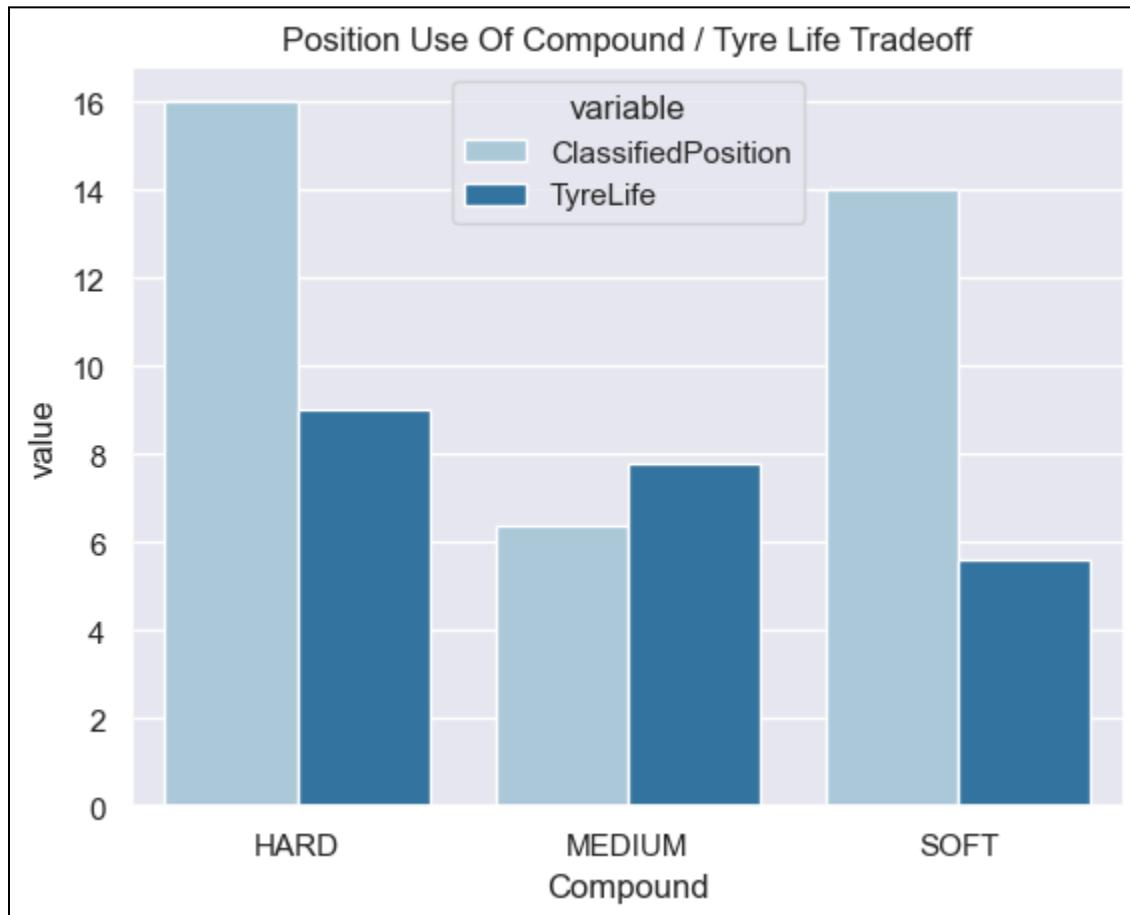


Insights

- Lap times increased on average until stint 3, although the variation between drivers increases greatly as the race continues
- These times are likely modified greatly by the safety car, which we explore further down below
- Stint 3 > 4 saw a significant drop in times on average, likely due to under-representation of a fourth stint

Chinese Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

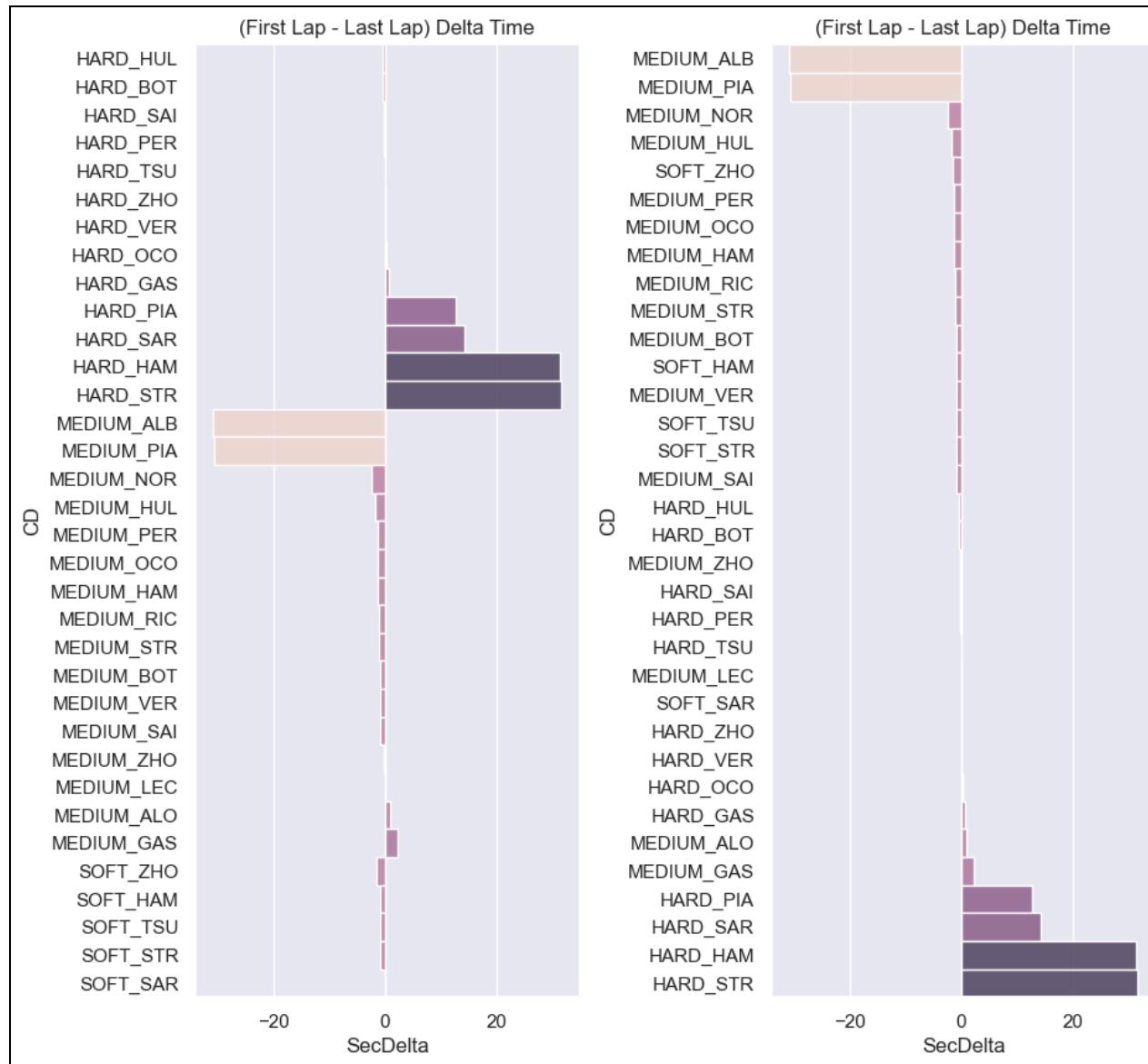
Compound	Position	ClassifiedPosition	TyreLife
HARD	14.0588	16	9
MEDIUM	6.5562	6.3787	7.7811
SOFT	14.9667	14	5.6



Insights

- Despite previous observations, those who started the race with HARD tires generally lost about 2 positions over the race
 - This is skewed by the safety car. If drivers could predict that they would need to change tires due to a safety car, **they wouldn't have chosen HARD tires to begin with**
- Also, **HARD tires were used most heavily by the winning teams and drivers** in this race
 - This is not a very good metric for success in this race due to extenuating circumstances
- Those that started with MEDIUM tires saw their positions increase slightly, around 0.2 positions
 - **Observation:** While soft tires have the highest relative increase ($14.9 > 14$), MEDIUM tires have the highest absolute position (6.5 & 6.3)
 - **Observation:** This could mean either: Usage of MEDIUM tires is better to gain absolute position, or **those that are already at the front of the race tend to benefit from MEDIUM tires, and those at the back (pos 15) tend to benefit more from SOFT tires**

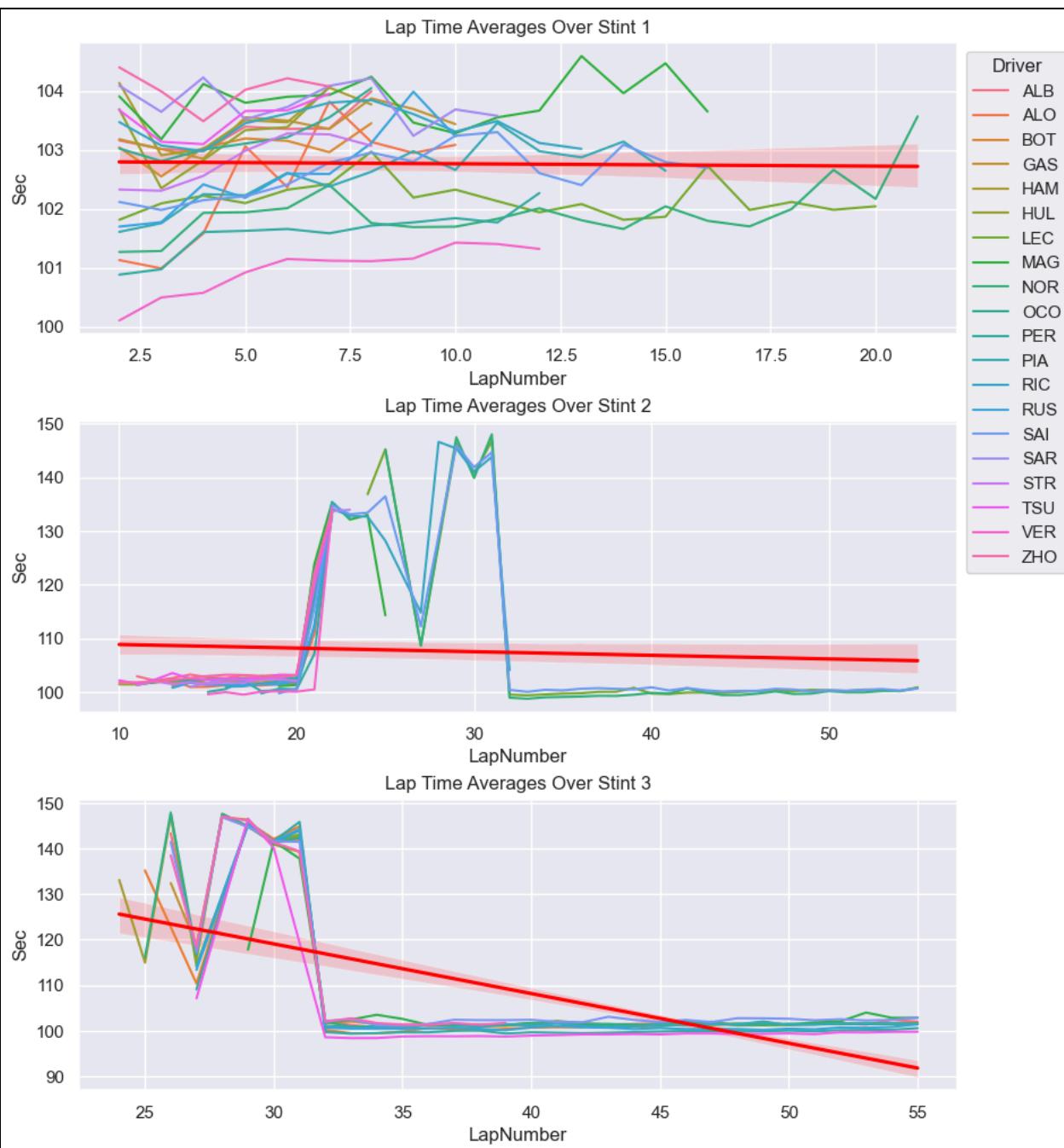
Chinese Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- The split time for HARD tires generally saw a very significant difference within each stint at almost -30 second split for HAM and STR, and a -17 /-18 split for PIA and SAR respectively
- ALB and PIA saw a positive split with MEDIUM tires of the same magnitude
 - These times are likely affected by the safety car
- The split times for the rest of the compounds / drivers were much smaller at around +/-1-2 seconds or less
 - Most drivers on all compounds had a small positive lap split

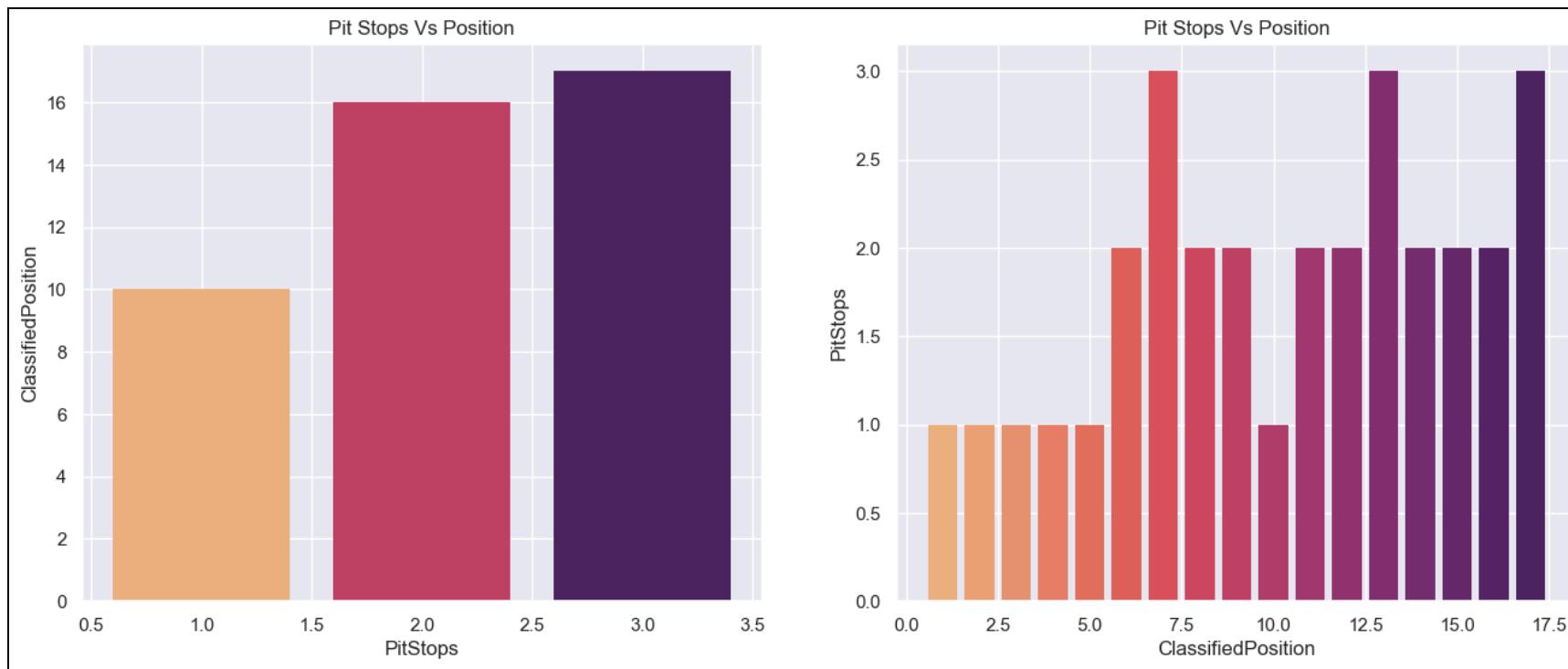
Chinese Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Stint 1 went off without much issue but was eventually hamstrung by the use of the safety car
- Stint 2 and stint 3 saw significant interruptions in standard lap times because of the safety car as well
- Generally there is a small downward decrease in times within each stint, although the safety car disrupts a lot of that analysis

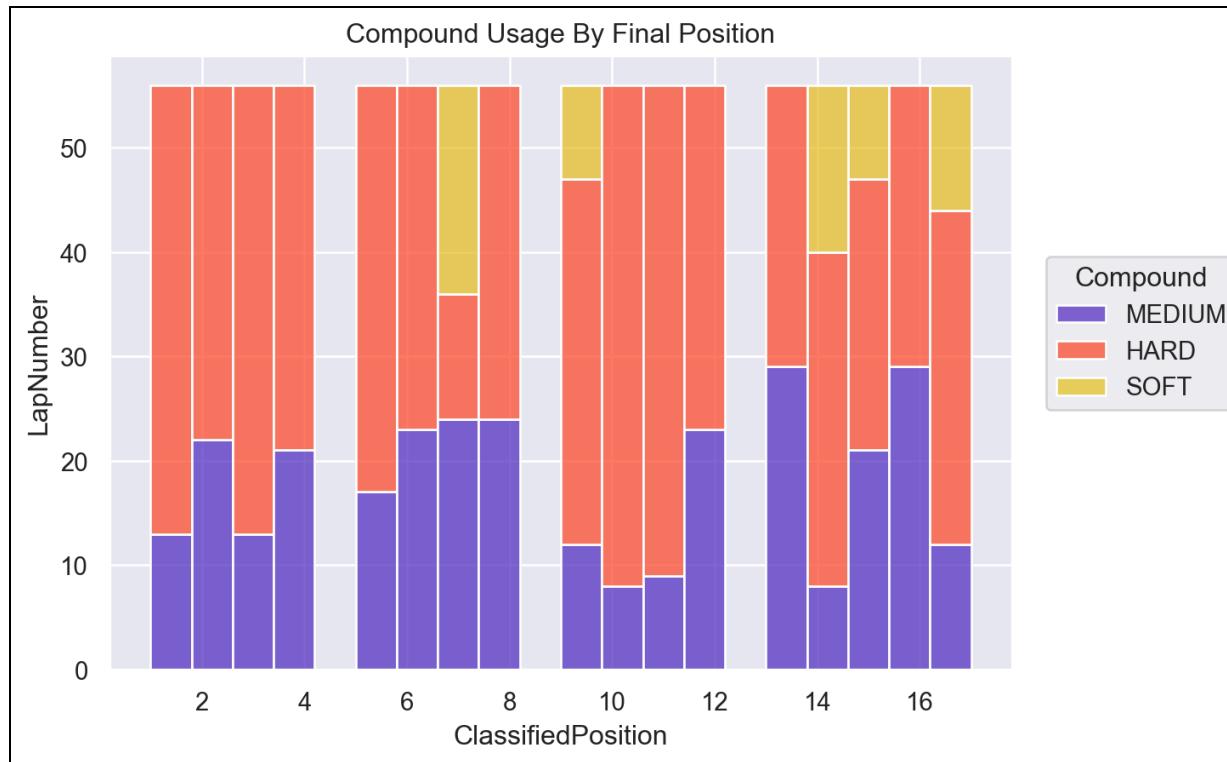
Chinese Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- With most races there is not a strong correlation between pit stops and final position. In this race, the correlation is much stronger
 - We see the top 5 positions only have one pit stop (usually a transition from MEDIUM to HARD tires)
 - Observation:** If a driver managed to only have one pit stop this race, they more than likely ended up in the top positions
 - Observation:** During a race that triggers a safety car, if a driver can manage to pit stop during the safety car time and finish out the race, they generally find more success

Chinese Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- The compound usage is actually pretty even for most drivers in this race
- As we usually see, SOFT compounds are only used by those in the middle or back of the race. Front-placing drivers tend to prefer to use MEDIUM and HARD compounds more

Miami Grand Prix - Basic Statistics

Teams

Alpine	GAS, OCO
Aston Martin	ALO, STR
Ferrari	LEC, SAI
Haas F1 Team	MAG, HUL
Kick Sauber	BOT, ZHO
McLaren	PIA, NOR
Mercedes	RUS, HAM
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	SAR, ALB

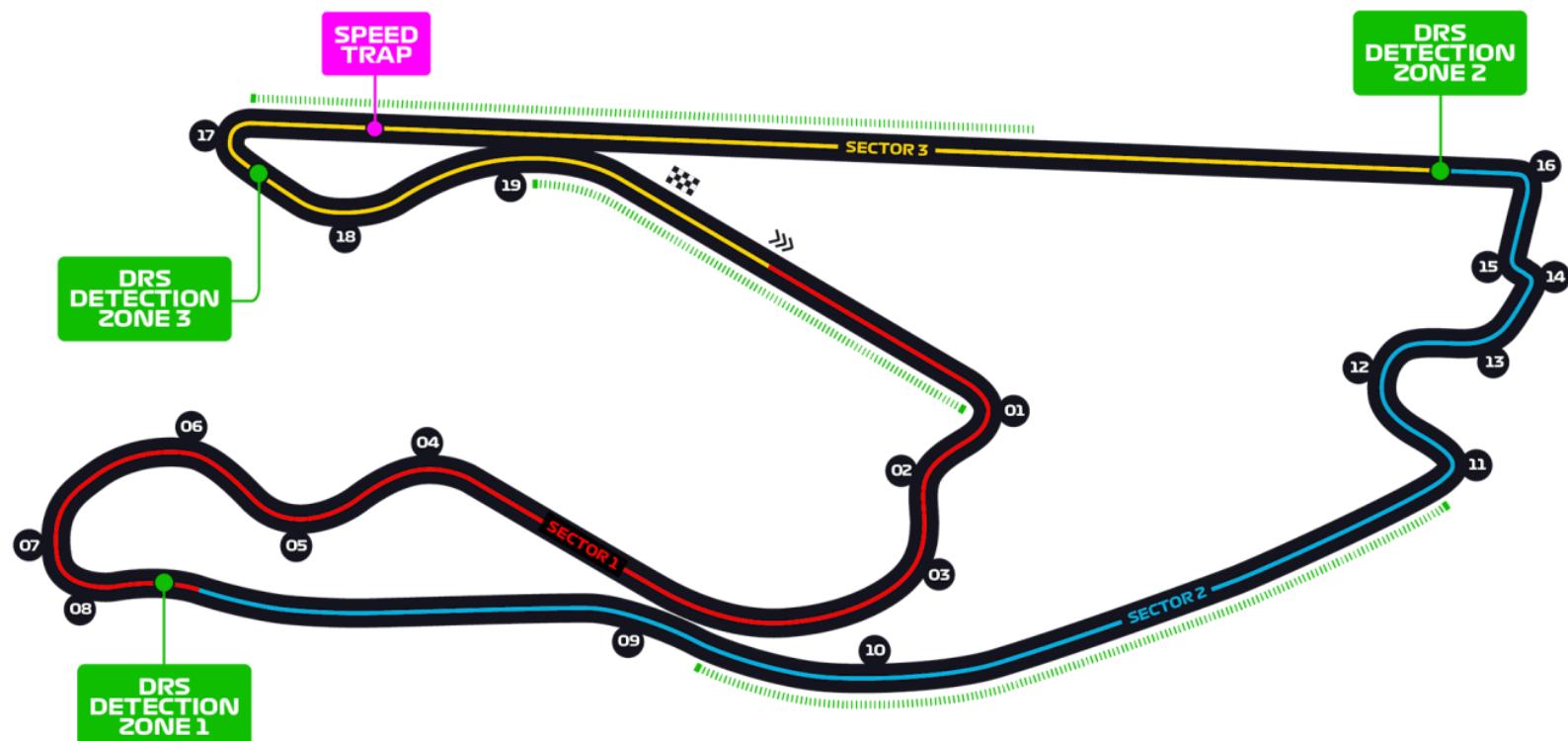
Total Statistics

Pit Stops	28
Pit Time	00:10:55
Laps Completed	1111
Lap Time	1 days 05:29:39
Race Laps	57
Compounds	[MEDIUM, HARD, SOFT]

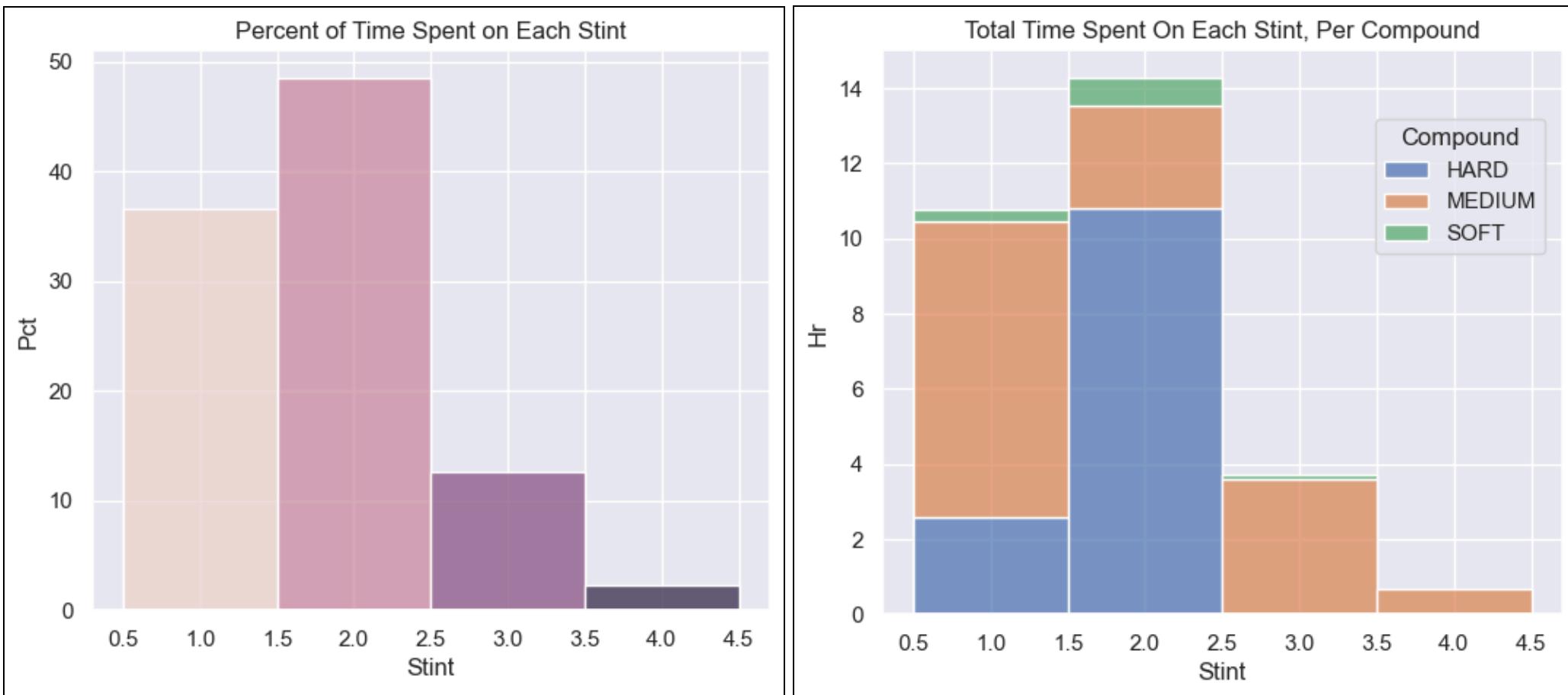
Average Statistics

Pit Stops	1.4
Pit Time	23.439
Laps Completed	57.2676
Lap Time	0:01:36

[Miami Grand Prix Link](#)



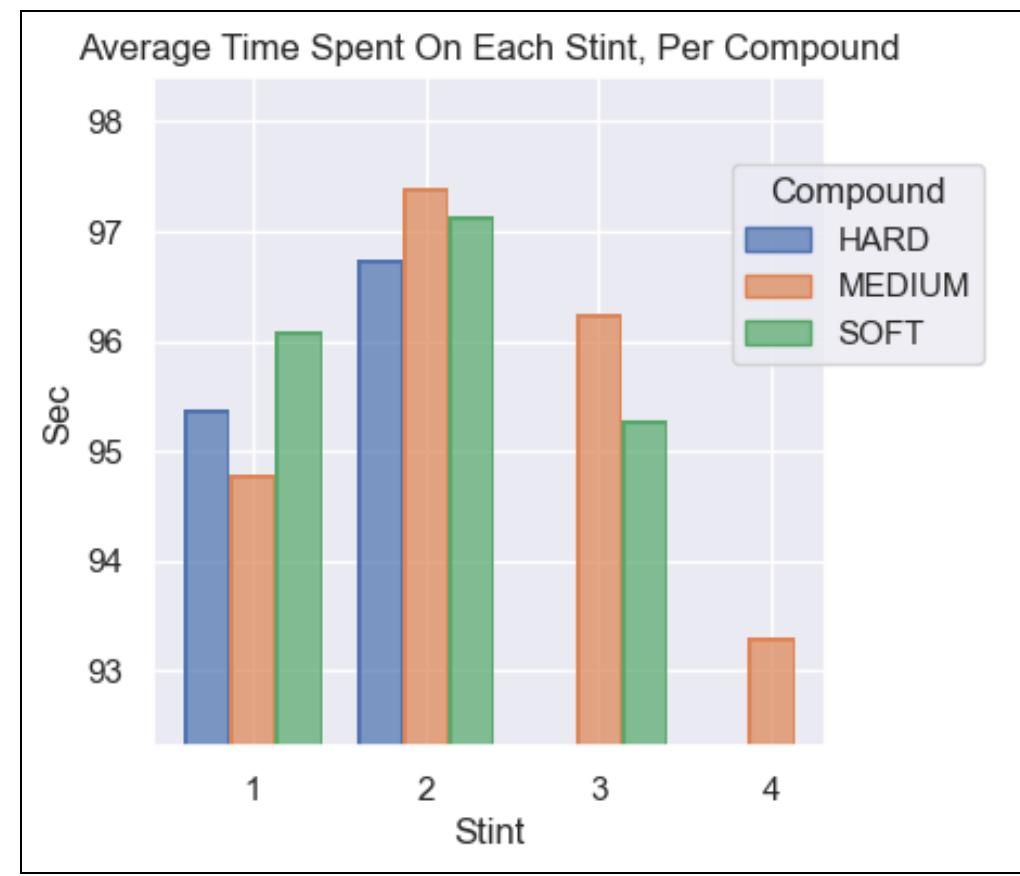
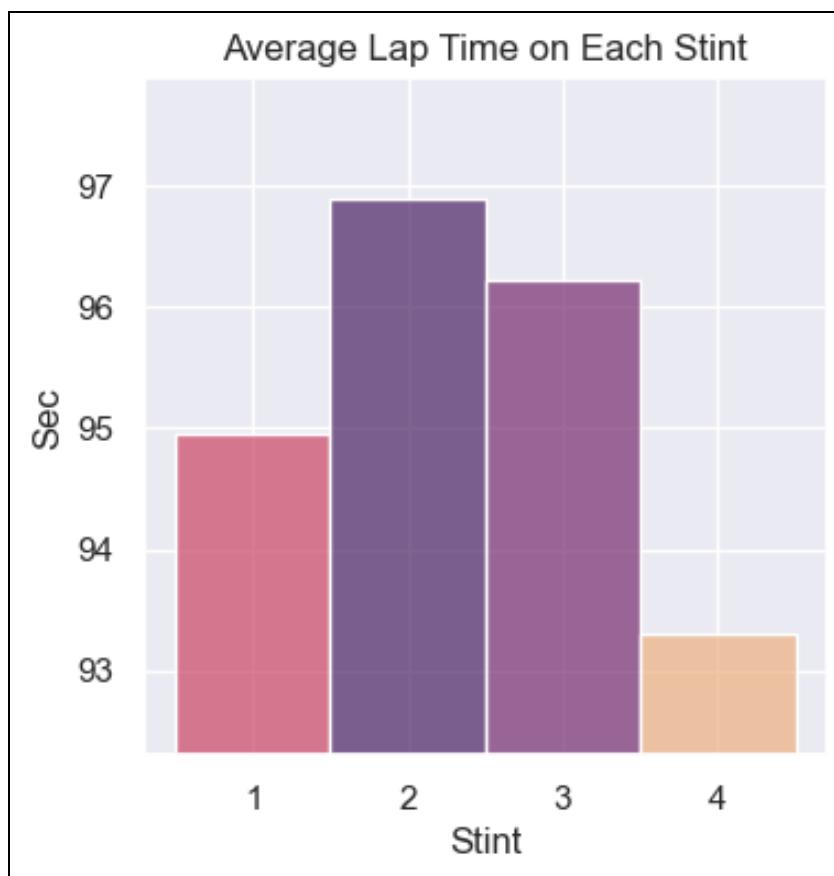
Miami Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stint 1 and 2 take up the majority of the time for this race
 - Stint 1 sees mostly MEDIUM compound usage with about 25% HARD usage and a very small portion of SOFT tires
 - Stint 2 sees the opposite, with a majority using HARD tires (80%) and the other 20% using MEDIUM tires, with some SOFT tire representation
 - Stint 3 is likely under-represented but still has mostly MEDIUM tires with some SOFT as well
- **Observation:** We've seen that HARD tires benefit disproportionately from a worn-in track, so it's interesting to see HARD tires being used in the first stint. It's likely that the large amount of straightaways favors consistency and durability more than it does quick acceleration around corners

Miami Grand Prix - Average Lap Time Per Stint / Per Compound

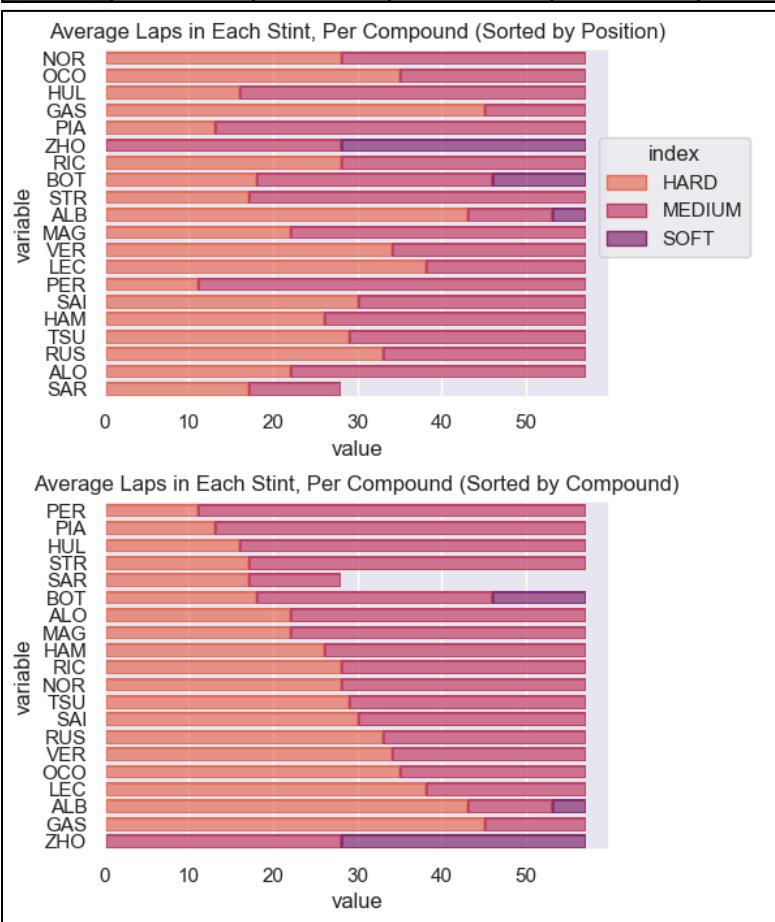


Insights

- Average lap times are fairly consistent throughout the race, regardless of stint
- Stint 1 sees approximately equal HARD / MEDIUM compound times, explaining the previous graph and Stint 1's high use of HARD compounds
 - SOFT compounds on stint 1 tend to see the worst times on average
 - **Observation:** Often we see SOFT tires being used by positions in the back of the race. It's possible SOFT tire users are being hamstrung by car adjacency at the beginning of the race
- Stint 2 sees pretty even average times, suggesting that HARD tires are likely the way to go because the small speed increase is not worth the durability tradeoff
- Stint 3 and 4 see only SOFT and MEDIUM tires being used, where they are generally faster than the first two stints
 - They are likely faster because there are fewer cars around and a more worn-in track

Miami Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	PitStops	PitTime	LapsDriven	TotalTime	Avg Time	Pos
NOR	1	22.052	57	1:28:13	0:01:35	1	HUL	2	23.08	57	1:31:31	0:01:36	11
VER	1	22.249	57	1:28:22	0:01:35	2	GAS	1	22.522	57	1:31:35	0:01:36	12
LEC	1	21.795	57	1:28:28	0:01:35	3	PIA	2	22.158	57	1:29:09	0:01:36	13
PER	2	21.742	57	1:31:05	0:01:36	4	ZHO	1	23.025	57	1:31:40	0:01:36	14
SAI	1	23.091	57	1:31:01	0:01:36	5	RIC	1	22.635	57	1:31:41	0:01:37	15
HAM	1	22.135	57	1:31:06	0:01:36	6	BOT	2	23.696	57	1:31:42	0:01:37	16
TSU	1	22.233	57	1:31:16	0:01:36	7	STR	2	23.015	57	1:31:35	0:01:36	17
RUS	1	22.848	57	1:31:25	0:01:36	8	ALB	2	22.68	57	1:32:06	0:01:37	18
ALO	1	22.358	57	1:31:27	0:01:36	9	MAG	3	23.29	57	1:31:45	0:01:37	19
OCO	1	22.743	57	1:31:30	0:01:36	10	SAR	1	99	28	0:43:04	0:01:36	99



Insights

- Most drivers chose to do just one pit stop, 6 chose to do 2, and one (MAG) did 3
- SAR was DNF this race after a collision on lap 29
- The average time was +- 1 second this race, which is tighter than usual
- Driver compound usage was all over the place this race
 - Generally, SOFT tire compounds did not do as poorly as they tend to do. SOFT tires saw usage in position 6, 8, and 10.
- Top drivers tended to use about half HARD, half MEDIUM compounds
 - As did most drivers, actually
- Observation:** This race sees less individual tire strategy and more driving skill than other races

Miami Grand Prix - Team Data

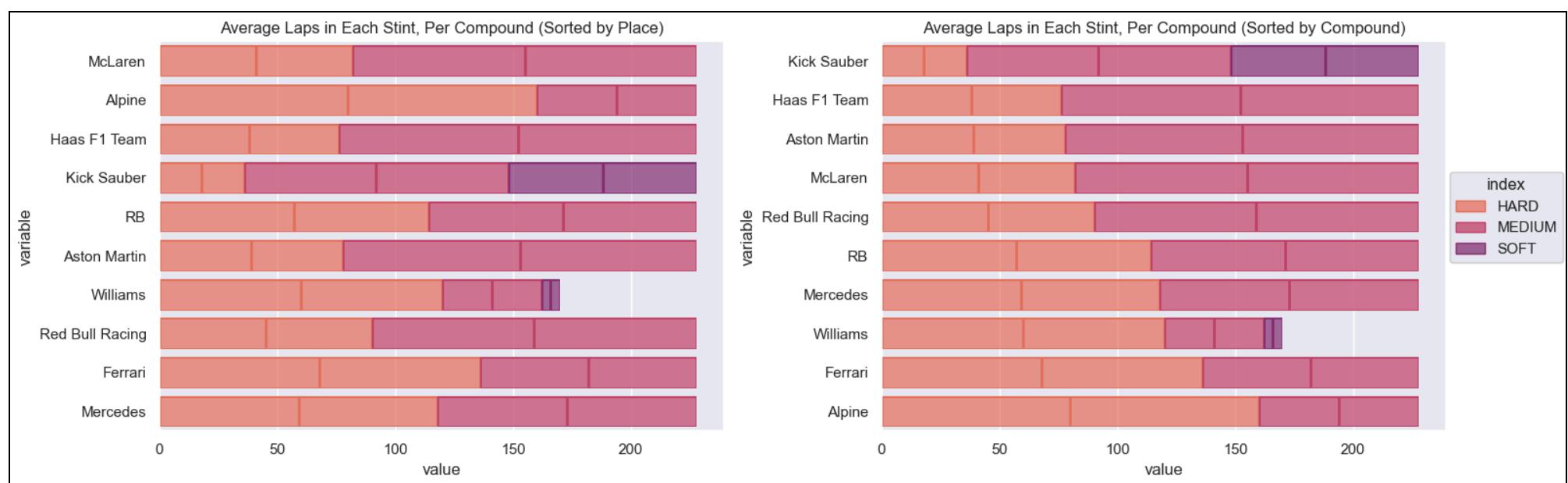
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Williams	2	3	45.126	57	2:15:10	0:01:37
McLaren	2	3	74.46	57	2:57:22	0:01:35
Red Bull Racing	2	3	66.509	57	2:59:27	0:01:35
Ferrari	2	2	44.886	57	2:59:29	0:01:35
Mercedes	2	2	44.983	57	3:02:31	0:01:36
RB	2	2	44.868	57	3:02:57	0:01:36
Aston Martin	2	3	68.034	57	3:03:02	0:01:36
Alpine	2	2	45.265	57	3:03:04	0:01:36
Haas F1 Team	2	5	129.219	57	3:03:15	0:01:36
Kick Sauber	2	3	69.506	57	3:03:22	0:01:37

Insights

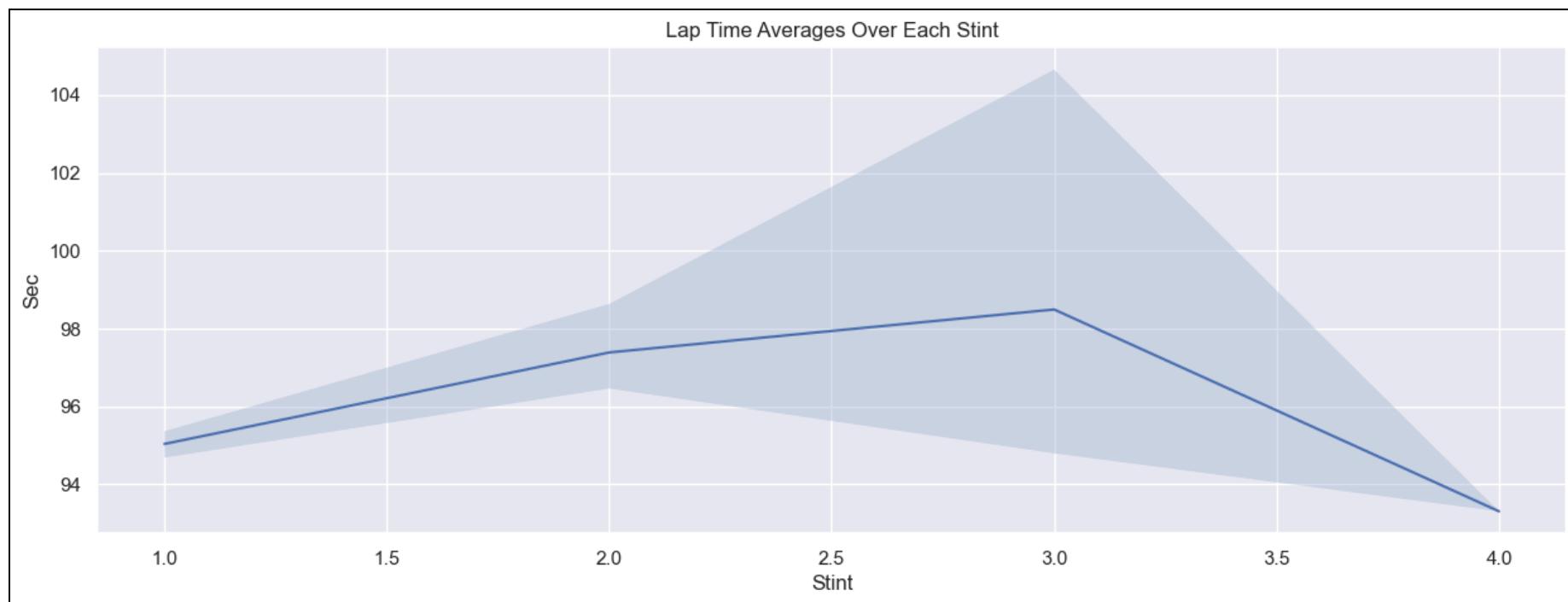
- Haas F1 had 5 pit stops, more than all other teams this race
- Average lap time was very consistent between all teams
- All teams had at least one finisher, most had two finishers

Insights

- The tire types becomes even more chaotic when viewed at the team level
 - A $\frac{1}{3}$ to $\frac{2}{3}$ HARD / MEDIUM representation (or vice versa) seemed to be the standard proportion this race
 - As mentioned earlier, compound type did not have nearly as clear of a priority and was likely less important than other races



Miami Grand Prix - Lap Time Averages

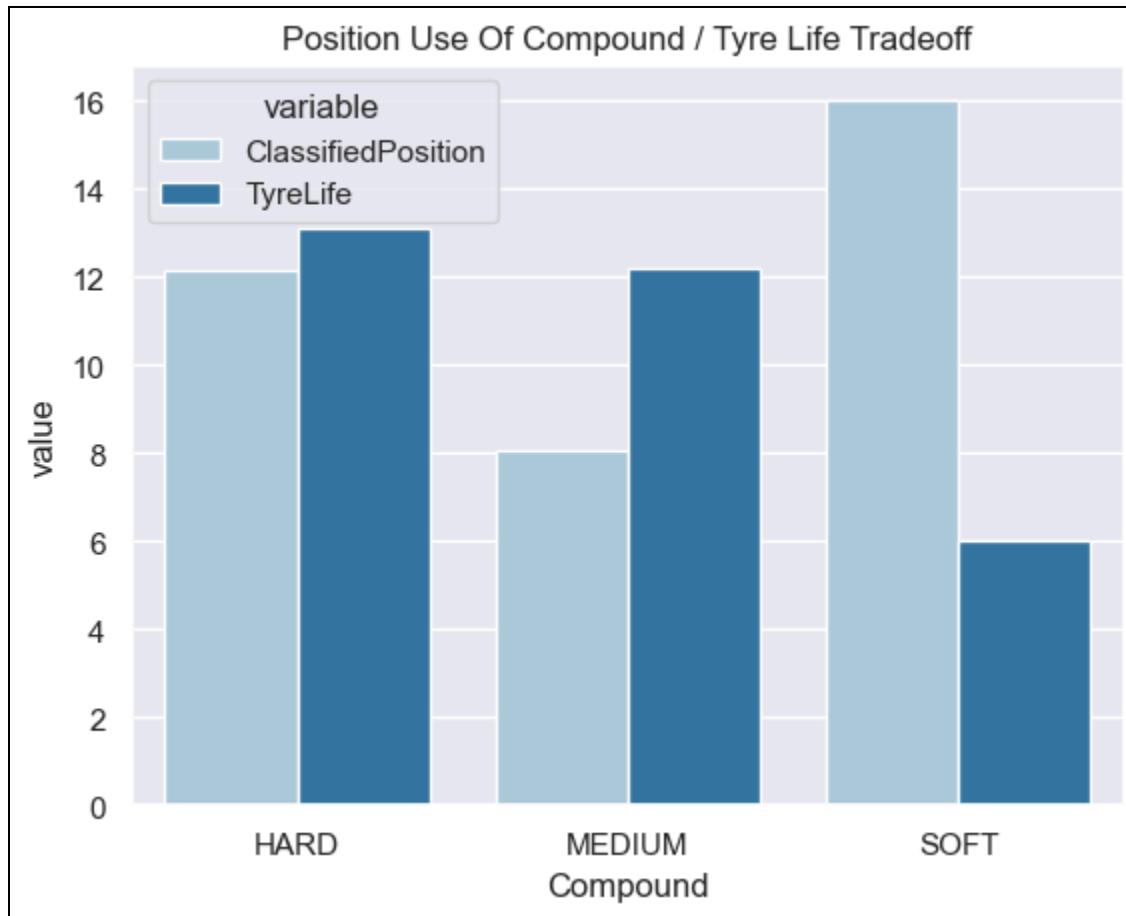


Insights

- Stint 1 > 2 saw a steady increase in times, but was interrupted by the safety car, and from there we see a wide variety of times as drivers went in and out of the pit
- More than usual, the safety car triggered a lot of pit stops which further added to the confusion and time discrepancy

Miami Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

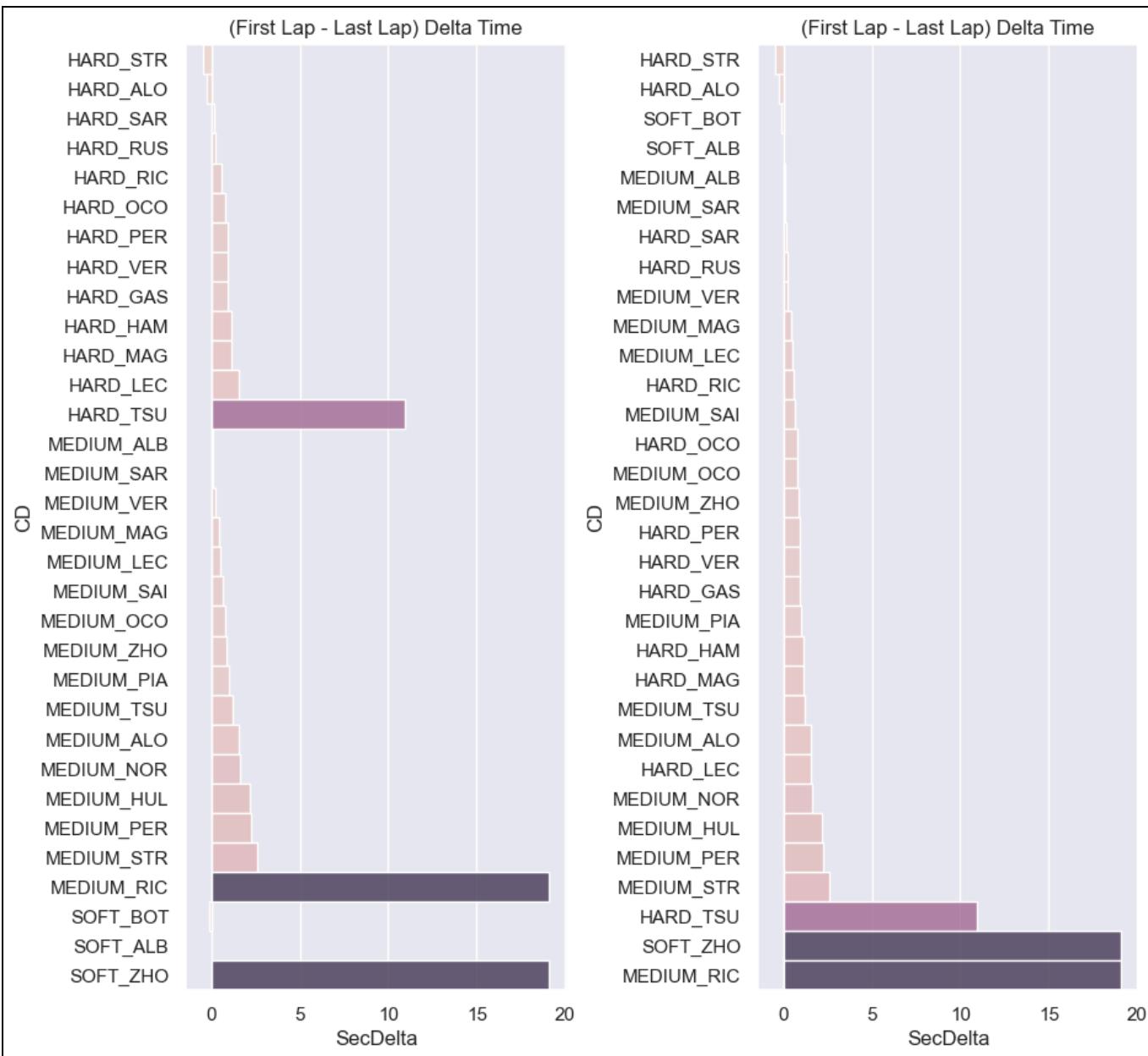
Compound	Position	ClassifiedPosition	TyreLife
HARD	12.5918	12.1633	13.1122
MEDIUM	7.0969	8.0588	12.1938
SOFT	18.0909	16	6



Insights

- Those that used HARD tires saw an increase in position by about 0.5
- MEDIUM tire users saw a decrease in about 1 place over the course of the race
 - While MEDIUM tires saw a decrease, they still resulted in an overall higher absolute final position relative to other compounds
- Drivers gained 3 positions on average when they started with SOFT tires
 - We see a pattern emerge between races where drivers positioned in the back tend to start with SOFT tires more often than those in the front
- **Observation:** Tire life tradeoff was less than one lap on average between HARD and MEDIUM tires. With the durability difference being about the same, it would have been smart to lean more heavily into MEDIUM tires this race
 - This tire strategy was modified by the presence of the safety car

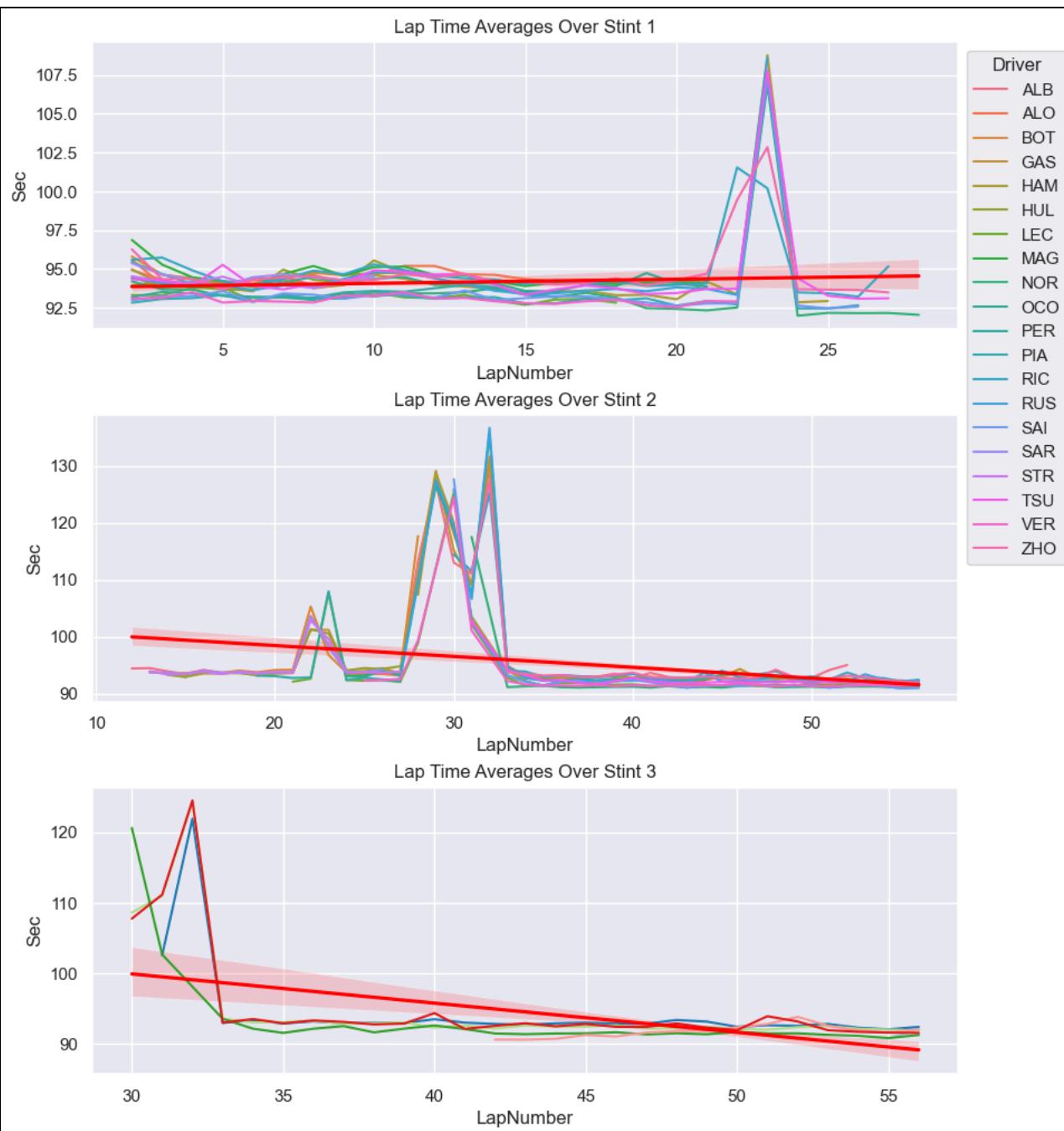
Miami Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- HARD, MEDIUM, and SOFT compounds saw a negative lap split across the board
- ZHO (soft) and RIC (medium) had the highest time saving deltas at a nearly -20 second split, and TSU (hard) also had a significant negative split at -11 seconds
- Most other compounds present has a negative split anywhere between -0.2 and -3 seconds
- The only positive splits were nearly inconsequential with STR, ALO, and BOT using HARD and SOFT tires

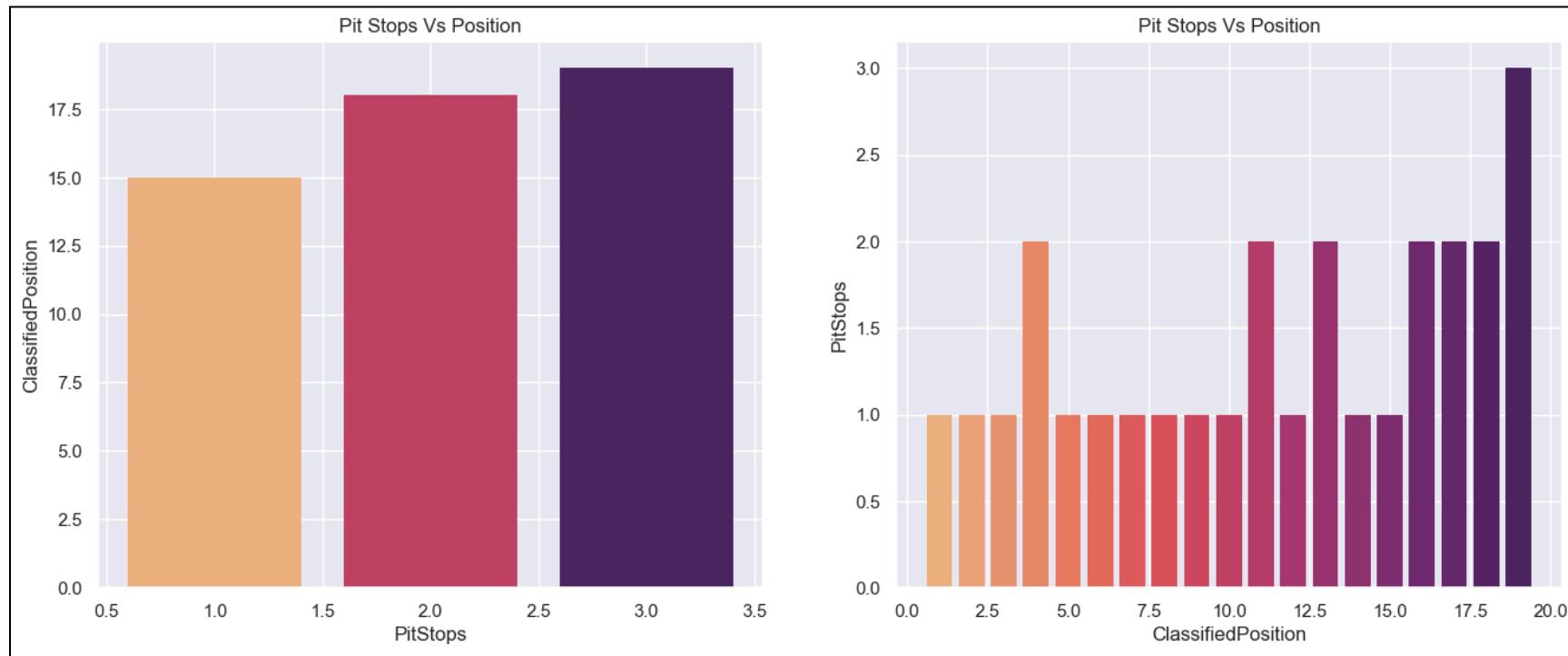
Miami Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- During Stint 1, lap times saw a steady decrease until the safety car
- Stint 2 and 3, outside of the large spikes in lap time data caused by the safety car, also saw a slight downward slope within each stint
- Stint 3 was under represented since most drivers only had one pit stop

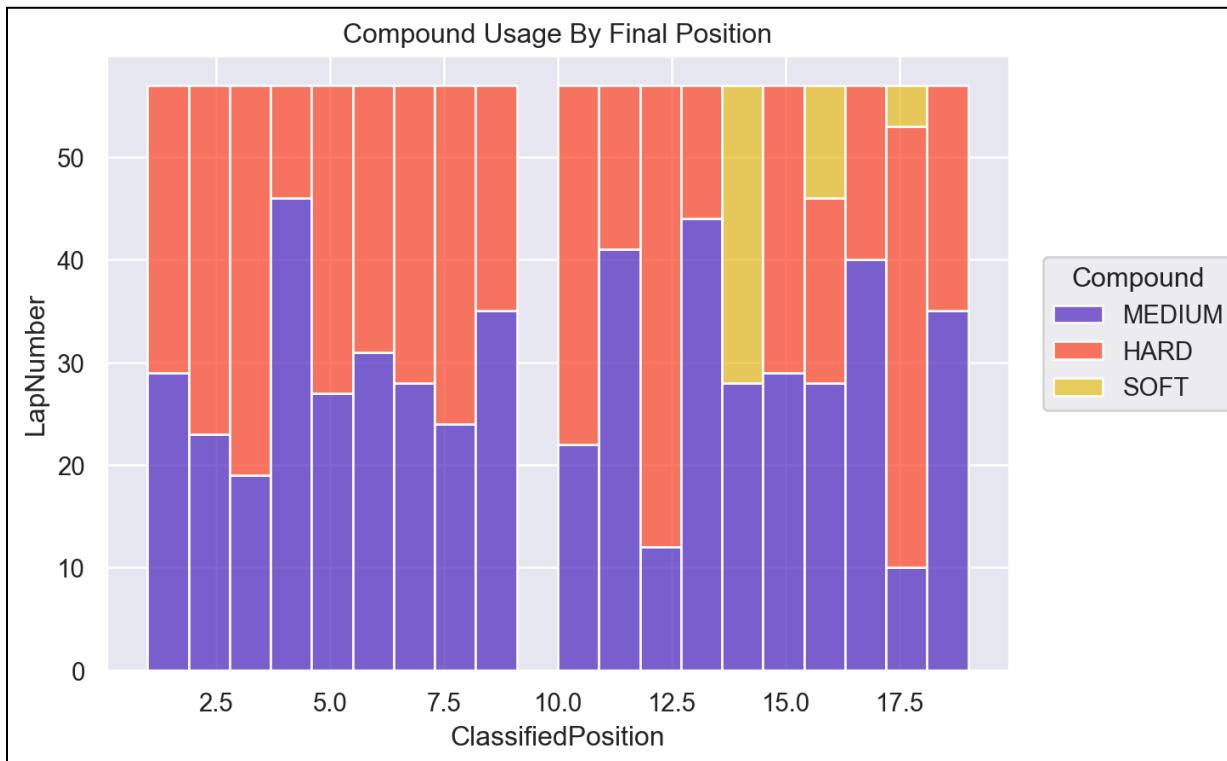
Miami Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Pit stops versus final position doesn't often have a strong correlation. In this case that is still generally true, although we see a general trend of higher scoring positions having fewer pit stops

Miami Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- We see an approximately even representation of tire compounds between HARD and MEDIUM for the top 10 drivers
- Position 1 had nearly perfect half / half usage of these two compounds
- SOFT tires are represented in the back half of the race, position-wise
- Observation:** Generally the tire strategy for this race seems to be less important, although the SOFT compound usage aligns with what we've seen historically: Drivers that start at the back tend to benefit from using SOFT tires, and those at the front benefit from using higher durability tires

Emilia Romagna Grand Prix - Basic Statistics

Teams

Alpine	OCO, GAS
Aston Martin	STR, ALO
Ferrari	LEC, SAI
Haas F1 Team	HUL, MAG
Kick Sauber	BOT, ZHO
McLaren	NOR, PIA
Mercedes	HAM, RUS
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	SAR, ALB

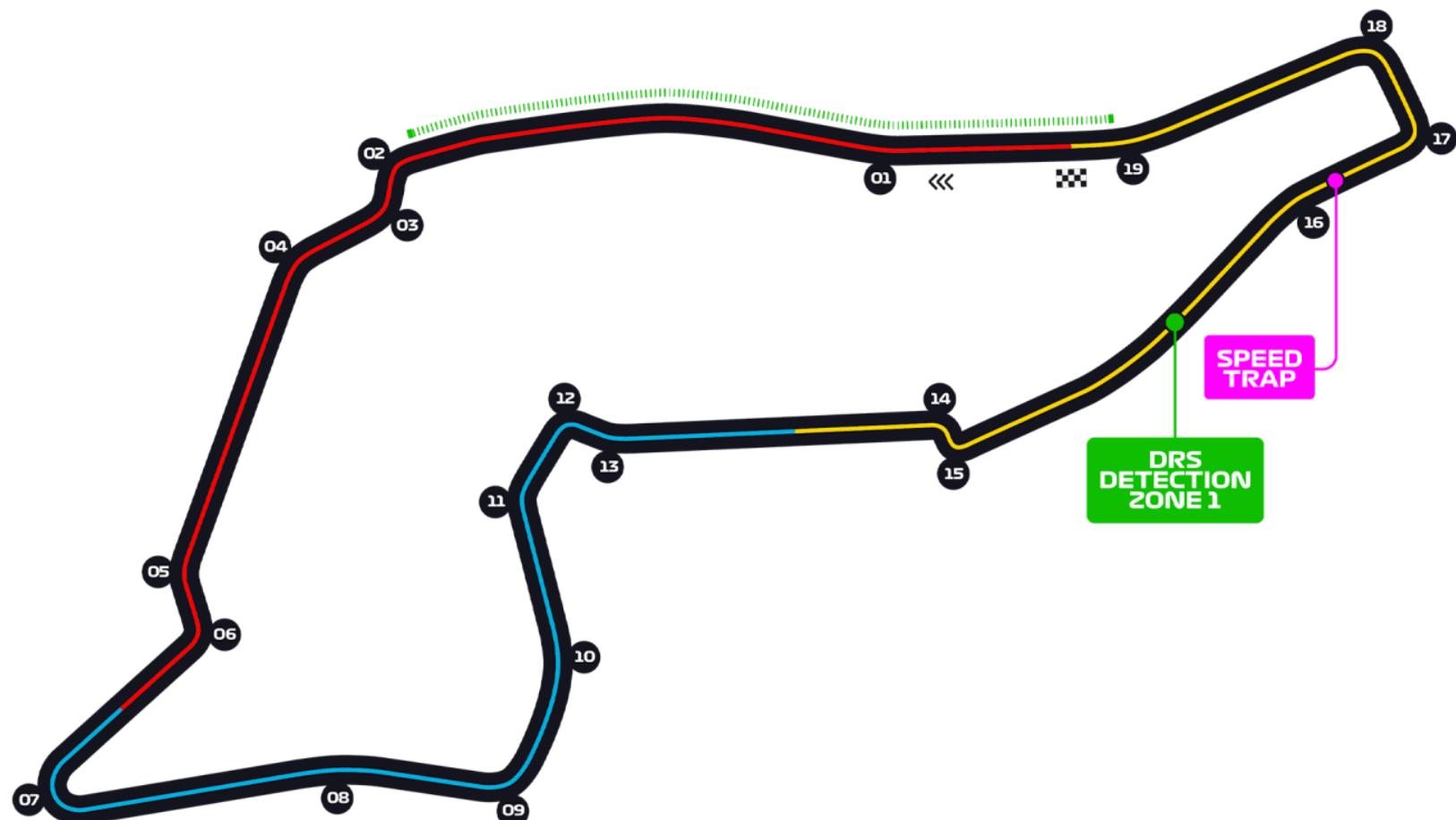
Total Statistics

Pit Stops	27
Pit Time	00:13:17
Laps Completed	1238
Lap Time	1 days 04:24:44
Race Laps	63
Compounds	[MEDIUM, HARD, SOFT]

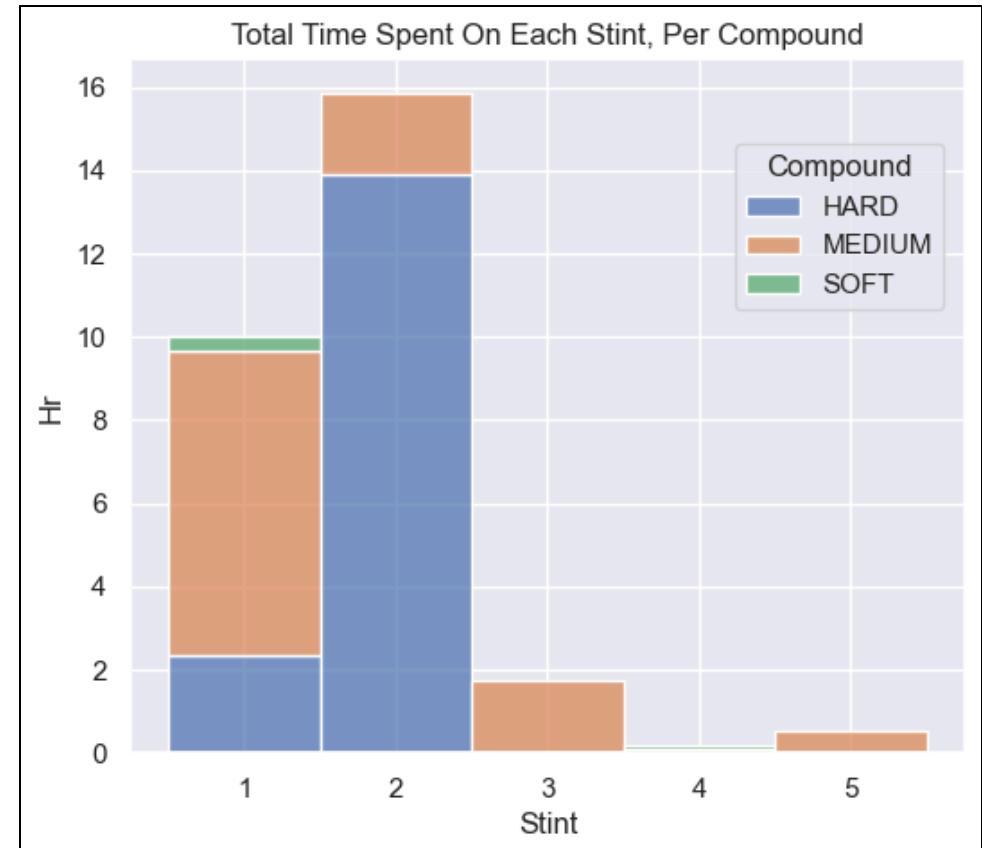
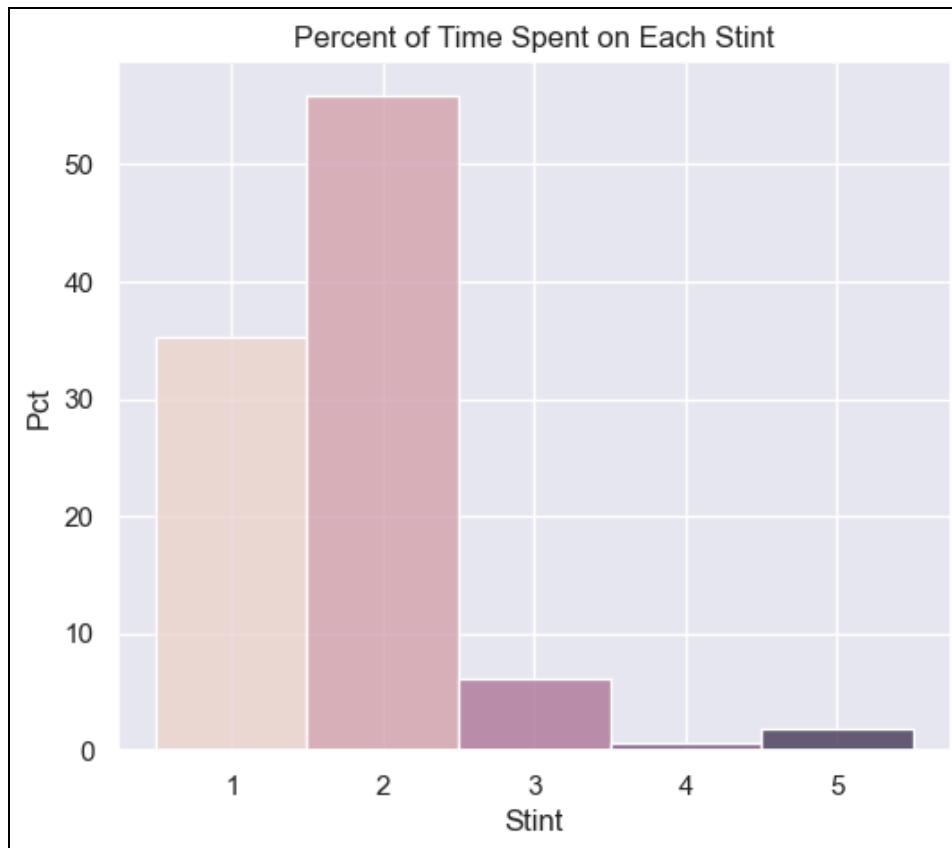
Average Statistics

Pit Stops	1.35
Pit Time	36.946
Laps Completed	61.9000
Lap Time	0:01:23

[Emilia Romagna Grand Prix Link](#)



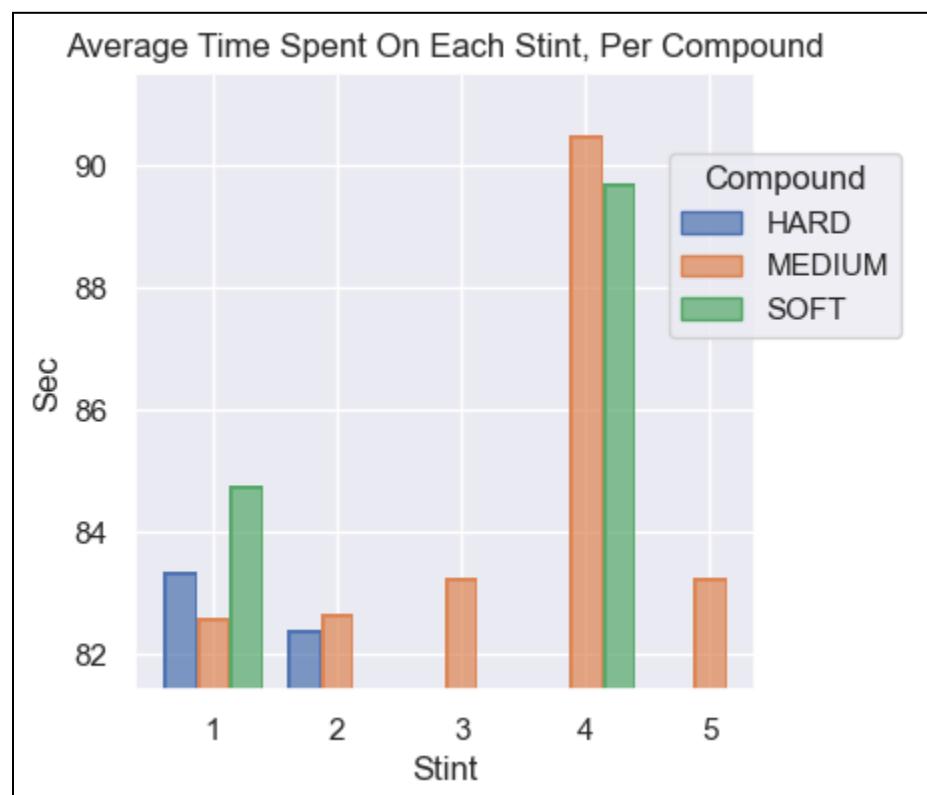
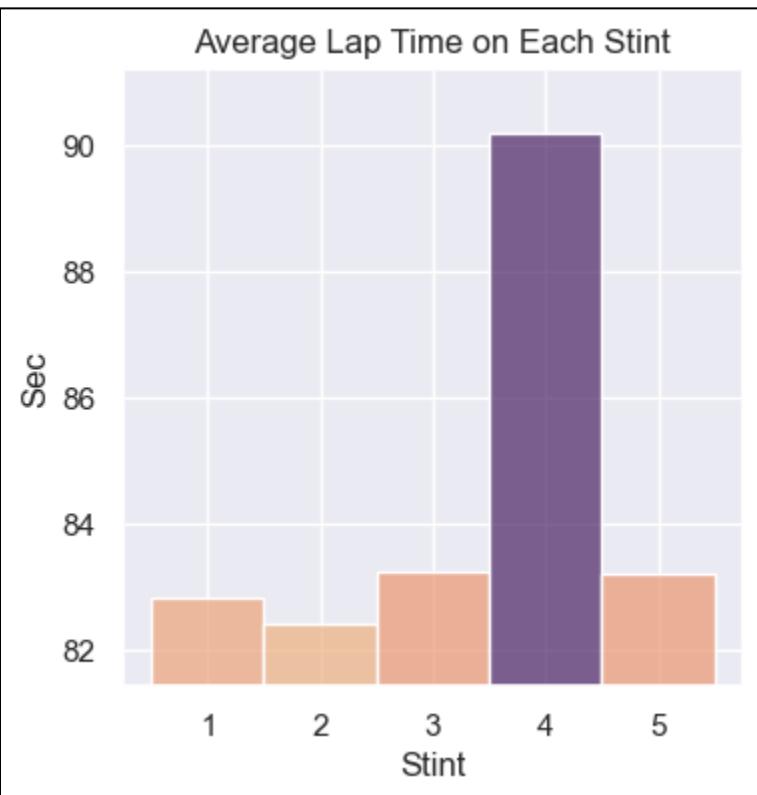
Emilia Romagna Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stints 1 and 2 see the highest total time in this race
- Usually we only see one under-represented stint (the last stint) but here we have three - stint 3,4,5
 - Likely, one or more drivers had some technical issue and required many more pitstops than normal
 - This driver (ALO) did not drive a lot in stint 4 before finishing the race in stint 5
- They chose to use MEDIUM tires for the duration of the race after stint 2
- Stint 1 saw mostly MEDIUM compound usage and a little bit of HARD tire representation (about 1:5 ratio)
- Stint 2 saw a much higher use of HARD compounds, as expected
 - This race has many straightaways which tend to be good for HARD compounds, hence the split between MEDIUM and HARD tires in the first two stints
- SOFT tires saw minimal use this race, only in the first stint

Emilia Romagna Grand Prix - Average Lap Time Per Stint / Per Compound



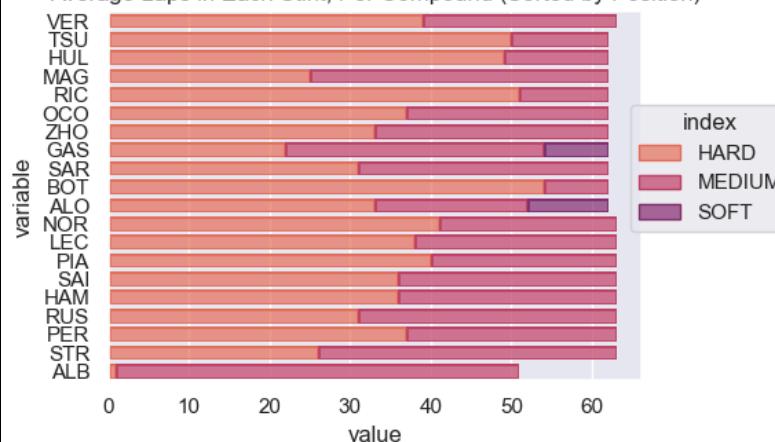
Insights

- Stints 4 and 5 are under-represented and mostly only driven by ALO and ALB
- As we've seen in other races, MEDIUM compounds tend to be the highest performing tires in stint 1, followed by HARD tires, followed by SOFT
 - **Observation:** This is backwards from common understanding and is affected more by car adjacency in the beginning of the race, than it is pure tire performance. In a vacuum, SOFT beats MEDIUM beats HARD, for speed and acceleration
- Tire compounds performed approximately equally between the first three stints, on average

Emilia Romagna Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	LapsDriven	TotalTime	Avg Time	Pos
VER	1	30.289	63	1:25:25	0:01:21	1	HUL	1	29.807	62	1:25:51	0:01:23	11
NOR	1	29.843	63	1:25:26	0:01:21	2	MAG	1	31.311	62	1:25:52	0:01:23	12
LEC	1	30.232	63	1:25:33	0:01:21	3	RIC	1	30.128	62	1:25:53	0:01:23	13
PIA	1	29.721	63	1:25:39	0:01:22	4	OCO	1	30.67	62	1:26:09	0:01:23	14
SAI	1	30.464	63	1:25:48	0:01:22	5	ZHO	1	30.2	62	1:26:10	0:01:23	15
HAM	1	29.603	63	1:26:00	0:01:22	6	GAS	2	30.119	62	1:26:15	0:01:23	16
RUS	2	29.767	63	1:26:12	0:01:22	7	SAR	1	31.082	62	1:26:16	0:01:23	17
PER	1	29.571	63	1:26:20	0:01:22	8	BOT	1	30.274	62	1:26:22	0:01:24	18
STR	1	30.128	63	1:26:45	0:01:23	9	ALO	4	31.355	62	1:26:40	0:01:24	19
TSU	1	29.763	62	1:25:43	0:01:23	10	ALB	3	196.12	51	1:10:25	0:01:24	99

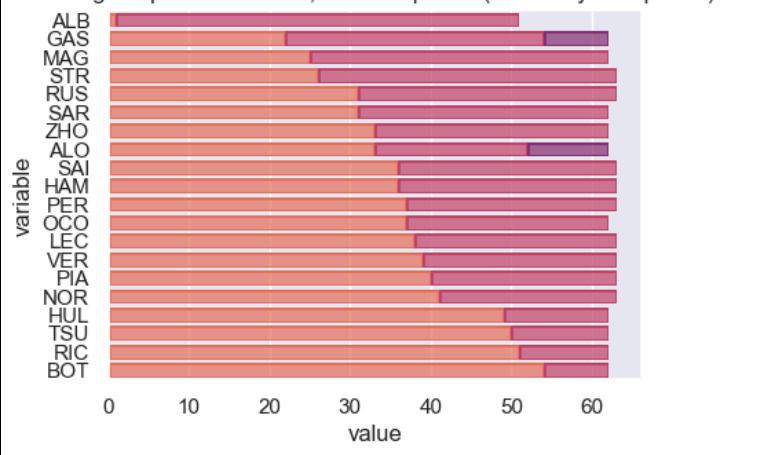
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- ALB was DNF this race at lap 51
- The driven laps are a little different (62 vs 63) due to sensor data on the cars being a little inconsistent with pit stops and what counts as a final "lap"
- Most drivers had 1 pit stop, two drivers had 2 (RUS / GAS) and ALO / ALB had 4 and 3, respectively
- Lap times averages were all within +/- 1 of each other, which for a race with so few turns is not uncommon
- Observation:** Top scoring drivers tended to use a higher proportion of HARD to MEDIUM tires, although this is not always true
- Observation:** Lower scoring drivers maintained closer to a half / half approach with MEDIUM / HARD tires

Average Laps in Each Stint, Per Compound (Sorted by Compound)

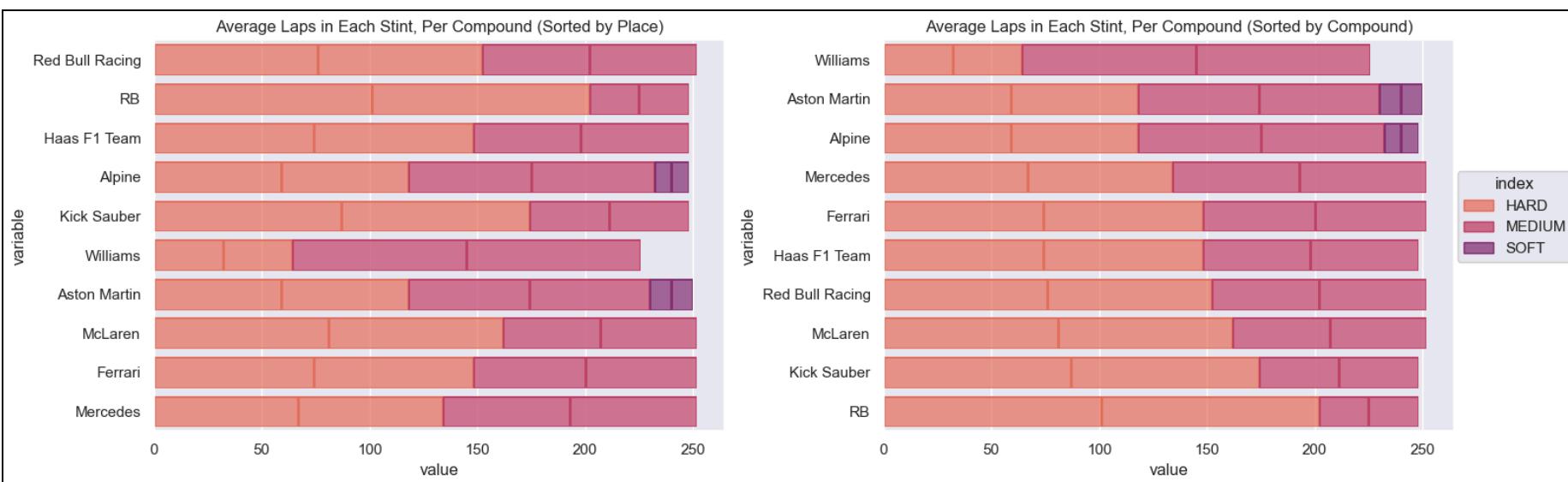


Emilia Romagna Grand Prix - Team Data

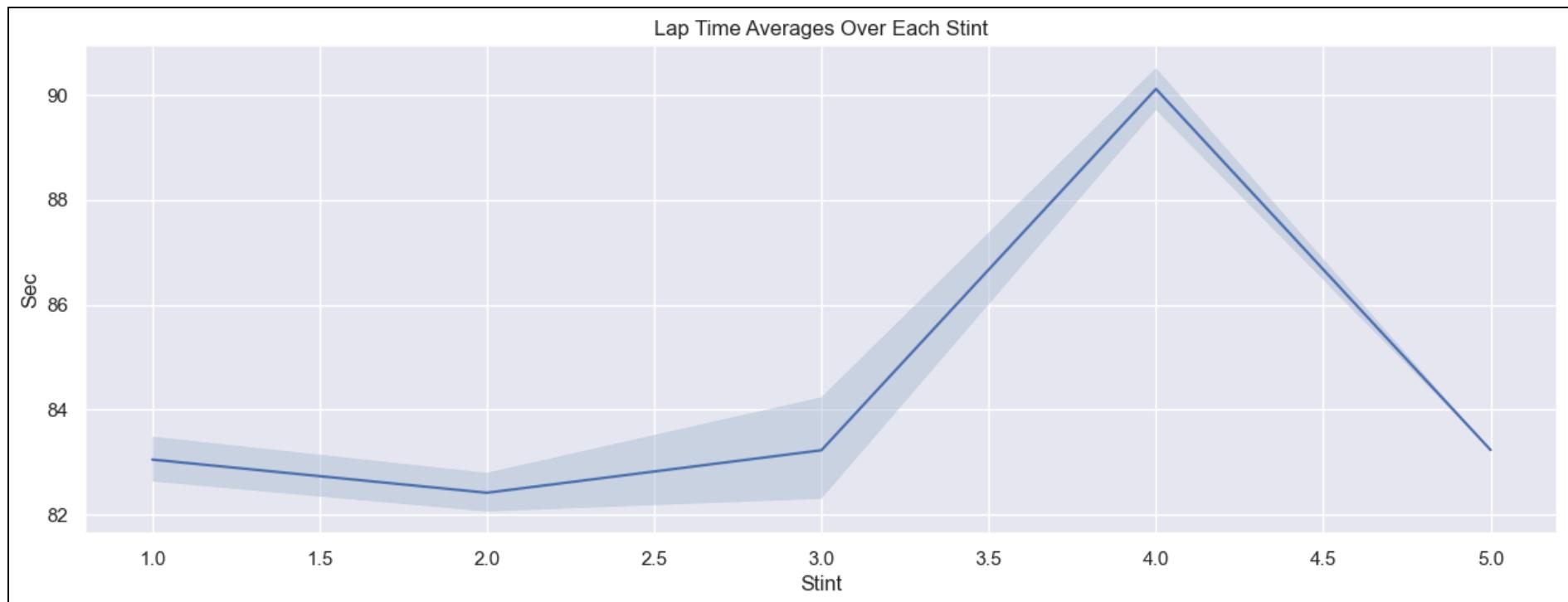
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Williams	2	4	296.679	51	2:36:41	0:01:24
McLaren	2	2	59.564	63	2:51:05	0:01:21
Ferrari	2	2	60.696	63	2:51:21	0:01:22
RB	2	2	59.891	62	2:51:36	0:01:23
Haas F1 Team	2	2	61.118	62	2:51:42	0:01:23
Red Bull Racing	2	2	59.86	63	2:51:45	0:01:22
Mercedes	2	3	89.077	63	2:52:13	0:01:22
Alpine	2	3	91.365	62	2:52:24	0:01:23
Kick Sauber	2	2	60.474	62	2:52:32	0:01:23
Aston Martin	2	5	121.898	62	2:53:25	0:01:23

Insights

- Williams and Aston Martin had the highest number of pit stops
- Williams was the only team that had a member DNF
- Average lap times were fairly consistent throughout this race
- The tire compound usage in this race was pretty even for everyone - most teams elected to use roughly half / half MEDIUM / HARD compounds with varying success
 - **Observation:** Tire compound choice may have been less important on this track than other races



Emilia Romagna Grand Prix - Lap Time Averages

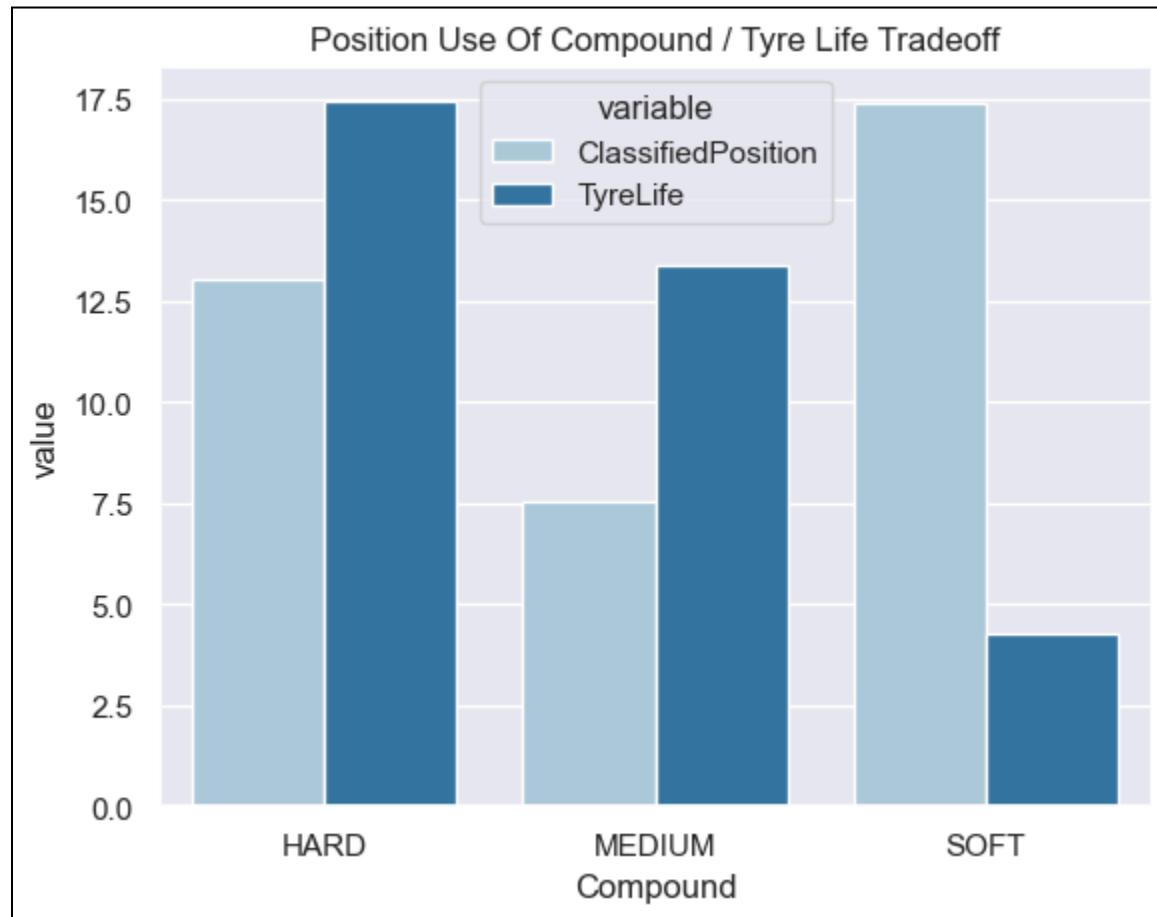


Insights

- Lap times increased steadily over the course of this race, if we include stint 4, which was only driven by two drivers
 - Stint 4 and 5 are under represented in this race
- Up to stint 3, there was a slight downturn and then a slight upturn in lap times
 - Likely due to the initial heavier use of MEDIUM compounds at the beginning of the race
 - We might expect to see worse times than recorded with HARD tire usage, but HARD tires benefit more from a worn in track and in stints 1 and 2, HARD tires were used more often

Emilia Romagna Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

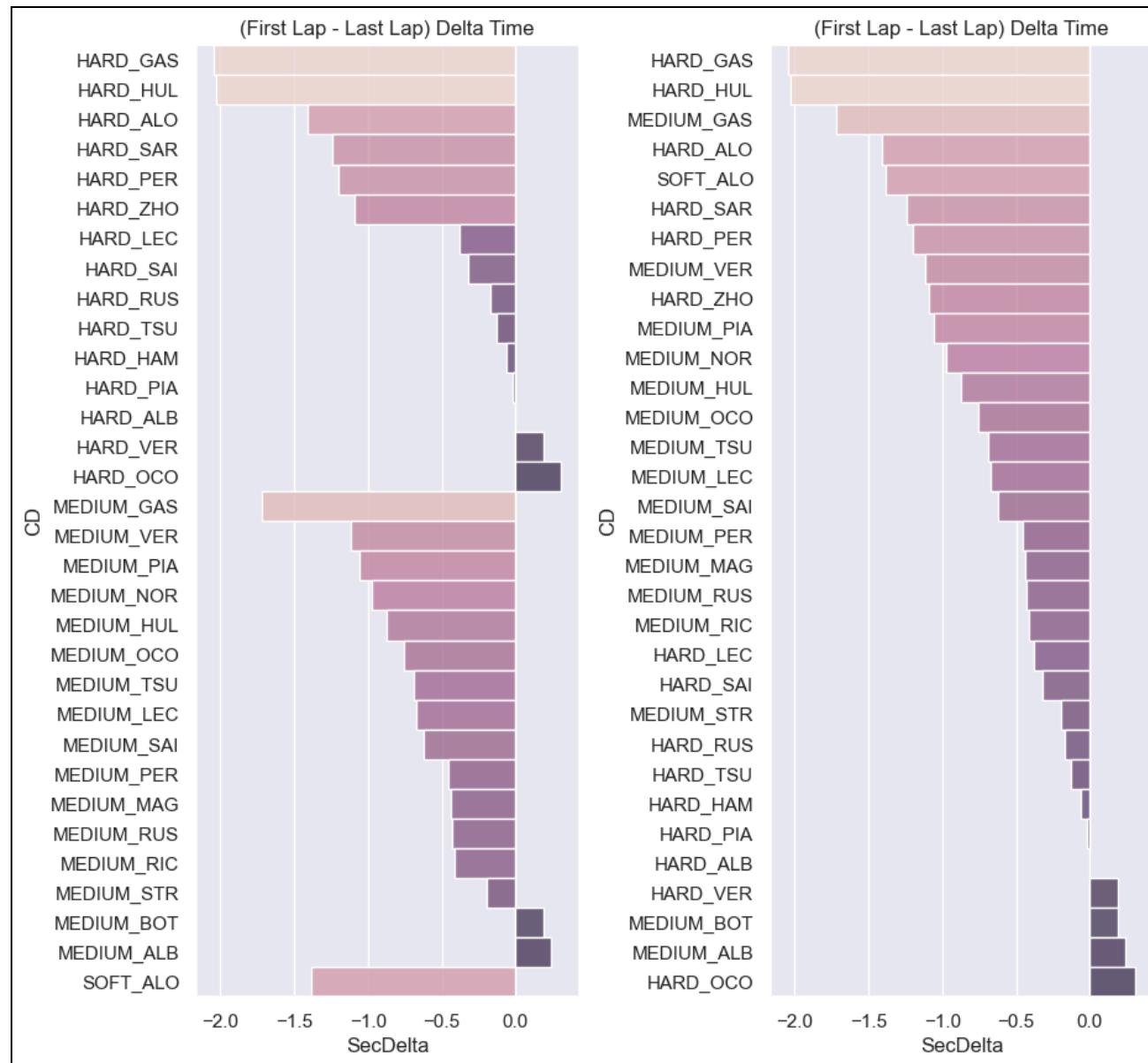
Compound	Position	ClassifiedPosition	TyreLife
HARD	12	13.0495	17.4257
MEDIUM	7.0897	7.5513	13.3974
SOFT	17.5333	17.4	4.2667



Insights

- Drivers that started the race with HARD tires tended to lose around 1 position
- Those that started with MEDIUM tires lost around 0.5 final positions
 - Although there is a loss in relative position, MEDIUM tires have the highest absolute position, correlating with the global trend of positional use of MEDIUM tires
 - The same can be said of SOFT tires, although in this case the increase was minimal (0.1 positions) with a significant decrease in tire durability
- **Observation:** Overall, MEDIUM tires seem to beat out HARD and SOFT tires in this race, although winning drivers did tend to use a higher proportion of HARD tires
 - Also, this relationship only describes the first stint (beginning tire) - **those that started with HARD tires tended to lose out to those who started with MEDIUM tires.** This does not describe the entire race

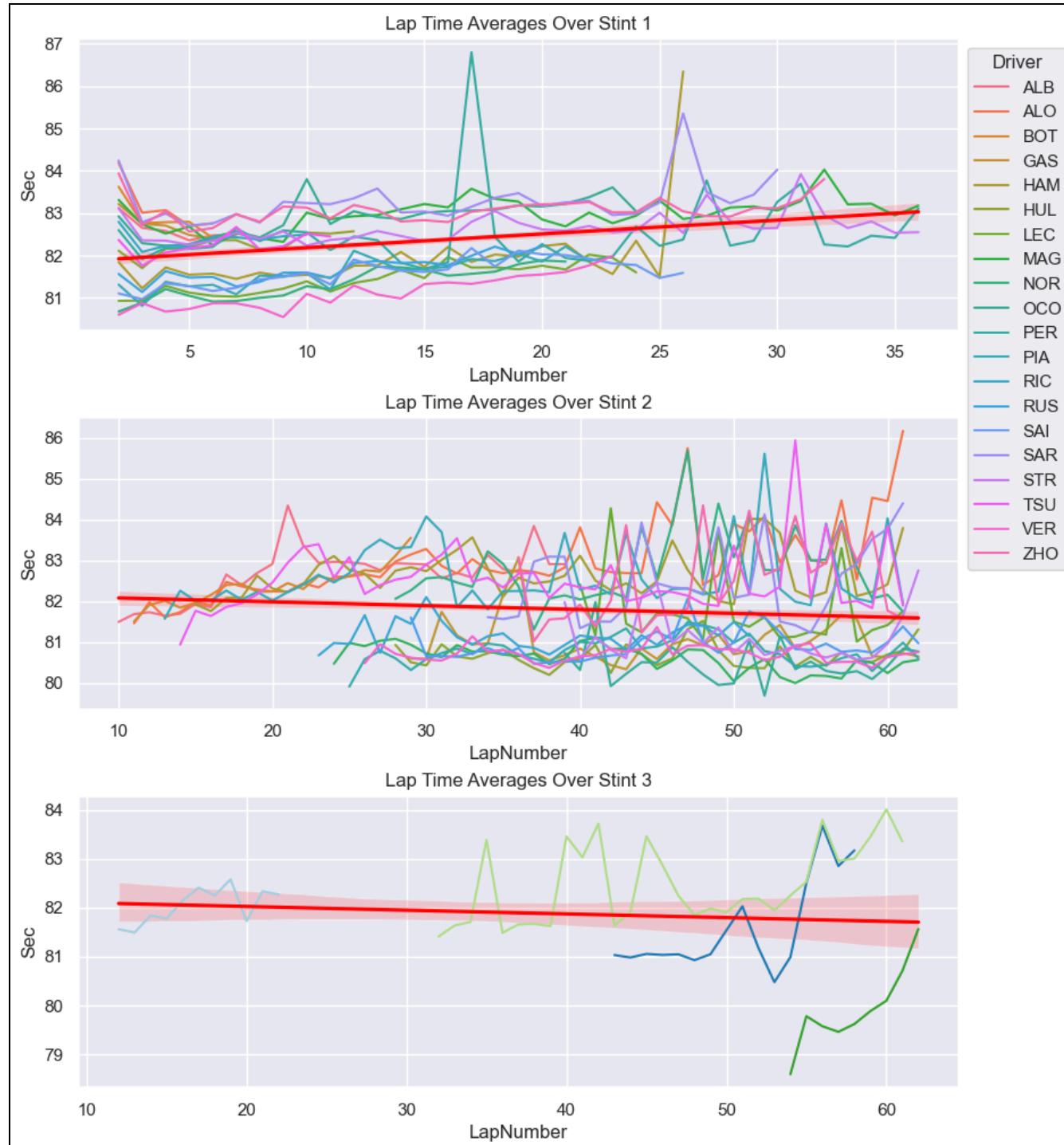
Emilia Romagna Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- Across the board, most drivers ended with a positive lap split except a few (BOT / ALB / OCO / VER) who came out with a slightly negative split (around -0.3s)
- Relatively speaking, **these times are actually fairly consistent** - over a 63 lap race with a lot of straightaways, **you won't expect to see very many significant gains in speed** because there is less car adjacency around tight turns
- It is interesting that we see so few negative splits, but this **might imply that tire choices are less important on this track than driving skill**, and none of the drivers were able to be consistent enough to have significant negative splits (or high positive splits - their positive splits are within +1.5s max, which is still pretty good)

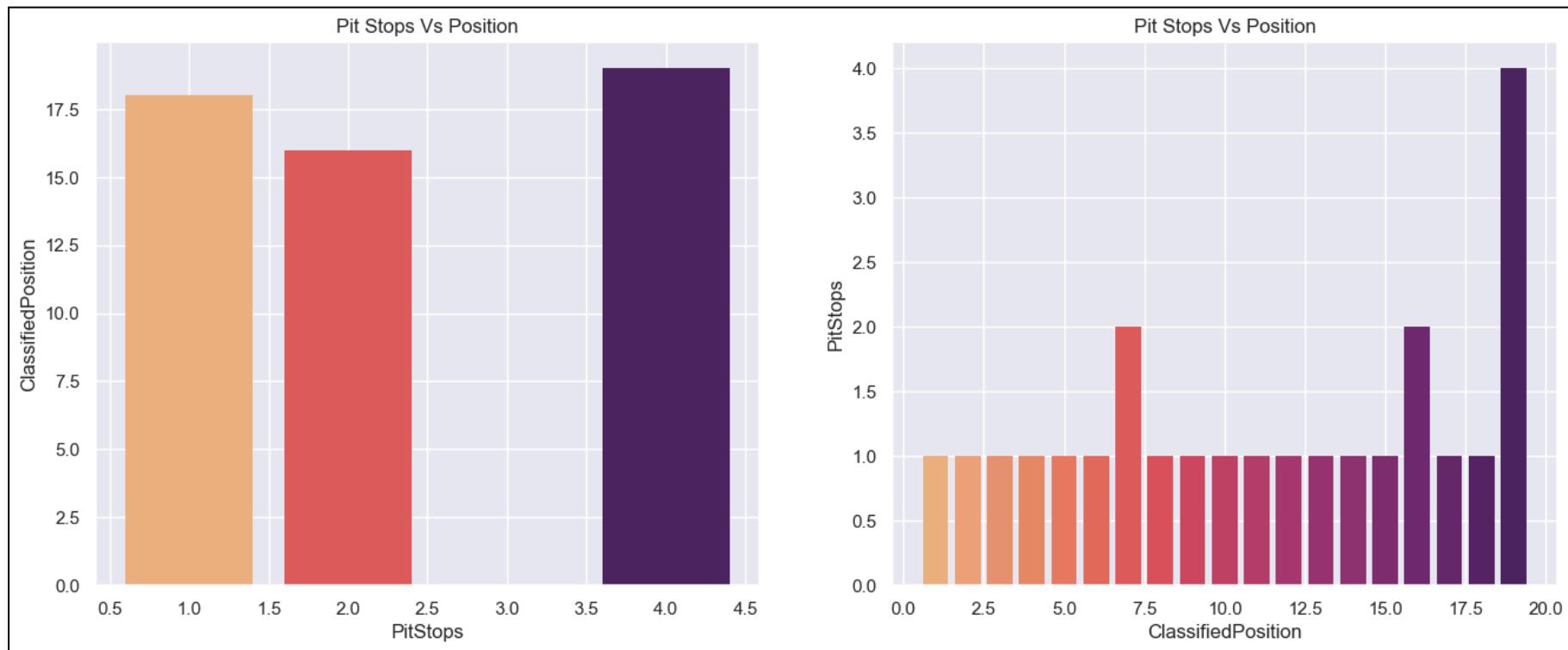
Emilia Romagna Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Stint 1 saw a general increase in lap split times. Usually we see either a neutral or negative slope
- The y-scale for this data is pretty tight - in Stint 2 we see a lot of spikes in lap time, but this lap time is easily explained by car adjacency and inconsistencies with driver lap times, individually
- Stint 3 is under-represented for this race with only a handful of drivers

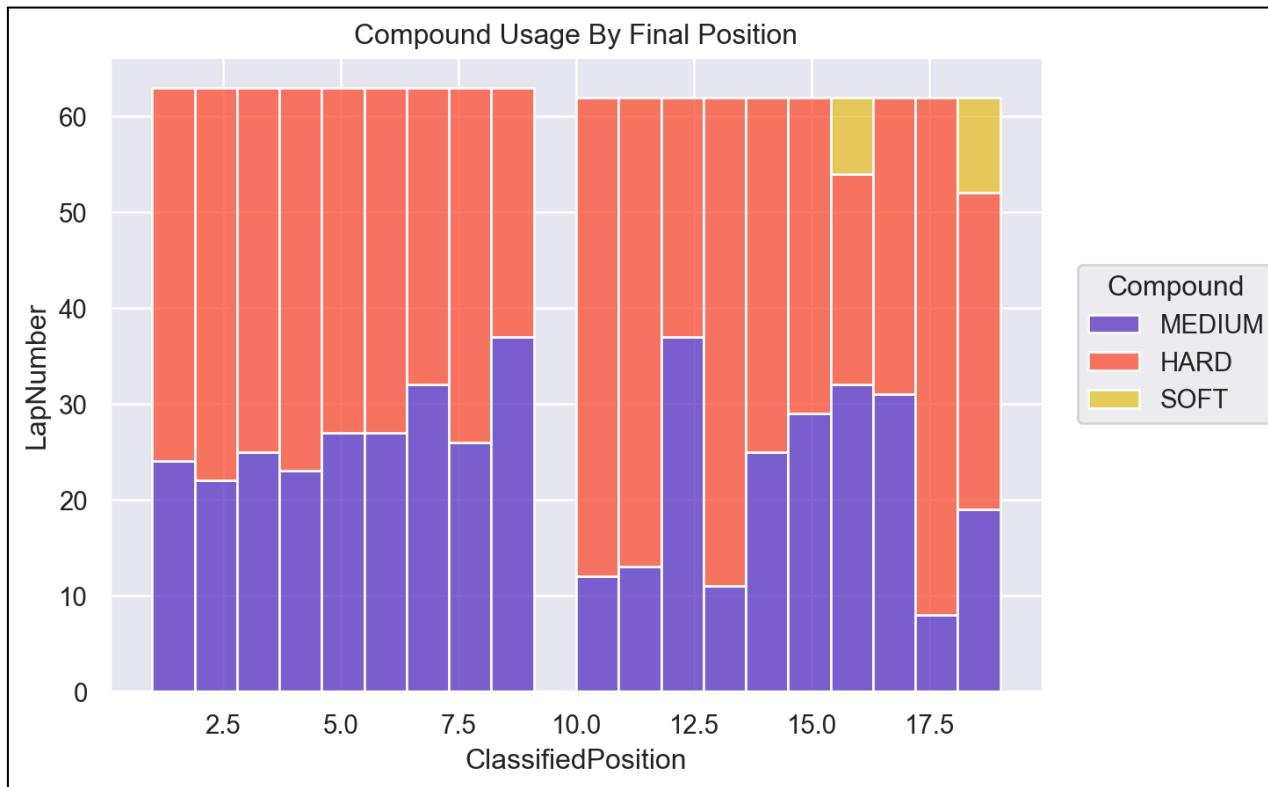
Emilia Romagna Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Interestingly, nobody had only three pit stops this race and either had 1, 2, or 4
- Besides the DNF driver (ALB), most drivers had mixed success driving with either 1 or 2 pit stops, although everyone tended to just have 1 pit stop

Emilia Romagna Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- The top positions had a very even mix of MEDIUM / HARD tire usage
- SOFT tires were represented by positions at the back of the race, like we normally see
- The even distribution of compound usage over all positions suggests that driver skill was the more important metric on this track than tire strategy

Monaco Grand Prix - Basic Statistics

Teams

Alpine	GAS, OCO
Aston Martin	STR, ALO
Ferrari	LEC, SAI
Haas F1 Team	HUL, MAG
Kick Sauber	BOT, ZHO
McLaren	NOR, PIA
Mercedes	HAM, RUS
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	ALB, SAR

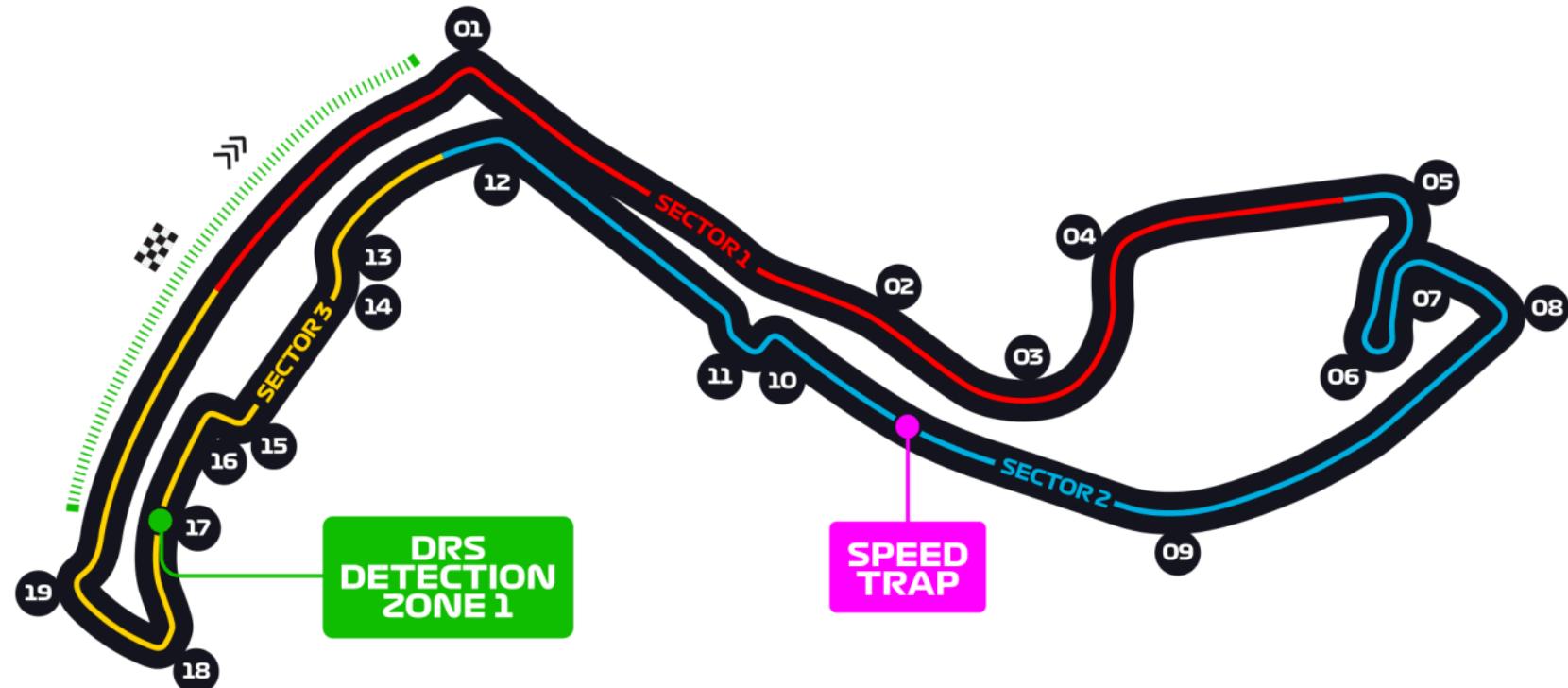
Total Statistics

Pit Stops	23
Pit Time	10:36:07
Laps Completed	1237
Lap Time	1 days 13:57:44
Race Laps	78
Compounds	[MEDIUM, HARD, SOFT]

Average Statistics

Pit Stops	1.4375
Pit Time	00:27:39
Laps Completed	61.8500
Lap Time	0:01:51

[Monaco Grand Prix Link](#)



Monaco Grand Prix - Foreword

This race was quite chaotic, per the description on F1:

The Lap 1 chaos came on the run out of Sainte Devote, as the Haas of Kevin Magnussen and the Red Bull of Sergio Perez - and then the second Haas of Nico Hulkenberg - all come together, putting all three drivers out on the spot.

There were a lot of crashes in this race, red flags were raised, and the race reset. As such the data for this race is a bit all over the place and there are some broader issues that are hard to analyze properly, like best tire compound usage (since that data is usually tied closely to pit stops and the pit stops in this race were messed up) or even things like, total track time.

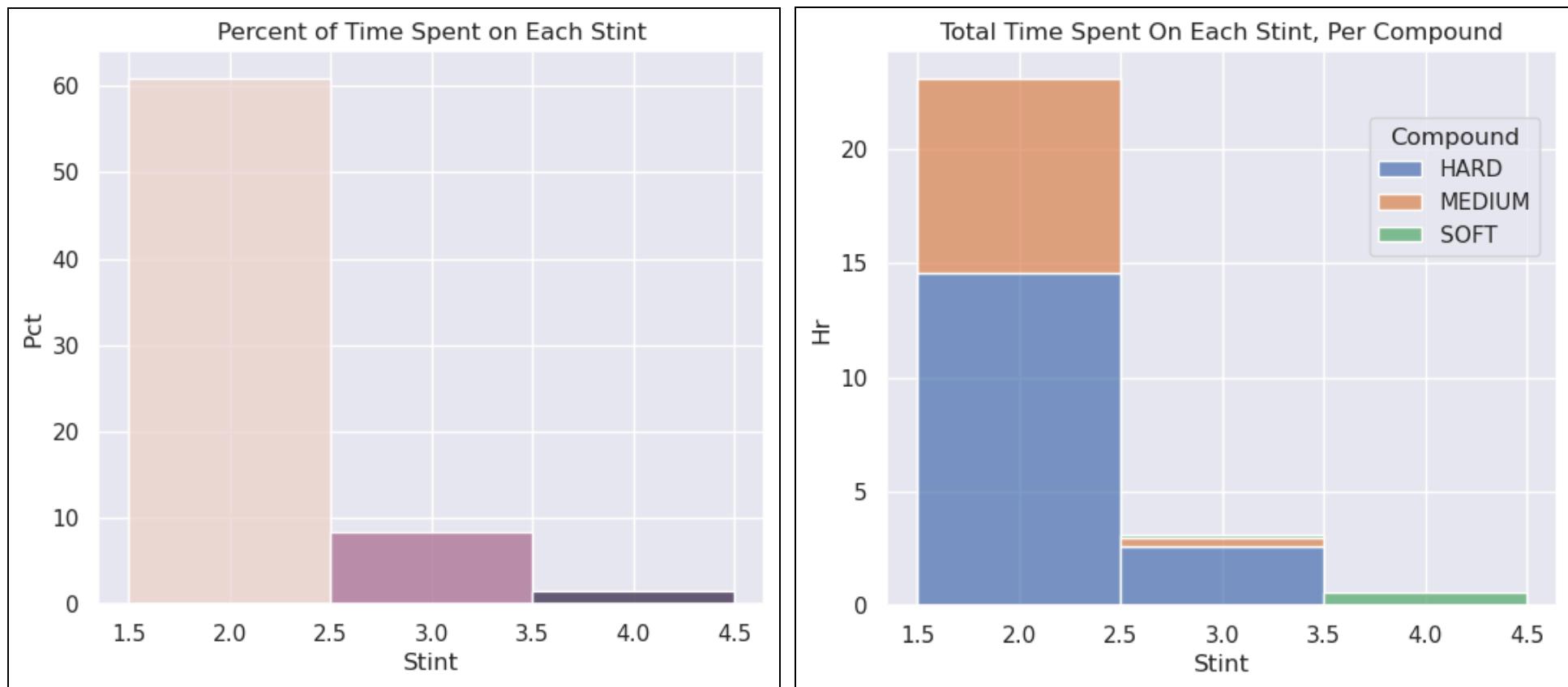
The sensors on the cars this race didn't delineate properly between laps and pit stops because so much was happening... this is not the fault of F1 or specific cars, just the nature of this race being quite chaotic. Usually when a race is hard-reset, the sensors are reset as well - some were in this case but I found difficulty doing proper analysis and realized that I'd need to spend a lot of time on this race specifically, which is out of scope for this project.

As such, some of the metrics will be **relative** instead of **absolute**; for example, the total time this race is measured comparatively, or the pit time has been normalized to values that are close together, instead of the real pit times each driver might have. We try to avoid this when we can, but this race had a lot of it.



(not my cat, enjoy)

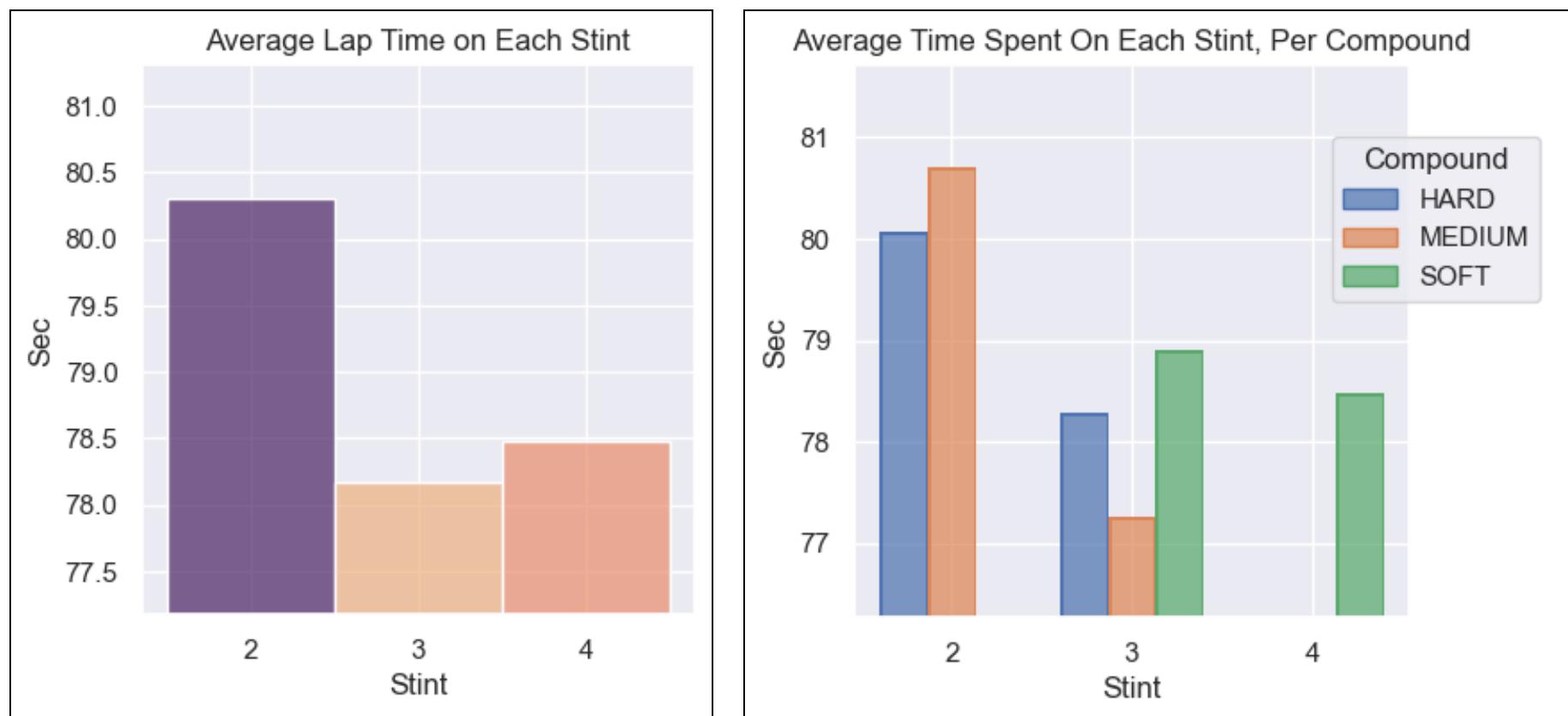
Monaco Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stint 2 and Stint 3 is where the majority of this race happens, with under-representation in Stint 4
- In this case, Stint 2 is really Stint 1 because of the race reset due to the crash
 - Usually we see a shorter Stint 1 and longer Stint 2, but here that pattern is reversed. Likely due to the chaotic nature of this race and drivers wanting to extend their time on HARD tires as much as they can

Monaco Grand Prix - Average Lap Time Per Stint / Per Compound



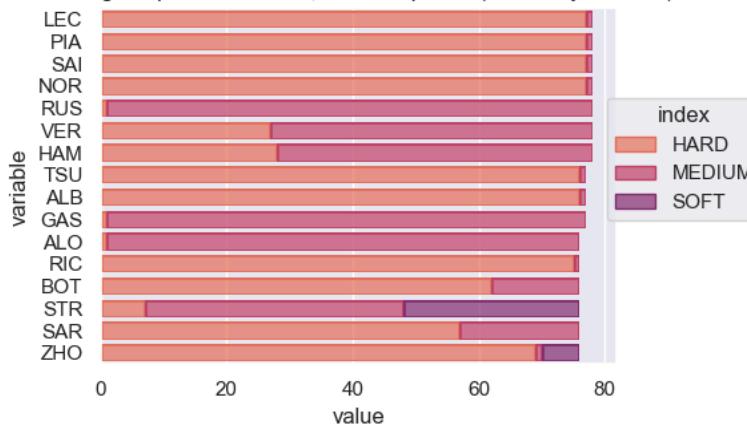
Insights

- Stint 1 is cut from this visualization due to the crash that occurred at the beginning of the race, resulting in abnormally high pit / lap times, and ended with a reset
- Stint 2 sees a typical higher lap time average than other stints, likely due to car adjacency
- While stints 3 and 4 are under represented, they also follow similar patterns of having a smaller average lap time than the "first" stint
- We see SOFT compound usage in stint 3 and 4, which is a little slower on average than other compounds
 - This is affected by driver position since most SOFT tire users are in the back half of the race

Monaco Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
LEC	1	57.749	78	2:20:18	0:01:49	1	ALO	1	89.249	76	2:23:19	0:01:53	11
PIA	1	57.441	78	2:20:27	0:01:49	2	RIC	1	85.475	76	2:23:20	0:01:53	12
SAI	1	26.813	78	2:20:30	0:01:49	3	BOT	2	118.1	76	2:23:20	0:01:53	13
NOR	1	65.334	78	2:20:37	0:01:50	4	STR	3	135.57	76	2:23:22	0:01:53	14
RUS	1	69.483	78	2:20:47	0:01:50	5	SAR	2	115.809	76	2:23:25	0:01:53	15
VER	2	96.145	78	2:20:52	0:01:50	6	ZHO	2	110.965	76	2:24:11	0:01:54	16
HAM	2	99.234	78	2:20:58	0:01:50	7	OCO	0	0	1			99
TSU	1	77.337	77	2:23:55	0:01:52	8	PER	0	0	1			99
ALB	1	81.054	77	2:24:10	0:01:52	9	HUL	0	0	1			99
GAS	1	81.591	77	2:24:16	0:01:52	10	MAG	0	0	1			99

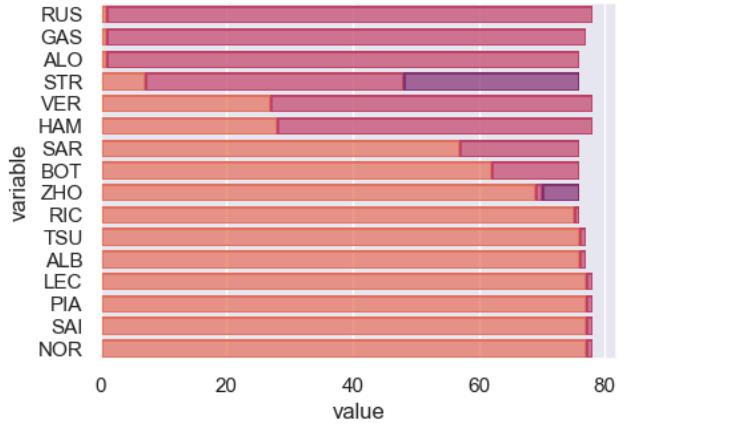
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- OCO, PER, HUL, MAG were all DNF due to crashes on the track
 - **Observation:** More often than not, some Formula 1 drivers get professional racing vehicles confused with six flags bumper cars
- Laps driven are usually within +- 1 lap due to car sensor inconsistencies but in this data they are +- 2. This isn't really important as all drivers except the last 4 finished the race as expected, just a data quirk.
- Overwhelmingly, most drivers (especially those in top 4) used HARD tires and minimal MEDIUM tires
 - Likely the MEDIUM tire usage was the 1 lap before the crash and everything after that was HARD
 - **Observation:** The crash occurred on lap 1, resulting in a reset. Why not continue using MEDIUM tires for what is essentially the "first" stint, instead of doing HARD tires the rest of the time? Evidently this strategy works just fine, as we see those with higher MEDIUM compounds fall behind in this race.

Average Laps in Each Stint, Per Compound (Sorted by Compound)



Monaco Grand Prix - Team Data

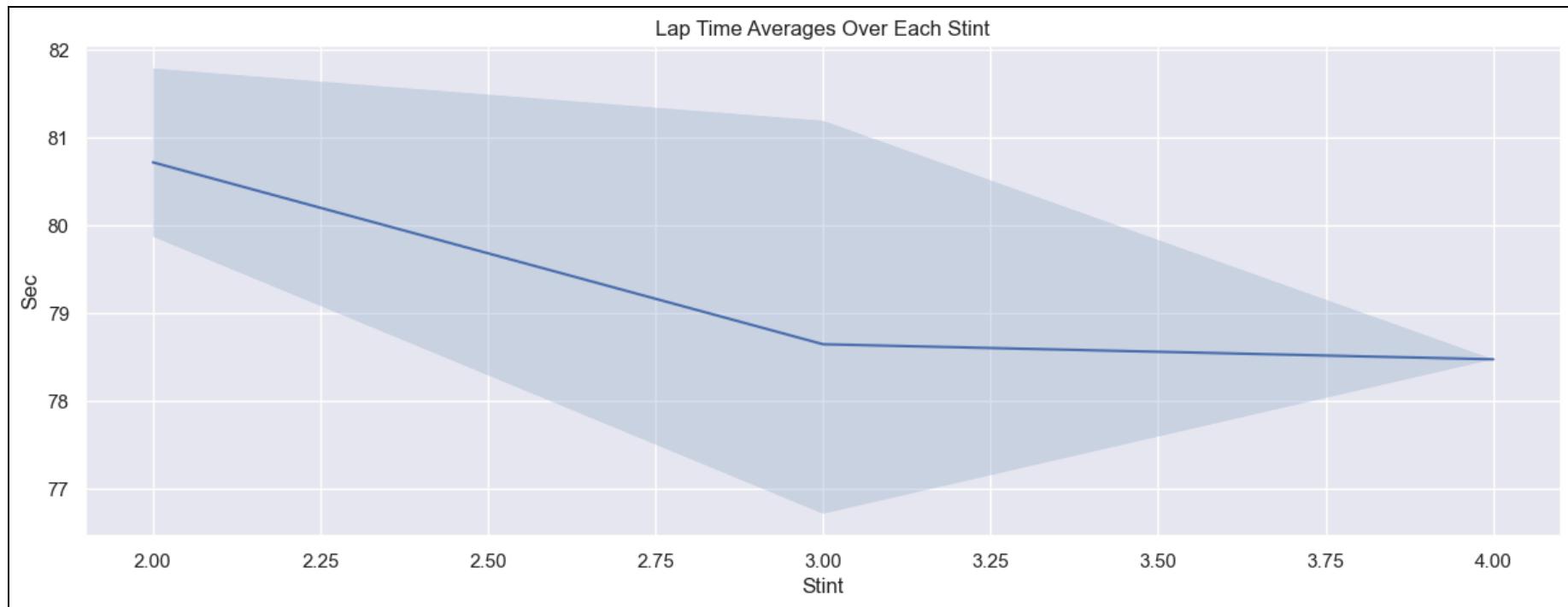
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Haas F1 Team	2	0	0	1		
Red Bull Racing	2	2	96.145	1	2:20:52	0:01:50
Alpine	2	1	81.591	1	2:24:16	0:01:52
Ferrari	2	2	84.562	78	4:40:48	0:01:49
McLaren	2	2	122.775	78	4:41:03	0:01:50
Mercedes	2	3	168.717	78	4:41:44	0:01:50
Aston Martin	2	4	224.819	76	4:46:41	0:01:53
RB	2	2	162.812	76	4:47:15	0:01:53
Kick Sauber	2	4	229.065	76	4:47:31	0:01:53
Williams	2	3	196.863	76	4:47:34	0:01:53

Insights

- The avocado team was completely removed from the race with the crash in lap 1
- Red Bull and Alpine were also affected by this crash
- While Ferrari had the lowest total lap time, the next full team (Aston Martin) had a nearly opposite tire strategy, and is the only team that successfully did so



Monaco Grand Prix - Lap Time Averages

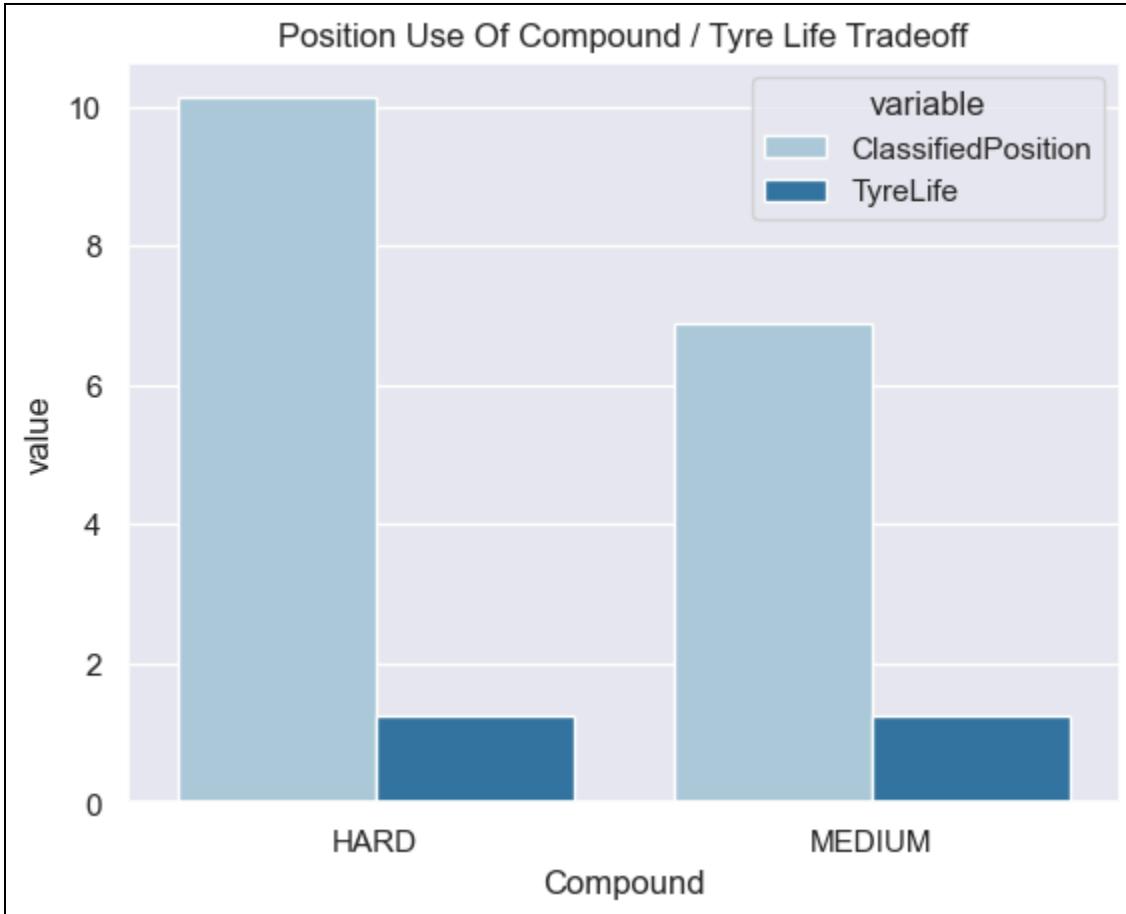


Insights

- Lap times over this race are essentially unreadable and there is no consistency between lap times or drivers
 - This tends to be what happens when a quarter of the drivers spontaneously explode on the first lap
- Seriously, let's just move on from this one. Look at that graph, drawing a line in there is just dishonest

Monaco Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

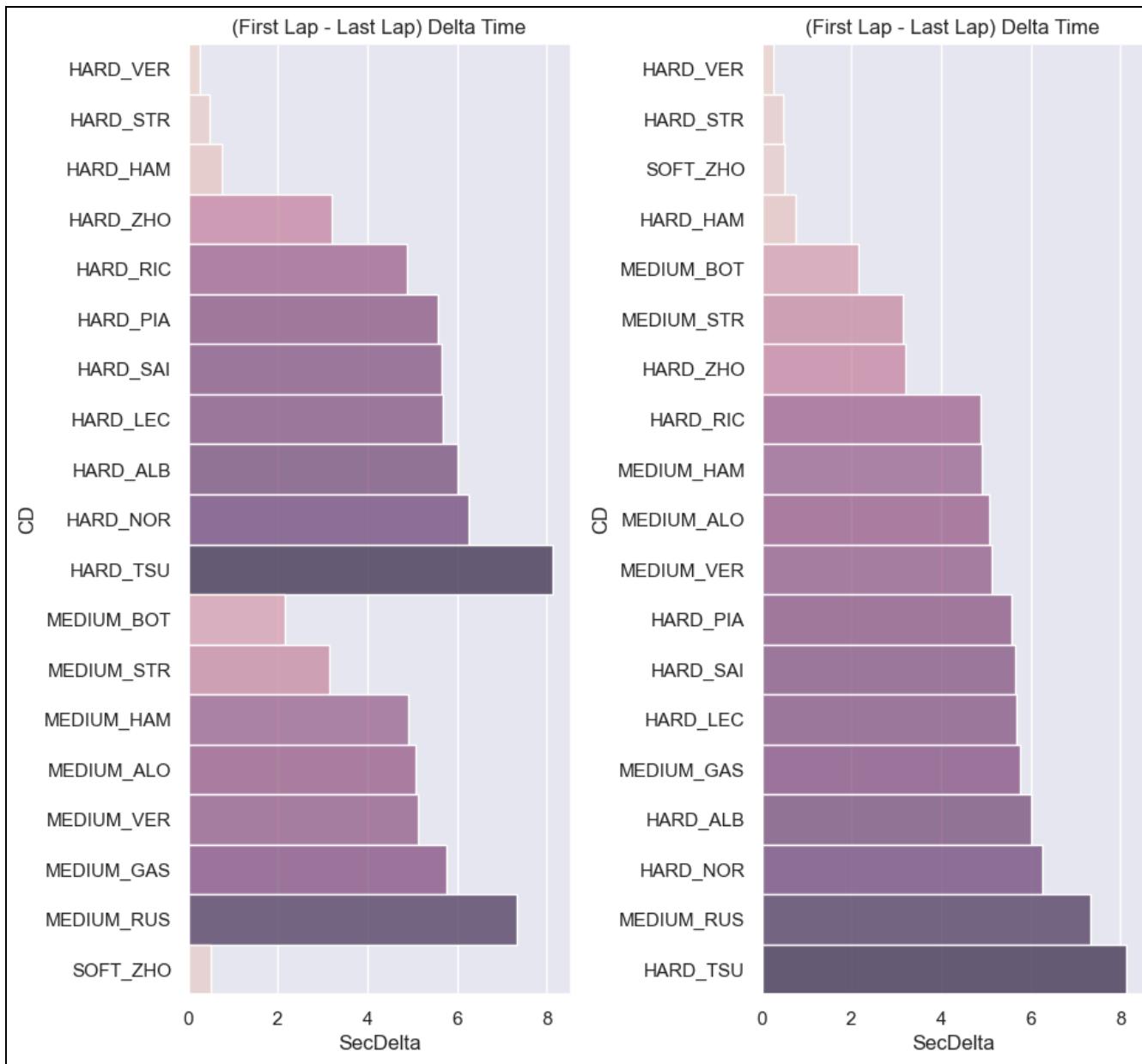
Compound	Position	ClassifiedPosition	TyreLife
HARD	14.125	10.125	1.25
MEDIUM	10.375	6.875	1.25



Insights

- This data is a little inconsistent because the starting tire compounds were used for literally one lap (not even a full lap), so that's the data we have
- We generally saw a pretty decent increase in position for both HARD and MEDIUM tire compounds, **although MEDIUM tires, per the data, tended to finish absolutely better**
 - If we look at the compound usage of the drivers this race, **the complete opposite is true - HARD tires were used almost exclusively**
- This data comes from the fact that many top drivers started with MEDIUM and then continued to use HARD compounds for the rest of the race, while those who started with HARD compounds at the beginning of the race tended to not do as well

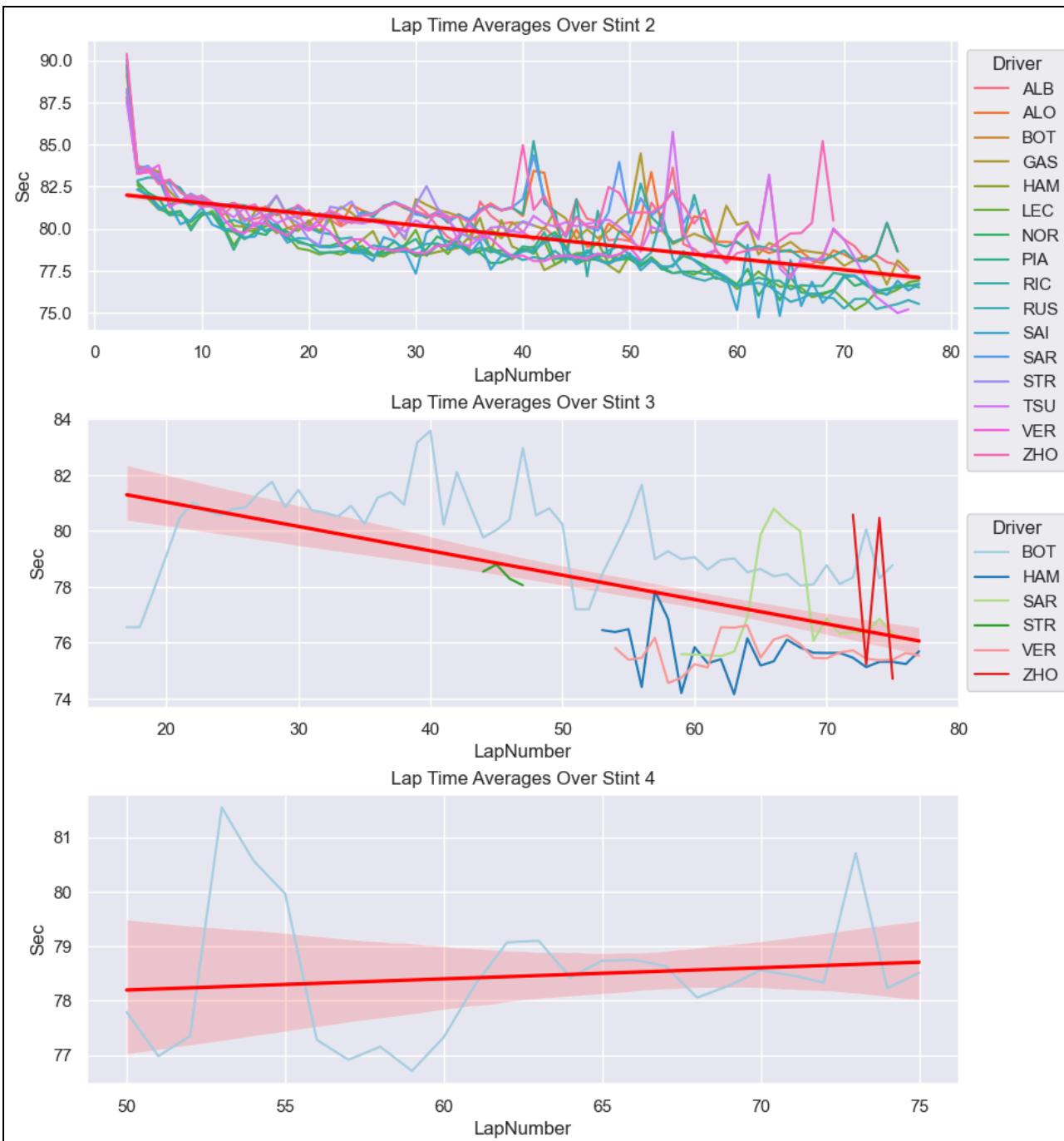
Monaco Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- The lap splits were negative across the board
- HARD compounds saw more negative lap splits than MEDIUM compounds, and generally had a (slightly) more negative time split than MEDIUM tires

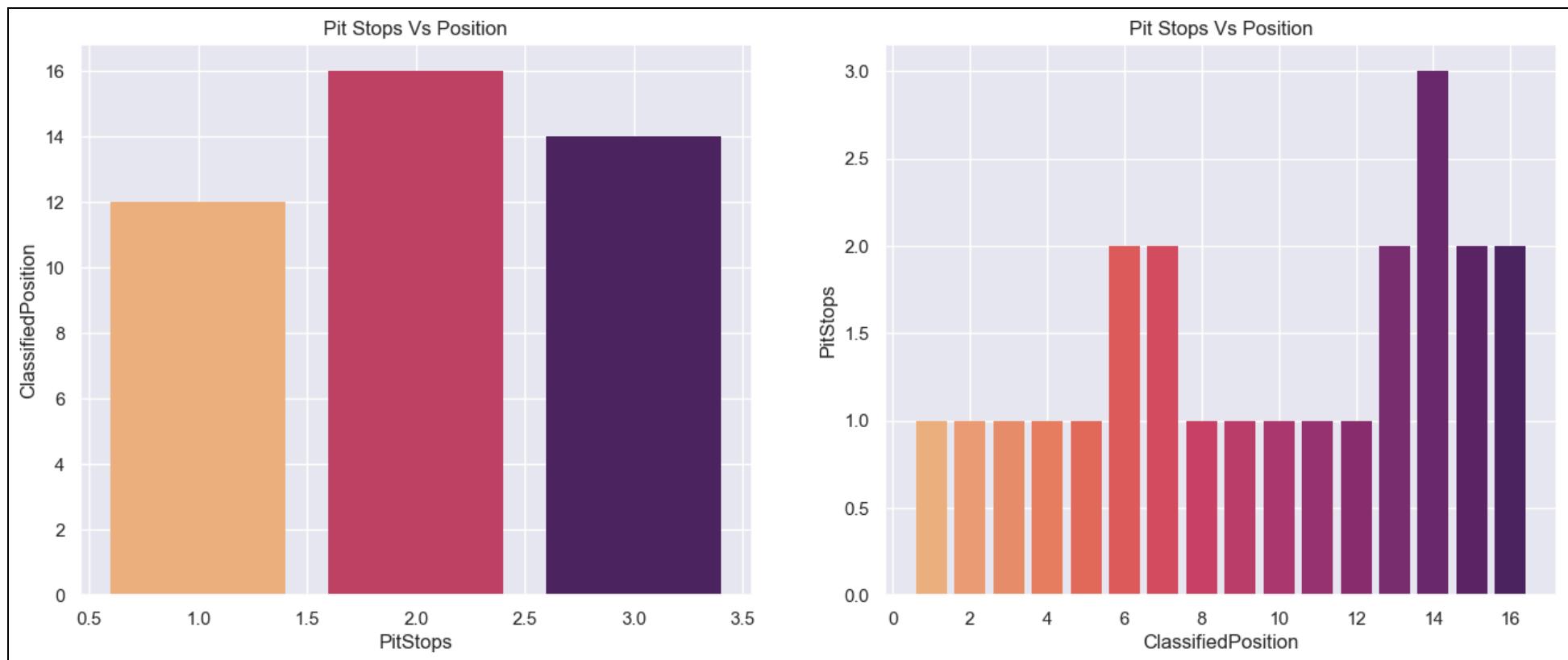
Monaco Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Look at this mess
- Stint 2 saw a general downward trend and is the only Stint that had consistent data for this race, despite expectations to the contrary
- Stints 3 and 4 are under-represented and are essentially just garbage data. Most of the data in those stints comes from BOT, who had a negative split for Stint 3 and a positive split for Stint 4

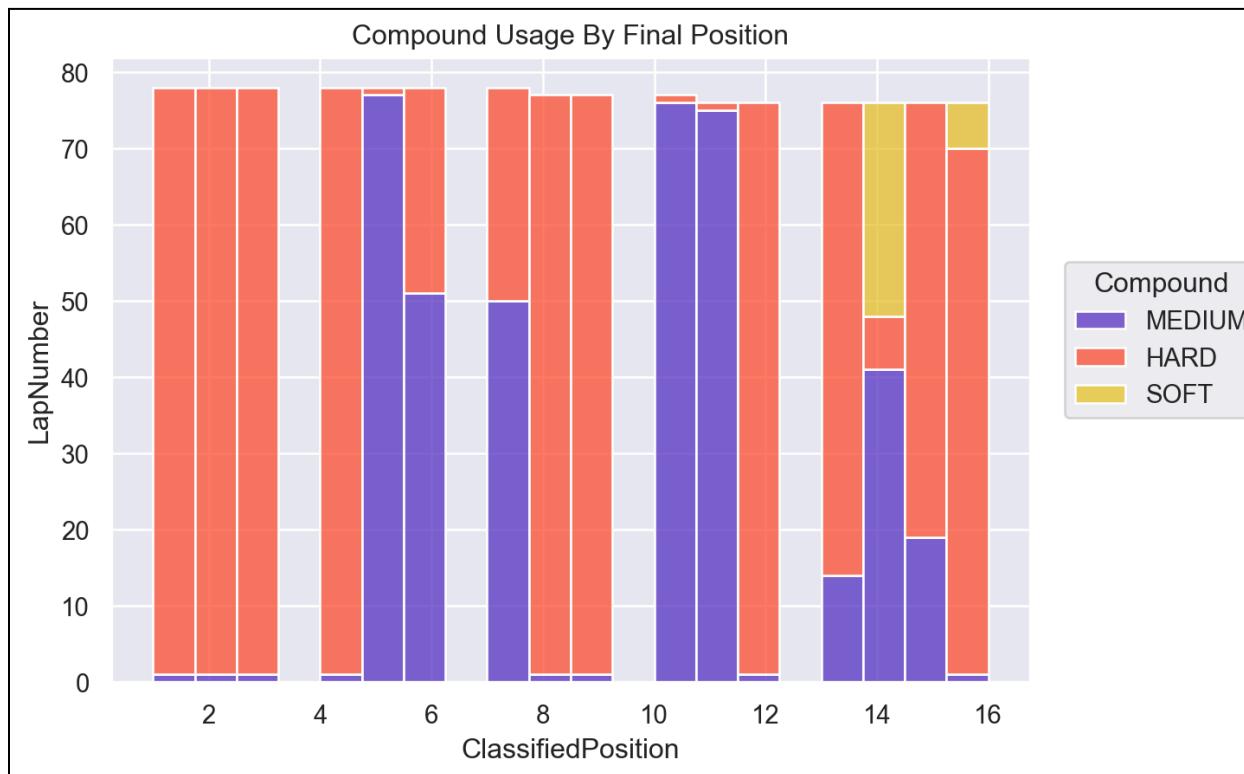
Monaco Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Despite every other part of this race having wild data, this correlation remains as expected: Fewer pit stops are roughly correlated with higher final positions, although this correlation is weak

Monaco Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- The top 4 positions used almost exclusively HARD tires for the duration of the race
- Position 5 had the opposite, with all MEDIUM tires
- Generally the trend was inconsistent and tire strategy was likely less important than just driving the race and surviving
- **Observation:** Most drivers elected to do 1 pit stop (before the safety car) and likely determined that the tradeoff between tire degradation outweighed the ~25s pit stop time that would occur with a second pit stop, hence the homogenous tire representation



Canadian Grand Prix - Basic Statistics

Teams

Alpine	GAS, OCO
Aston Martin	ALO, STR
Ferrari	LEC, SAI
Haas F1 Team	MAG, HUL
Kick Sauber	BOT, ZHO
McLaren	PIA, NOR
Mercedes	RUS, HAM
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	SAR, ALB

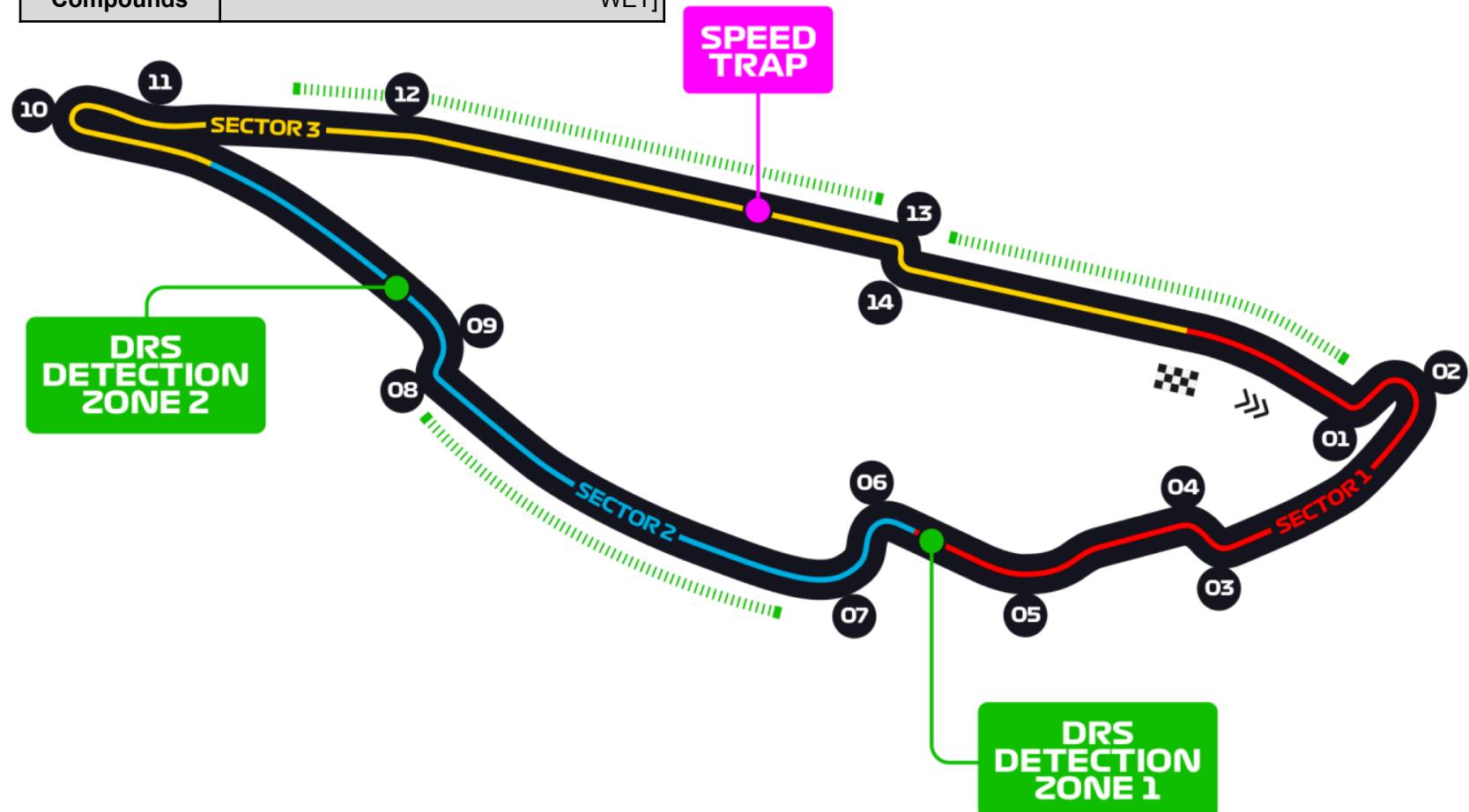
Total Statistics

Pit Stops	44
Pit Time	00:18:51
Laps Completed	1272
Lap Time	1 days 08:11:17
Race Laps	70
Compounds	[INTERMEDIATE, MEDIUM, HARD, WET]

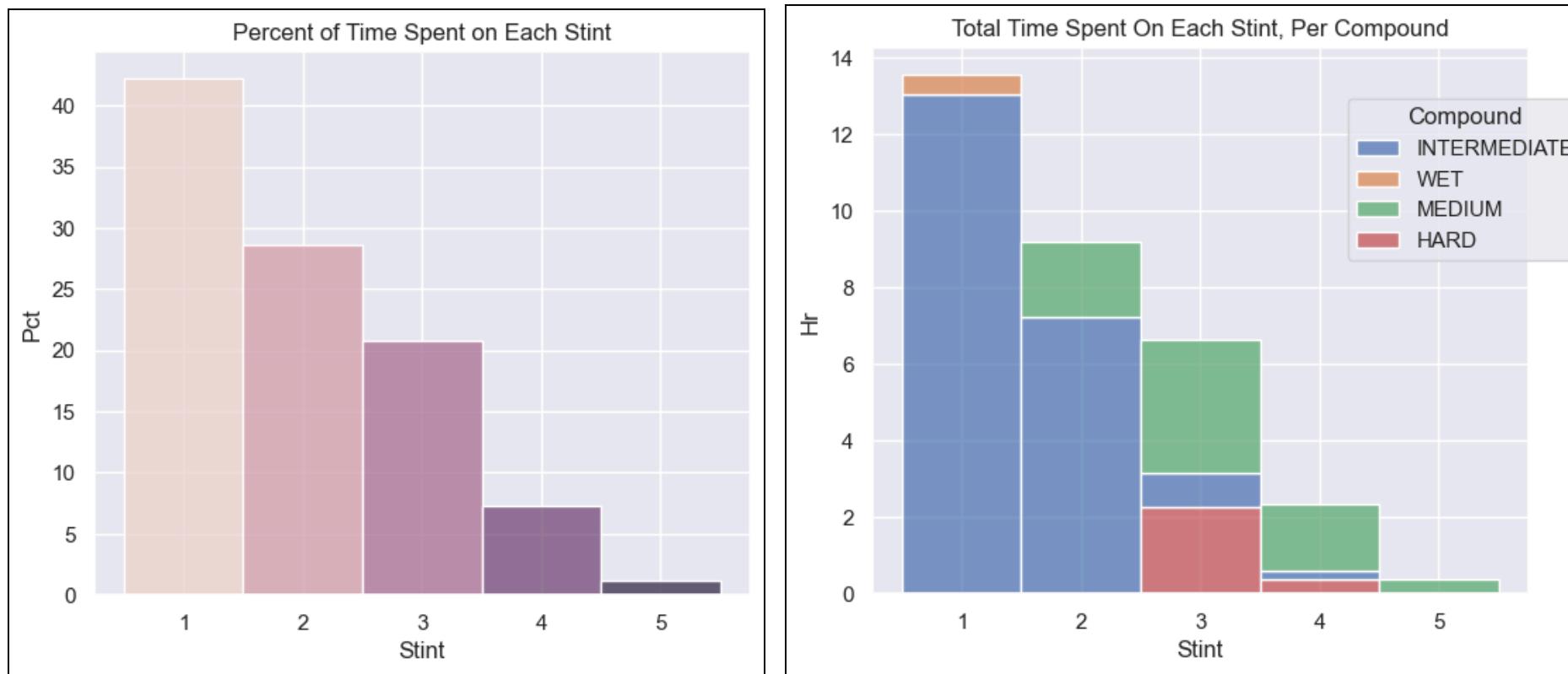
Average Statistics

Pit Stops	2.3158
Pit Time	26.943
Laps Completed	63.6
Lap Time	0:01:31

[Canadian Grand Prix Link](#)



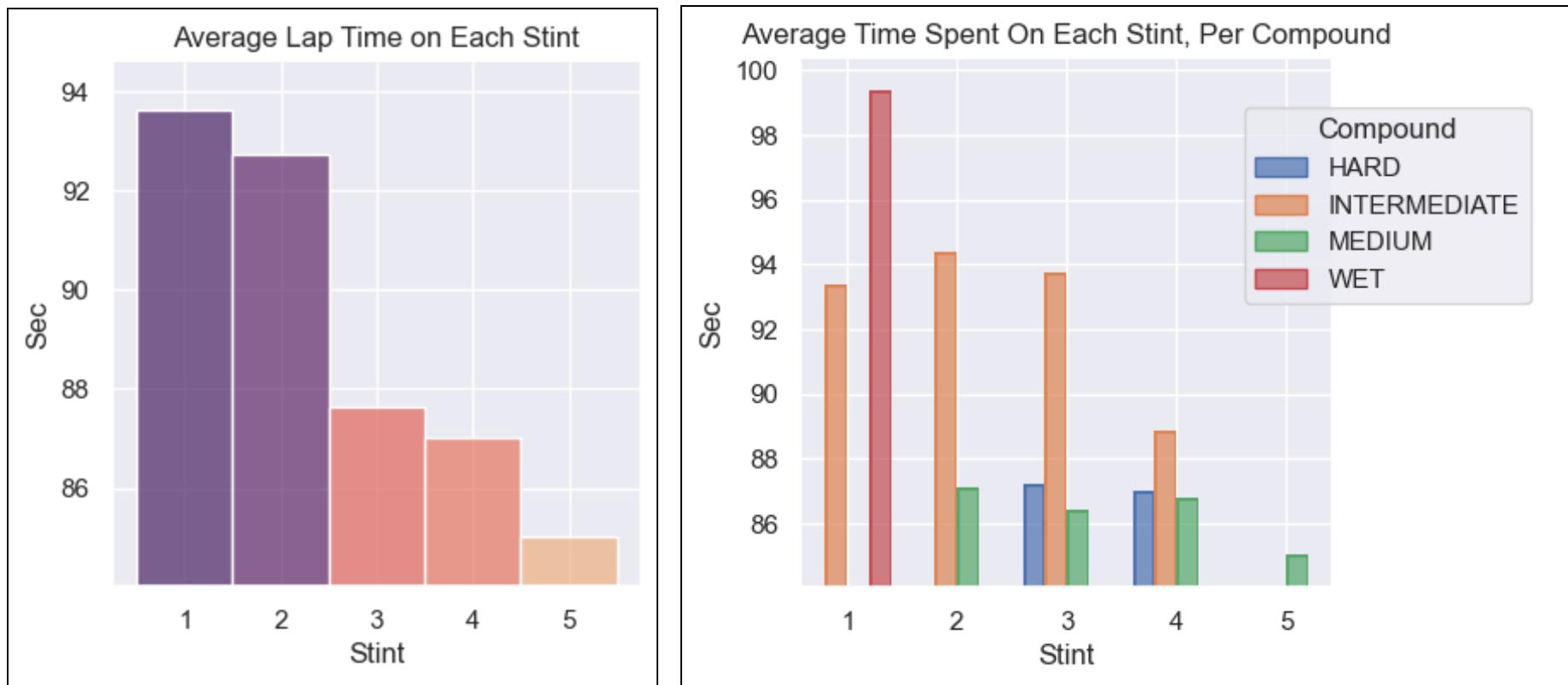
Canadian Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- A majority of the time in the race was spent on Stint 1 and 2, likely because of the weather
 - This is different than usual, where the first stint is usually the shortest
 - Usually a majority of the time spent on the track is in one or two stints, but there is significant representation in lap time from Stints 1 to 3, and even Stint 4 is not terribly under-represented
 - **Observation:** Tire strategy becomes much more complex and/or drivers have less experience with WET & INTERMEDIATE tires when the weather is rainy, hence the heavy deviation from the norm
 - **Observation:** On rainy days you may expect to only see INTERMEDIATE & WET tire compounds, but as seen here that's not necessarily the case
- This race is one of the only races in 2024 that has significant INTERMEDIATE and WET tire representation
- Despite the weather, some drivers elected to use non-wet compounds (MEDIUM / HARD) in the last part of the race

Canadian Grand Prix - Average Lap Time Per Stint / Per Compound



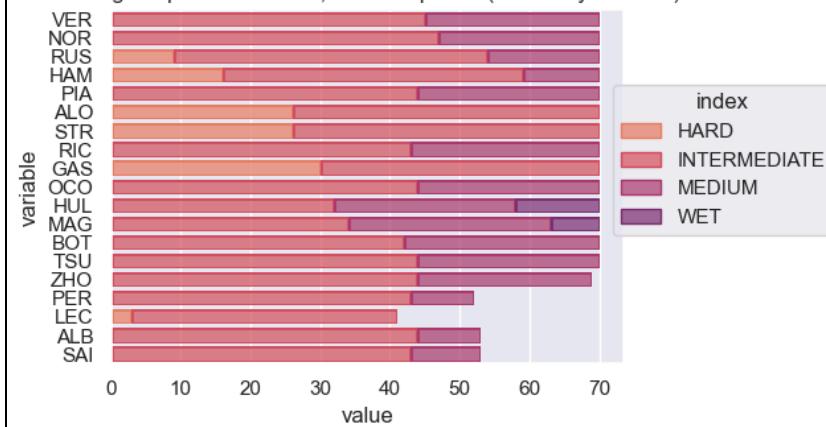
Insights

- INTERMEDIATE tires were generally faster in the first stint
 - **Observation:** We see analogues to INTERMEDIATE tires being similar to MEDIUM tires in the greater strategy. Those at the front might use INTERMEDIATE tires more, and those at the back may use WET tires more (similar to SOFT tires)
- Usually we see a dip in average time after Stint 1, but Stint 2 maintained approximately the same average lap time
 - Probably due to the weather & heavy use of INTERMEDIATE tires
- Stints 3 and 4 even out a bit and presumably the weather got better for those Stints, enabling drivers to use common compounds more effectively than at the beginning of the race
 - This suggests that track wear may have cleared up the water some after being rubbered-in

Canadian Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
VER	2	48.415	70	1:45:48	0:01:31	1	HUL	3	73.449	70	1:46:19	0:01:31	11
NOR	2	47.431	70	1:45:52	0:01:31	2	MAG	4	109.174	70	1:46:19	0:01:31	12
RUS	3	77.82	70	1:45:52	0:01:31	3	BOT	2	24.83	70	1:46:28	0:01:31	13
HAM	3	76.727	70	1:45:53	0:01:31	4	TSU	1	25.613	70	1:46:41	0:01:31	14
PIA	2	47.331	70	1:45:58	0:01:31	5	ZHO	4	119.71	69	1:46:41	0:01:33	15
ALO	2	48.231	70	1:46:05	0:01:31	6	SAR	0	0	24	0:36:05	0:01:34	99
STR	2	49.361	70	1:46:12	0:01:31	7	PER	2	58.177	52	1:18:31	0:01:32	99
RIC	2	54.129	70	1:46:17	0:01:31	8	SAI	2	51.902	53	1:19:48	0:01:32	99
GAS	2	49.471	70	1:46:18	0:01:31	9	LEC	3	95.84	41	1:04:03	0:01:36	99
OCO	1	24.458	70	1:46:18	0:01:31	10	ALB	2	49.561	53	1:19:49	0:01:32	99

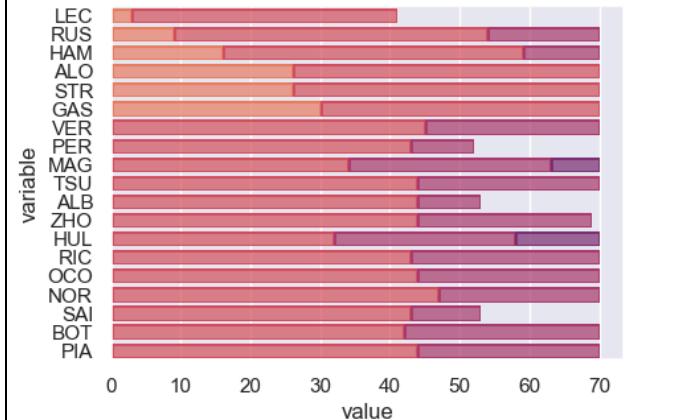
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- Top positions tended to use a 2:1 ratio of INTERMEDIATE:MEDIUM tire compounds
 - This was true for many drivers throughout the race, suggesting that tire strategy may not have been as important of a factor than driver skill
- Two safety car incidents sprouted from a total of 5 DNF drivers in this race, higher than normal
- The safety cars enabled two time-saving pit stops for a majority of the drivers

Average Laps in Each Stint, Per Compound (Sorted by Compound)

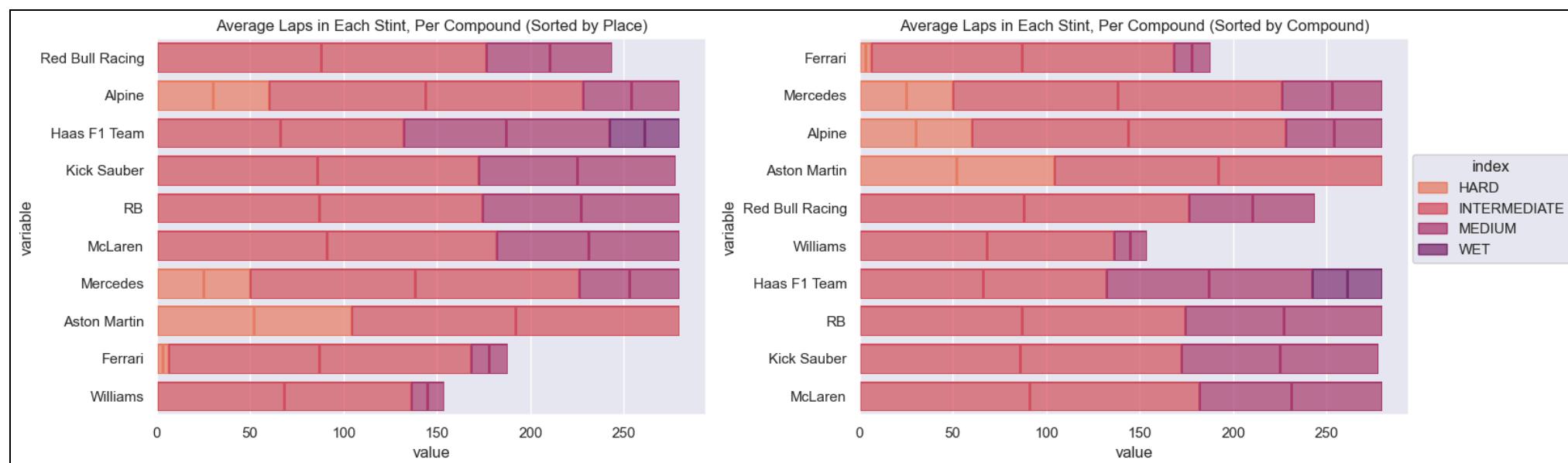


Canadian Grand Prix - Team Data

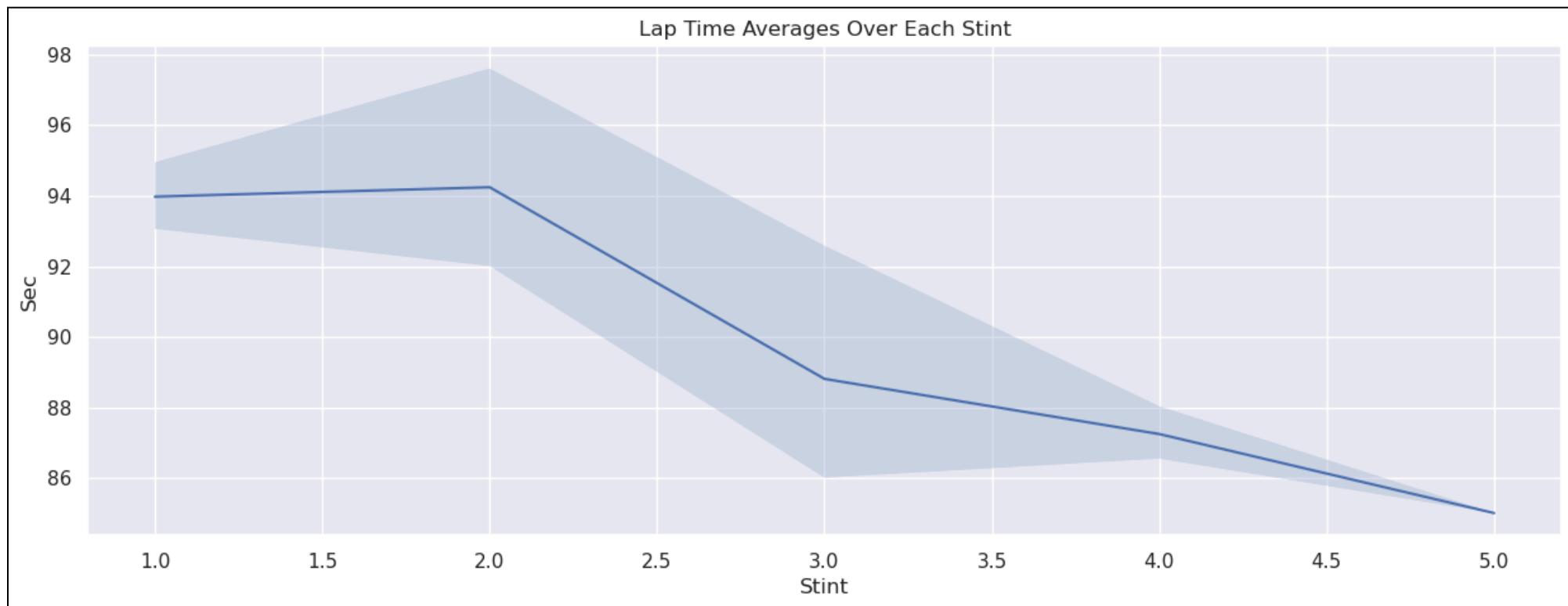
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Williams	2	2	49.561	53	1:55:54	0:01:33
Ferrari	2	5	147.742	53	2:23:52	0:01:34
Red Bull Racing	2	4	106.592	52	3:04:19	0:01:31
Mercedes	2	6	154.547	70	3:31:45	0:01:31
McLaren	2	4	94.762	70	3:31:50	0:01:31
Aston Martin	2	4	97.592	70	3:32:17	0:01:31
Alpine	2	3	73.929	70	3:32:36	0:01:31
Haas F1 Team	2	7	182.623	70	3:32:38	0:01:31
RB	2	3	79.742	70	3:32:57	0:01:31
Kick Sauber	2	6	144.54	70	3:33:10	0:01:32

Insights

- Three teams were affected by the various crashes during this race
- The average lap time was pretty consistent between teams, with +- 1 second
- Pit time was an inconsistent measure of final position because the number of safety car incidents allowed many drivers to exchange their tires without losing much time, if any
- HARD tires saw very little representation this race and we mostly saw INTERMEDIATE and MEDIUM tires because of clear weather in the last half of the race
- Among all teams, the tire compound proportions were quite similar



Canadian Grand Prix - Lap Time Average

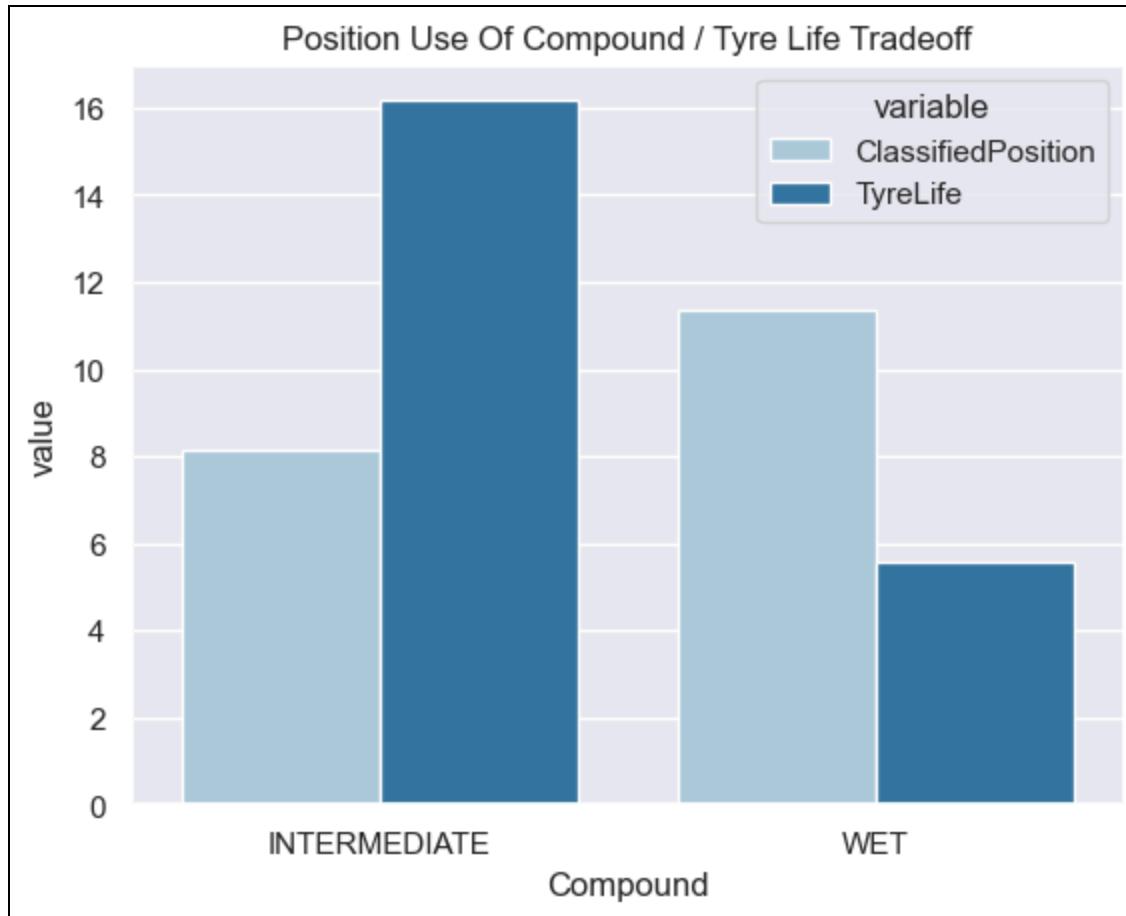


Insights

- We see a general downward trend in lap times as the race progresses, even though those lap times tend to have some variability per-driver
- All laps are not equally represented, but unlike most races, Stints 3 and 4 are less under-represented in this race and have some actual participation

Canadian Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

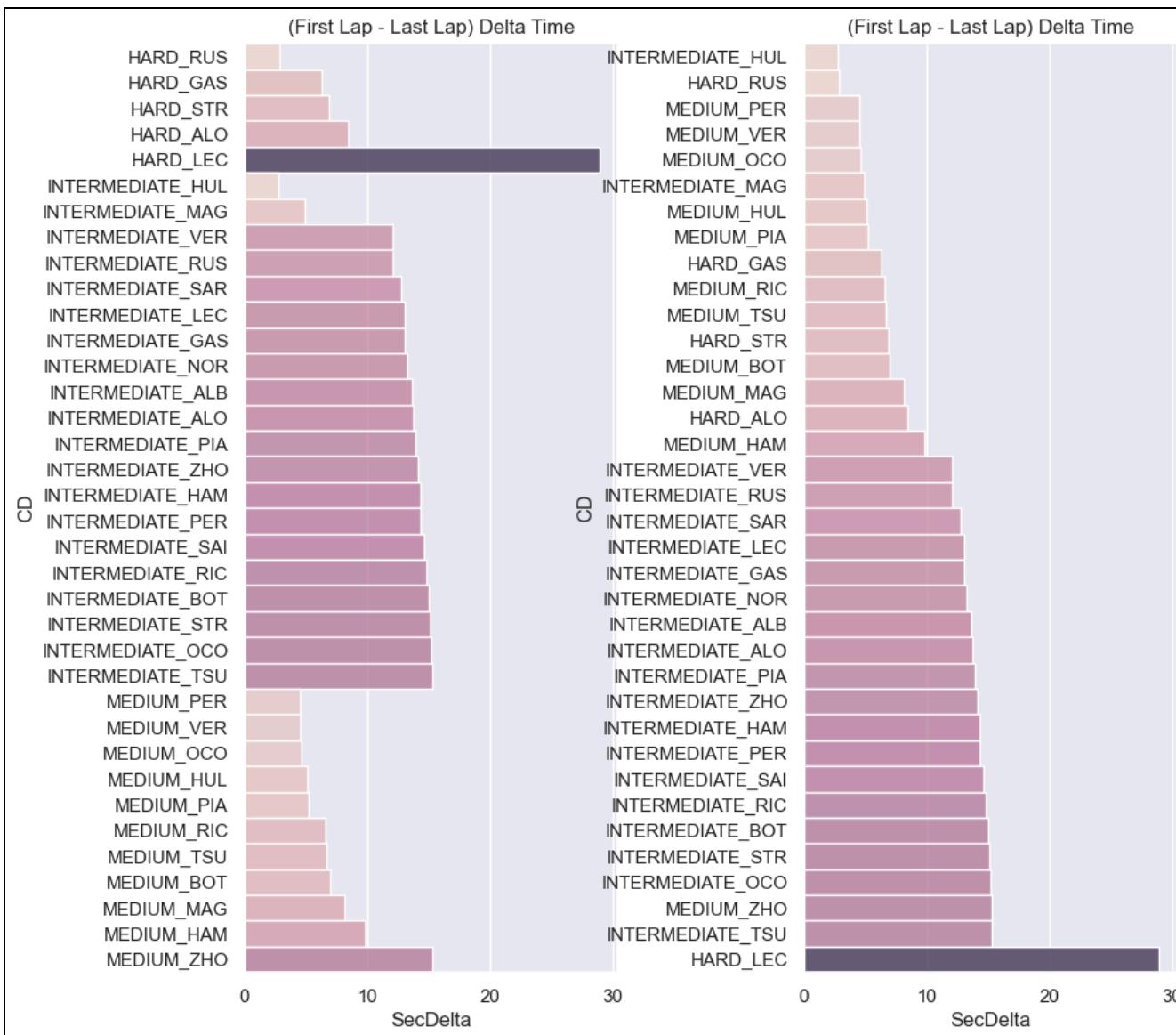
Compound	Position	ClassifiedPosition	TyreLife
INTERMEDIATE	8.9501	8.1286	16.168
WET	8	11.3684	5.5789



Insights

- Those who started with INTERMEDIATE tires tended to gain about 0.8 positions over the course of the race
- Those who started with WET tires tended to lose around 3.3 positions over the course of the race
- **Observation:** There is some analogous behavior with SOFT / MEDIUM tire usage in other races, where drivers further back use one over another more often than those in the front
- **Observation:** The amount of crashes in this race significantly skew these results, so they are less powerful than they otherwise would be, especially when paired with the weather

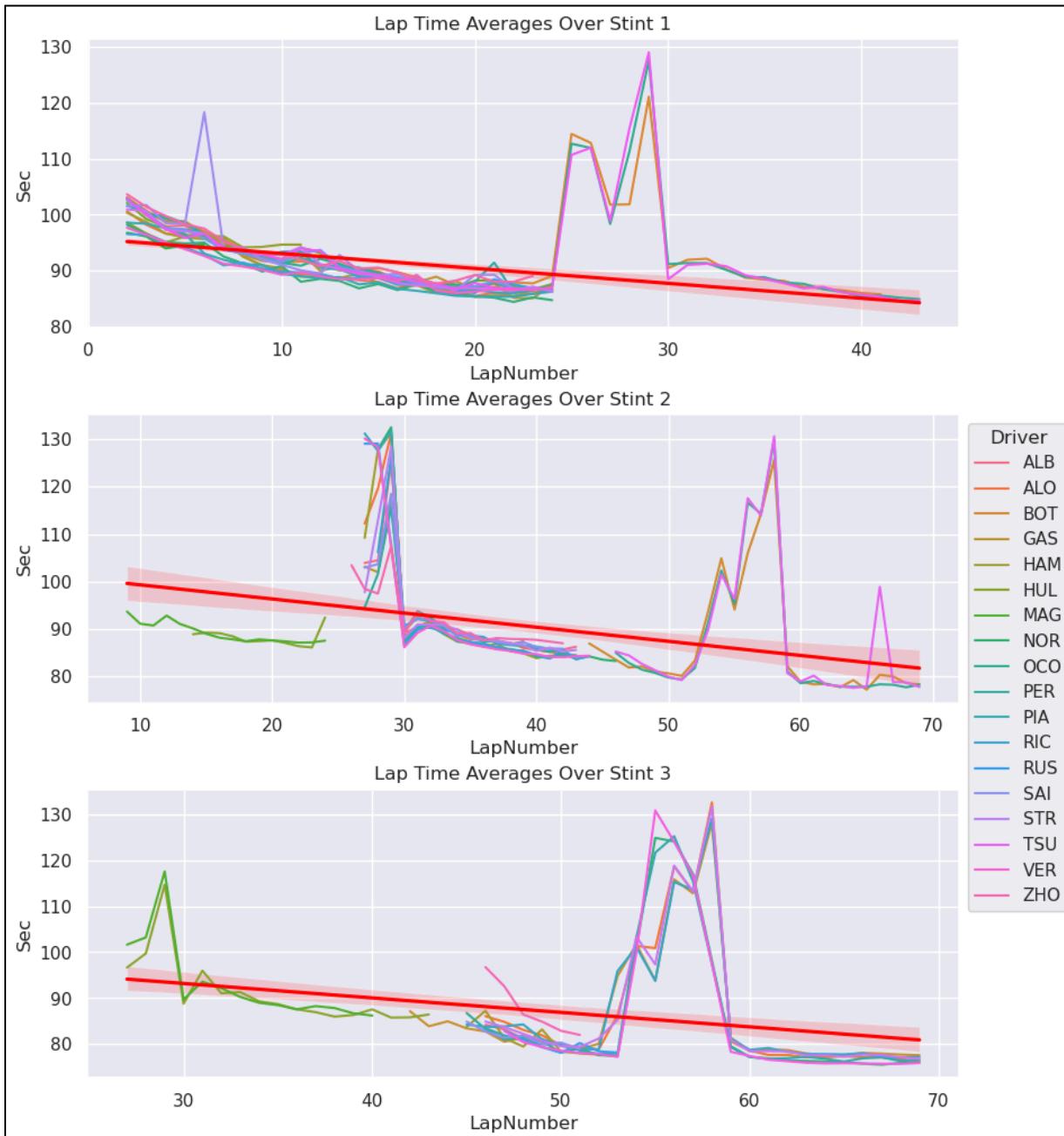
Canadian Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- LEC saw an almost 30 second negative lap split on HARD tires
- Everyone else was surprisingly even on INTERMEDIATE tires - lap splits were negative across the board and were anywhere from -12 to -15 seconds
- INTERMEDIATE tires saw a more consistent negative split than MEDIUM tires, which generally saw between a 5-10 second improvement in time over the course of a Stint, except for ZHO who saw a -15 second lap split during that Stint
- **Observation:** This data suggests that driving on the track increased the performance of drivers over time, in a wet environment. This could be because of track conditions improving with weather, or because the cars / track wear benefited significantly from a worn-in track independent of weather

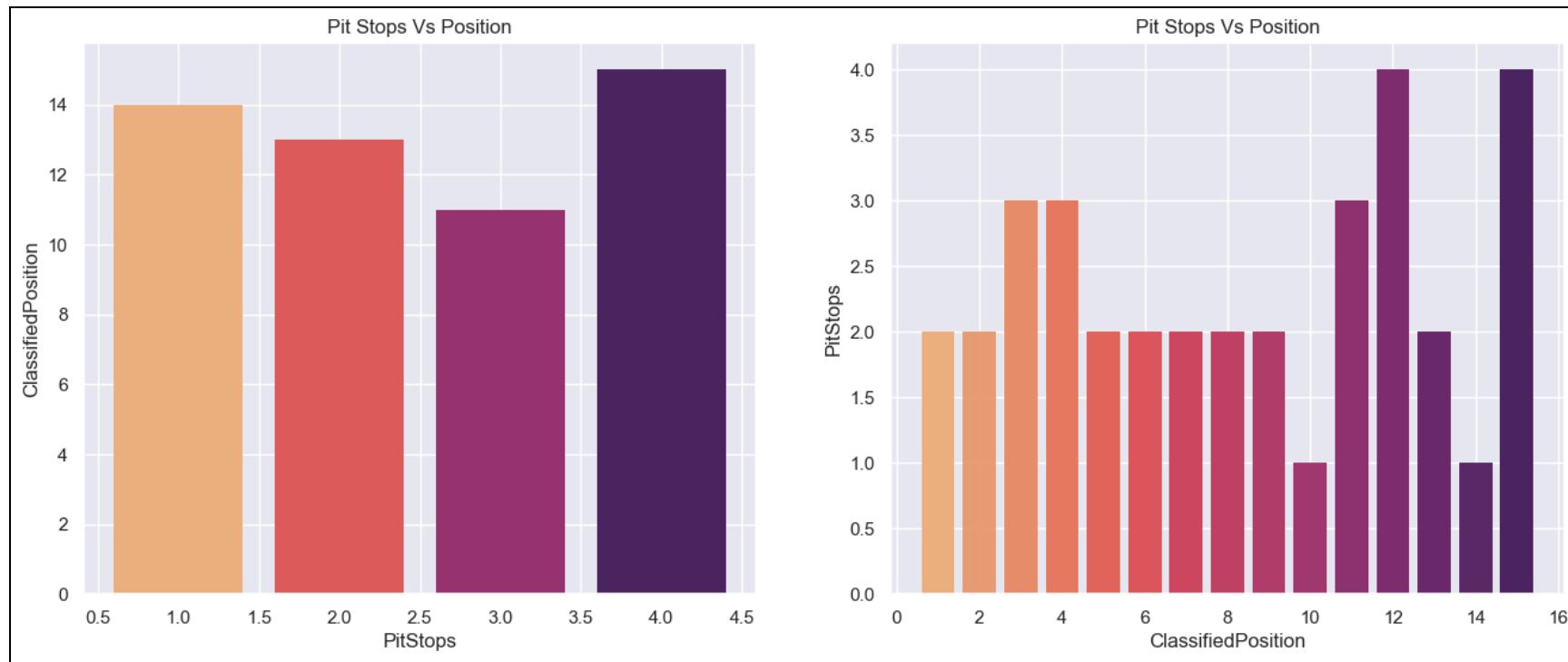
Canadian Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Because of the two safety car incidents, the lap time averages within each stint are a little skewed, but we **generally see a negative lap split over time**
- Even with the safety car incidents, the lap splits here are more significant - these splits were affected disproportionately (in a good way) by the rainy weather

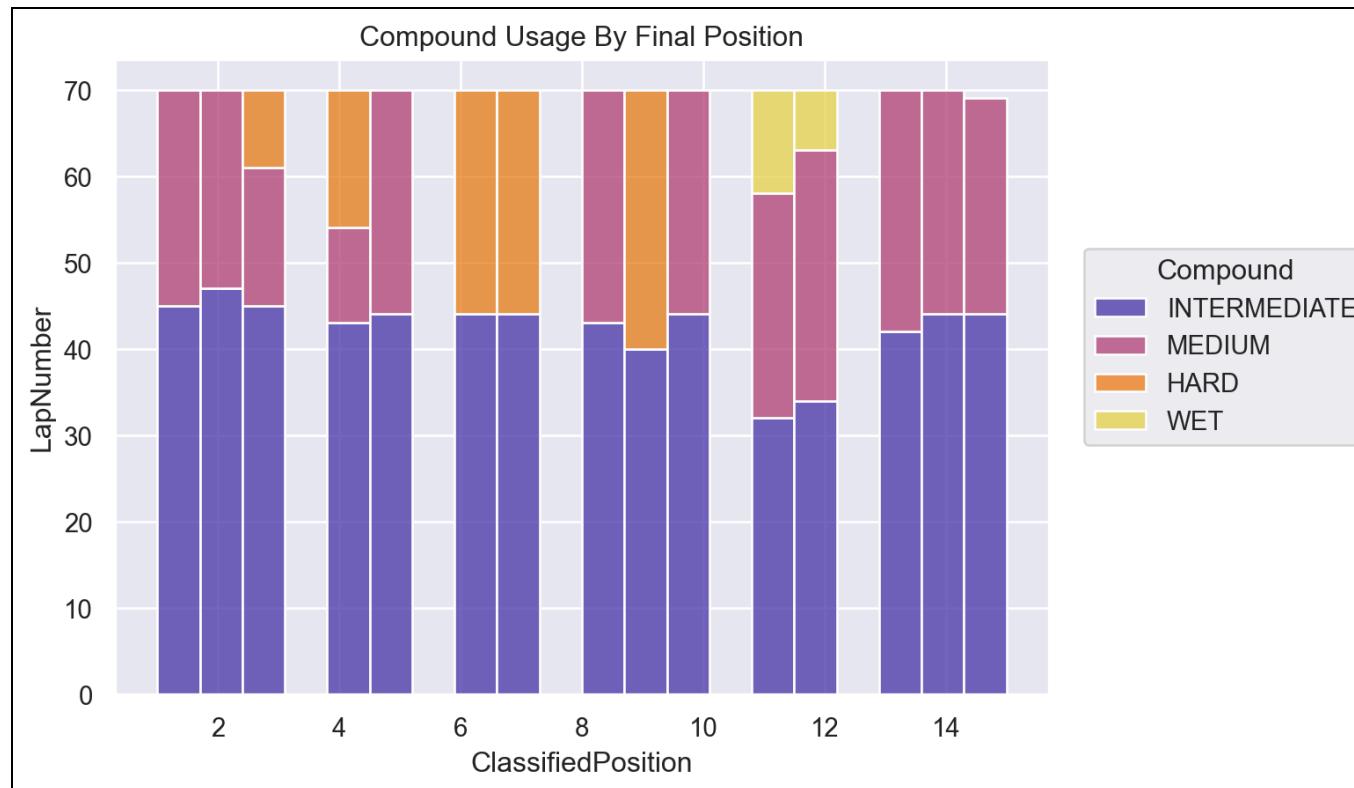
Canadian Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- We almost see an opposite relationship here than we have in previous races - the correlation is weak, but generally those with 2 pit stops benefitted the most, and anything below or above reduced performance

Canadian Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- Most of the compounds in this race see approximately equal representation throughout each driver
- Observation:** When it rains, there is an obvious choice about what tires to use. This suggests that this race (dependent on weather) had a lesser focus on tire strategy and a higher focus on driver skill

Spanish Grand Prix - Basic Statistics

Teams

Alpine	OCO, GAS
Aston Martin	ALO, STR
Ferrari	LEC, SAI
Haas F1 Team	MAG, HUL
Kick Sauber	ZHO, BOT
McLaren	NOR, PIA
Mercedes	HAM, RUS
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	ALB, SAR

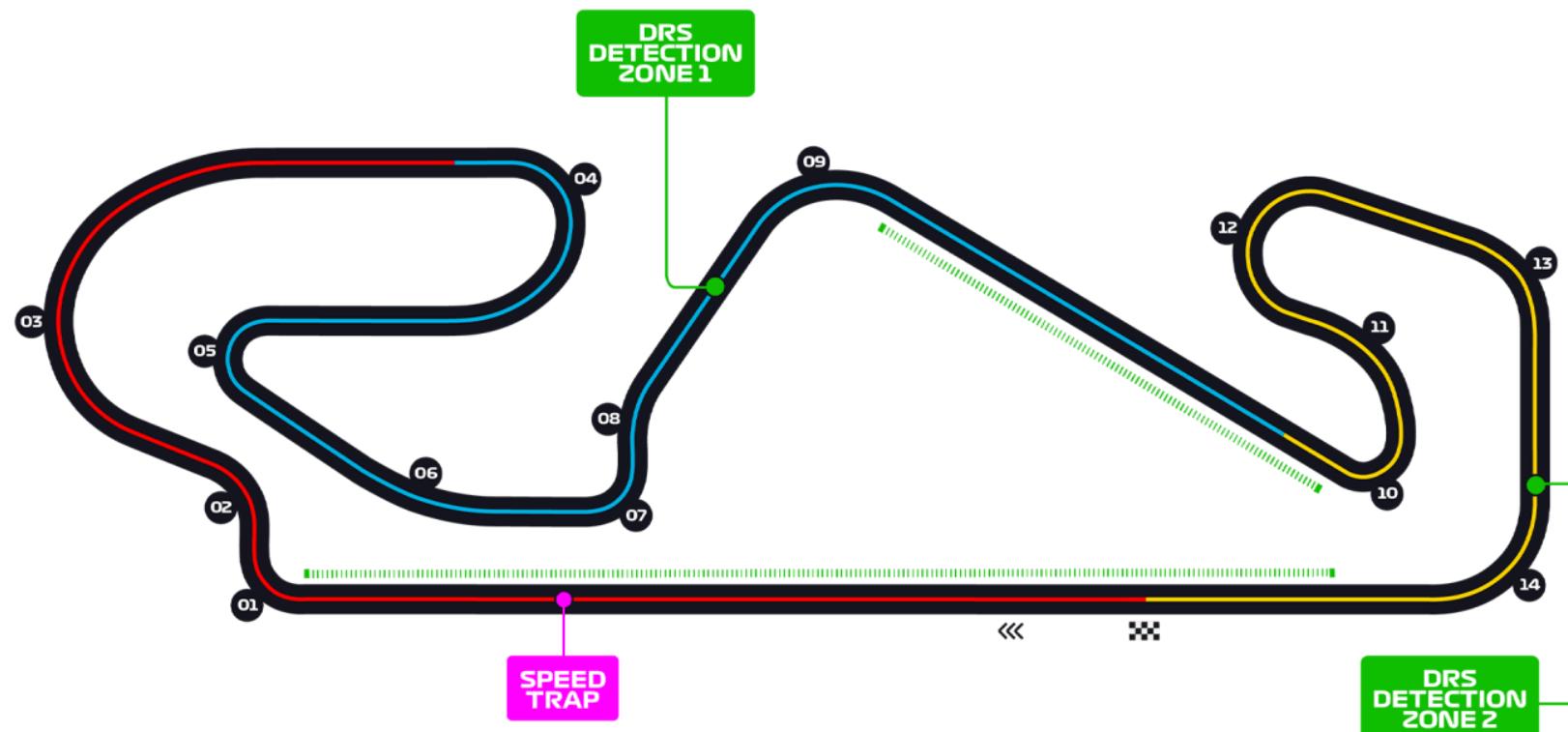
Total Statistics

Pit Stops	43
Pit Time	00:15:48
Laps Completed	1310
Lap Time	1 days 05:38:51
Race Laps	66
Compounds	[SOFT, MEDIUM, HARD]

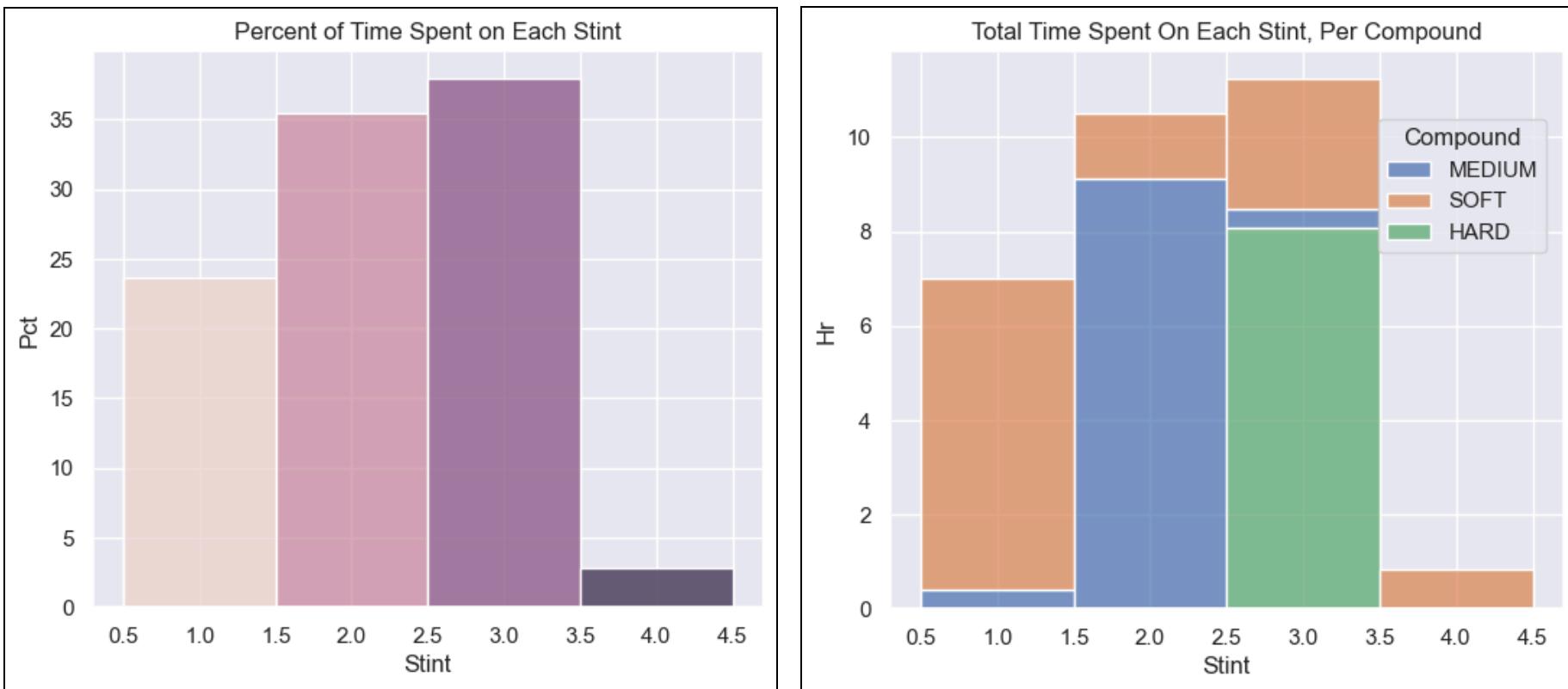
Average Statistics

Pit Stops	2.15
Pit Time	22.589
Laps Completed	65.5
Lap Time	0:01:21

[Spanish Grand Prix Link](#)



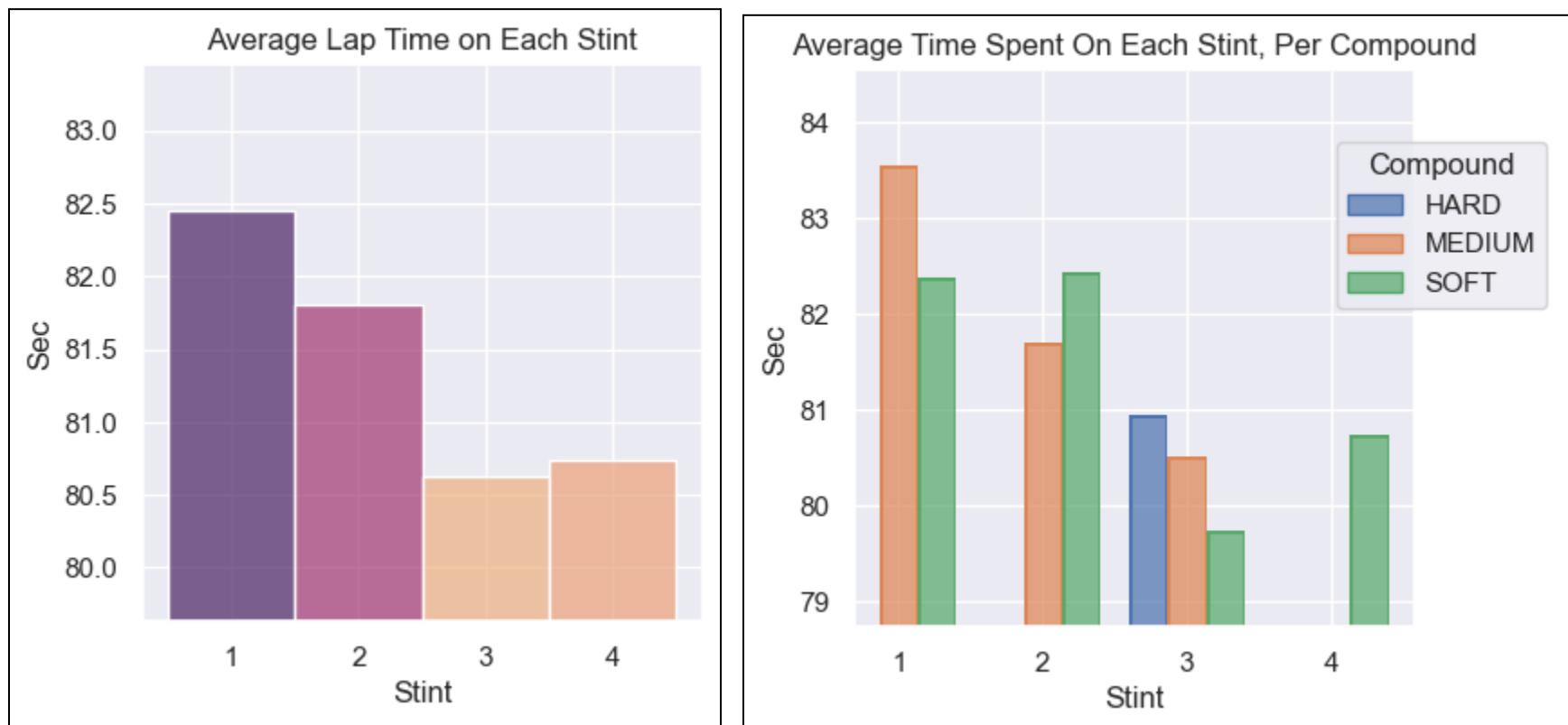
Spanish Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- This track is characterized by lots of wide turns and long straightaways, so we might expect to see heavier use of SOFT / MEDIUM compounds in order to pass effectively and take advantage of positional trades
- Stints 1 through 3 see approximately equal time representation, with this race being characterized by a "sprint stint" and then two maintenance stints
- Stint 1 is represented overwhelmingly by SOFT tires, which is different than we usually see
 - **Observation:** It's possible drivers intend to take advantage of the straightaways to gain a lot of positions quickly, and take advantage of the wide turns in this race which require more traction
- Stint 2 has significant MEDIUM compound usage with some SOFT tire usage as well
- HARD compounds are used heavily in stint 3, which works out because we've seen in previous races that HARD compounds benefit disproportionately from a worn-in track
- Overall this race seems to heavily favor softer compounds more so than HARD compounds

Spanish Grand Prix - Average Lap Time Per Stint / Per Compound



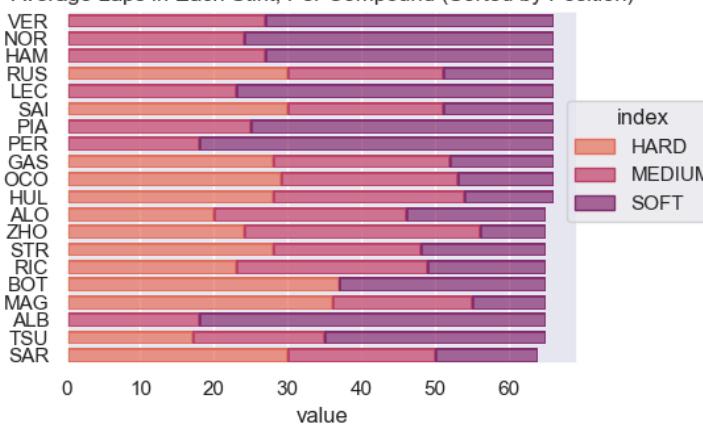
Insights

- Average lap time over all stints is relatively similar, with only a 2 second difference between the first two Stints and the third stint
- MEDIUM and SOFT compounds trade places for time performance between Stints 2 and 3
- Stint 3 sees HARD compound usage outperform MEDIUM and SOFT compounds in the first two stints, and slightly underperform in Stint 3
- Stint 4 is under-represented in this race

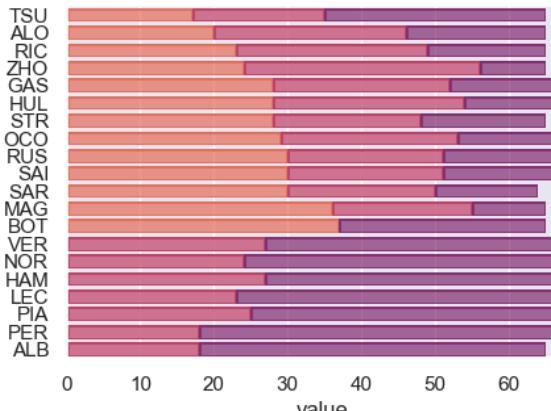
Spanish Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
VER	2	43.974	66	1:28:20	0:01:20	1	HUL	2	45.19	66	1:29:34	0:01:21	11
NOR	2	44.07	66	1:28:22	0:01:20	2	ALO	2	44.357	65	1:28:30	0:01:22	12
HAM	2	43.246	66	1:28:38	0:01:21	3	ZHO	2	46.71	65	1:28:36	0:01:22	13
RUS	2	47.698	66	1:28:43	0:01:21	4	STR	2	45.186	65	1:28:45	0:01:22	14
LEC	2	43.865	66	1:28:43	0:01:21	5	RIC	2	44.393	65	1:29:04	0:01:22	15
SAI	2	44.443	66	1:28:51	0:01:21	6	BOT	2	45.829	65	1:29:14	0:01:22	16
PIA	2	44.655	66	1:28:54	0:01:21	7	MAG	2	52.14	65	1:29:15	0:01:22	17
PER	3	64.977	66	1:29:20	0:01:21	8	ALB	3	44.966	65	1:29:18	0:01:22	18
GAS	2	47.715	66	1:29:22	0:01:21	9	TSU	3	66.619	65	1:29:24	0:01:23	19
OCO	2	43.861	66	1:29:32	0:01:21	10	SAR	2	44.849	64	1:28:25	0:01:23	20

Average Laps in Each Stint, Per Compound (Sorted by Position)



Average Laps in Each Stint, Per Compound (Sorted by Compound)



Insights

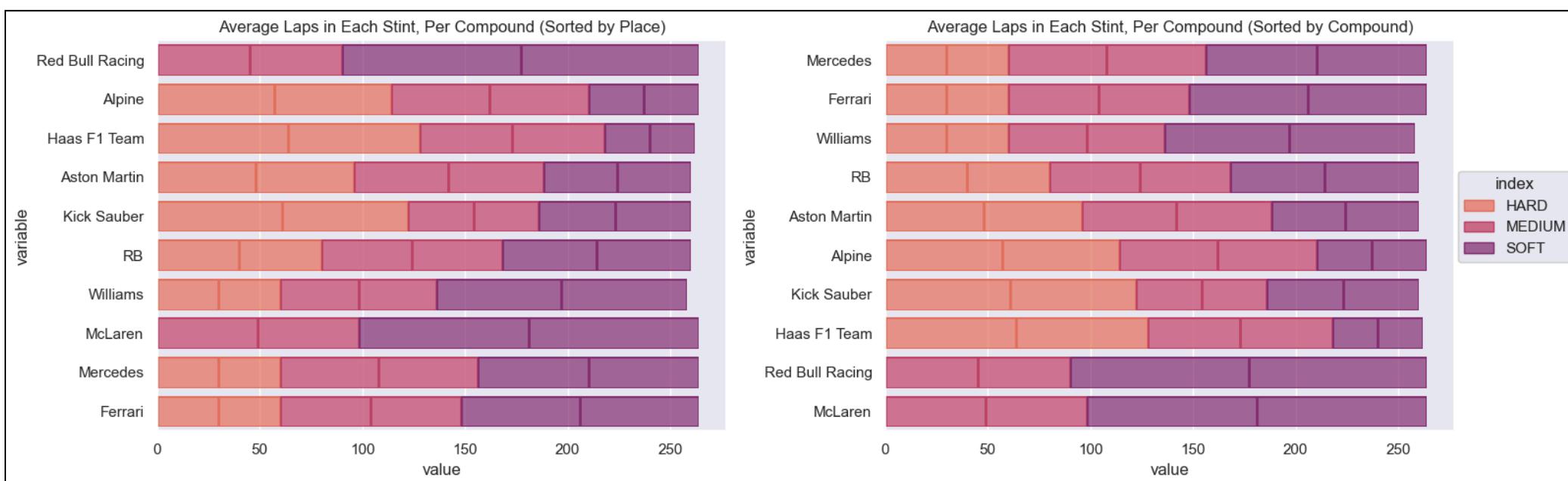
- Most drivers elected to do 2 pit stops, while three drivers (PER, ALB, TSU) chose to do 3
- Average lap time between all drivers was very close, at less than +1 second
- Compound usage was very different throughout this race
 - The top drivers elected to use a combination of only SOFT / MEDIUM tires
 - Bottom drivers elected to use a more even distribution of SOFT / MEDIUM / HARD tires
 - This is one of the only races we see a significant use of more than two compounds within the whole race

Spanish Grand Prix - Team Data

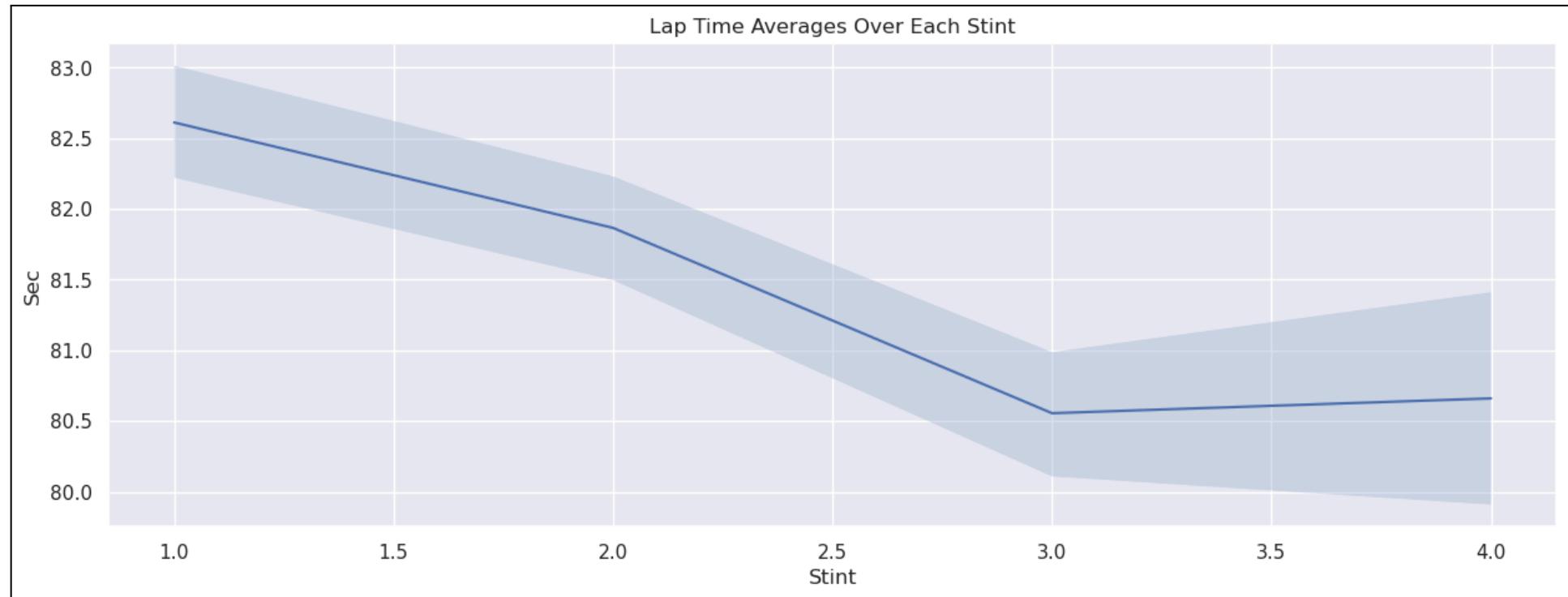
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Aston Martin	2	4	89.543	65	2:57:15	0:01:22
McLaren	2	4	88.725	66	2:57:16	0:01:21
Mercedes	2	4	90.944	66	2:57:21	0:01:21
Ferrari	2	4	88.308	66	2:57:34	0:01:21
Red Bull Racing	2	5	108.951	66	2:57:40	0:01:21
Williams	2	5	89.815	64	2:57:43	0:01:23
Kick Sauber	2	4	92.539	65	2:57:49	0:01:22
RB	2	5	111.012	65	2:58:28	0:01:22
Haas F1 Team	2	4	97.33	65	2:58:49	0:01:22
Alpine	2	4	91.576	66	2:58:54	0:01:21

Insights

- None of the drivers or teams crashed into each other or any stationary objects - a unique situation for F1 in 2024, where a majority of the races see at least 1 DNF
- Average lap times within this race are very close with less than +/- 1 second between teams
- Pit time varies between teams but most teams elected to do 2 pit stops each, some 3
- Exclusive use of SOFT / MEDIUM compounds were more performant than use of SOFT / MEDIUM / HARD compounds, although on average the two-compound strategy performed moderately
- Observation:** Of those teams who used more than two compounds, increased use of HARD compounds were correlated with increased performance



Spanish Grand Prix - Lap Time Averages

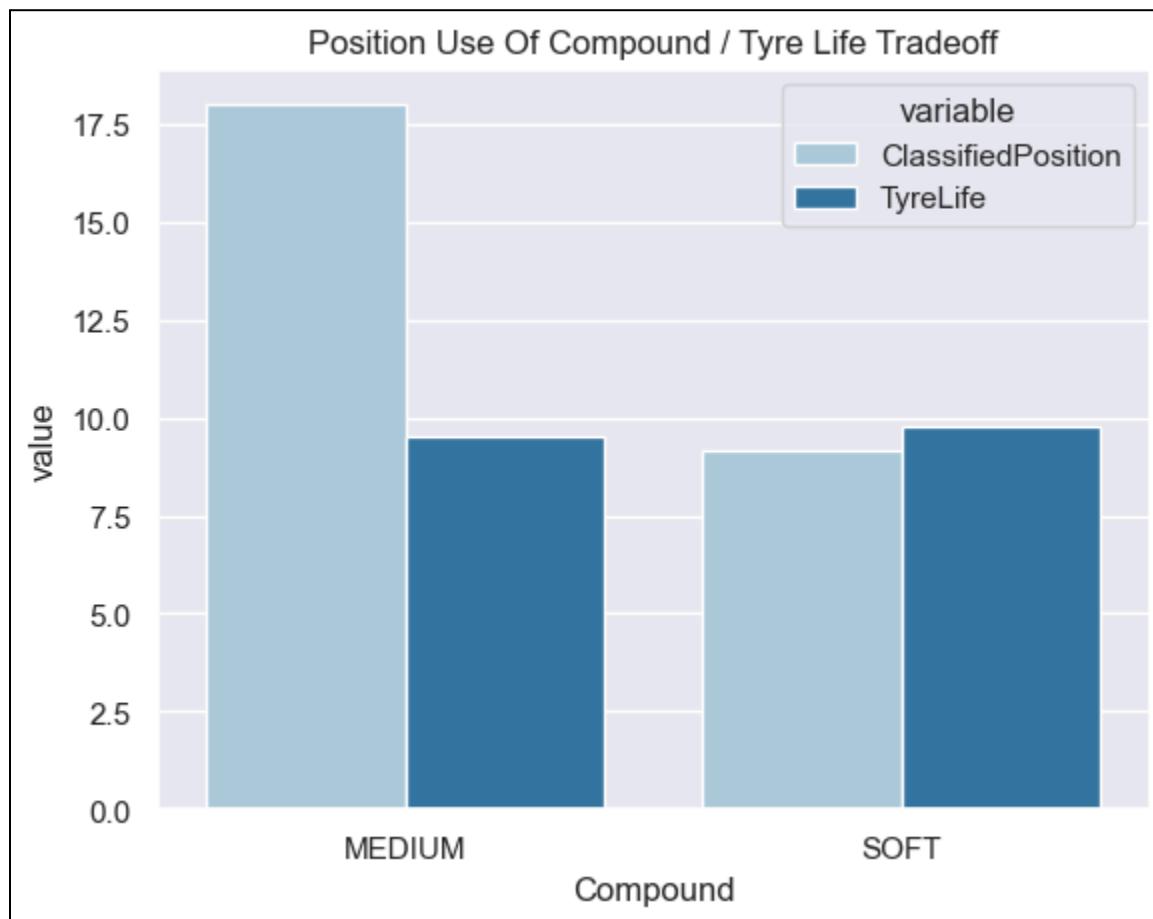


Insights

- Very standard expectation here, where we see a general trend of decreasing lap times as the race continues on, and then a sharper increase towards the end (Stint 4) where stints at that stage are usually under-represented by one or two drivers

Spanish Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

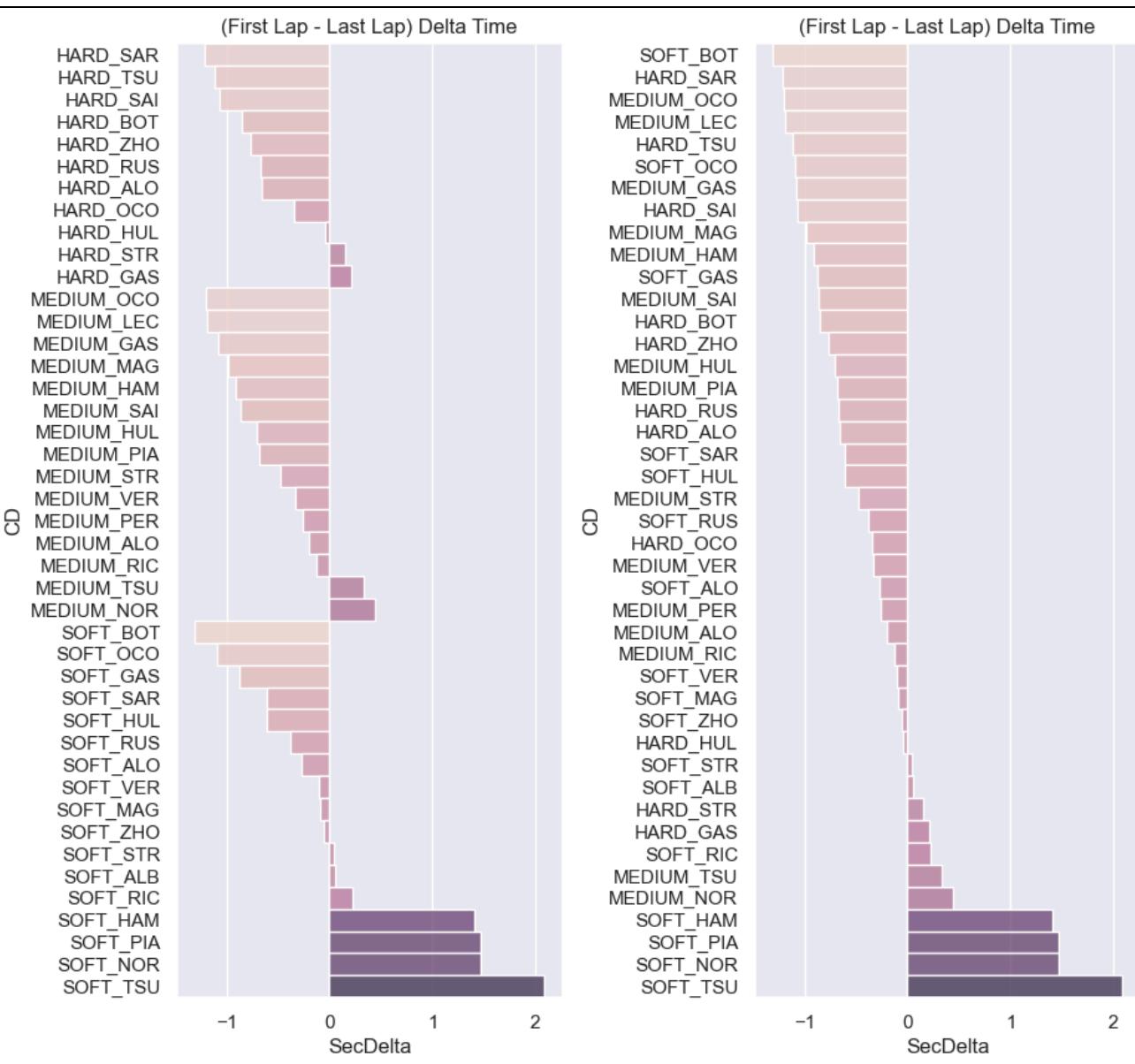
Compound	Position	ClassifiedPosition	TyreLife
MEDIUM	16.6667	18	9.5
SOFT	8.6458	9.1667	9.8021



Insights

- All drivers in this race, regardless of tire strategy, started with either MEDIUM or SOFT compounds this race
- **Observation:** Both tire compounds lose some positions (1 to 2) but SOFT tires see a better absolute position than those who start with MEDIUM tires
 - This is opposite past observations where we normally see SOFT tires perform worse and MEDIUM tires win out
- **Observation:** Tire life for both compounds was about the same, suggesting that use of SOFT tires was the better option this race in accordance with driver pit stop strategy, which seems to have been a ~16 lap first stint

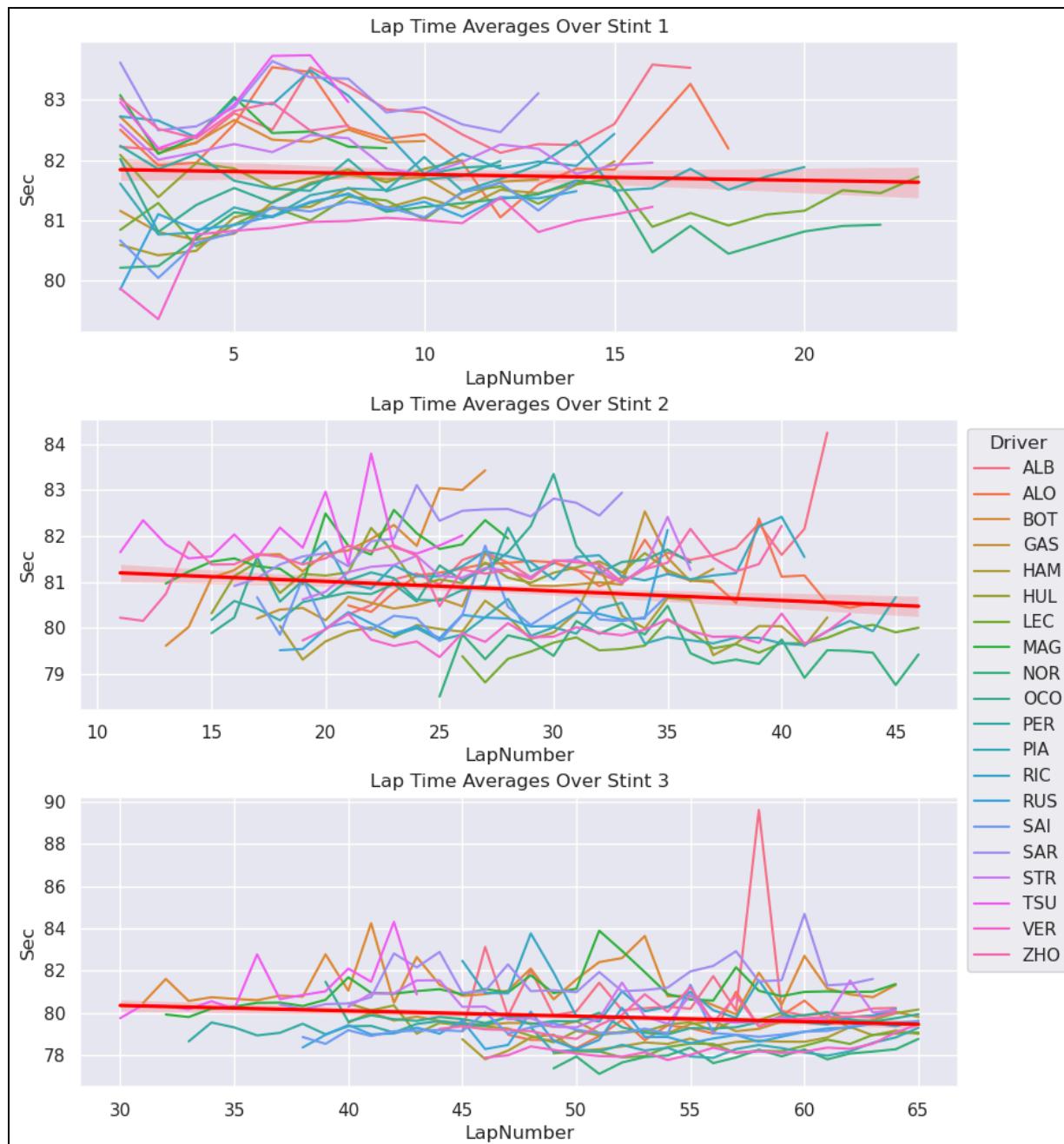
Spanish Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- Most drivers saw a positive split across the board
- MEDIUM and HARD tires almost exclusively saw positive lap splits, although they were all minor at +0.5s - +1.2s max
- SOFT tires saw a more even distribution of splits, with splits ranging fairly evenly between +1.2s to -2.1s
 - Observation:** SOFT tires performed better on this track than other compounds

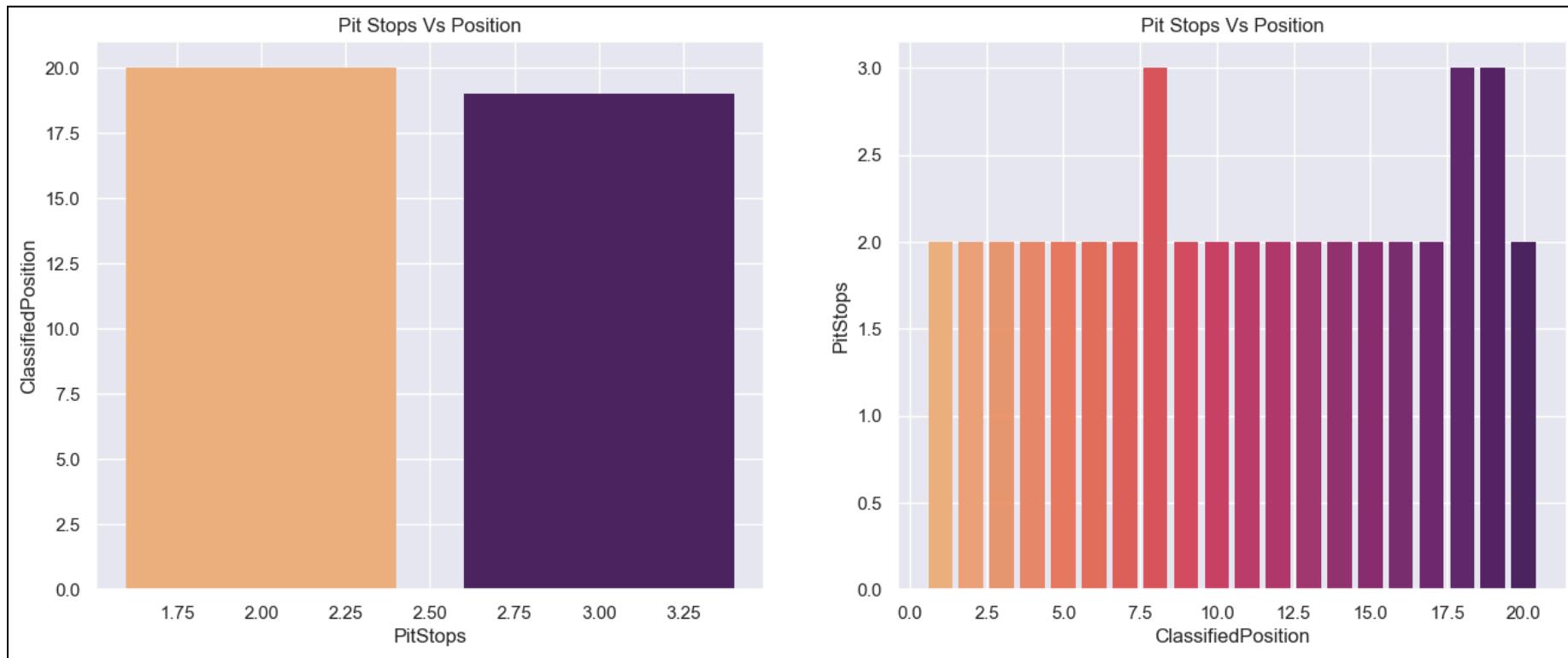
Spanish Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- We see in this race a fairly standard pattern of a chaotic first Stint, which doesn't have significant positive or negative intra-stint times due to car adjacency and lack of track wear
- Stint 2 and 3 have a general decrease in times despite some of the high lap averages present in both Stints
- As the race progresses, lap times tend to get more consistent

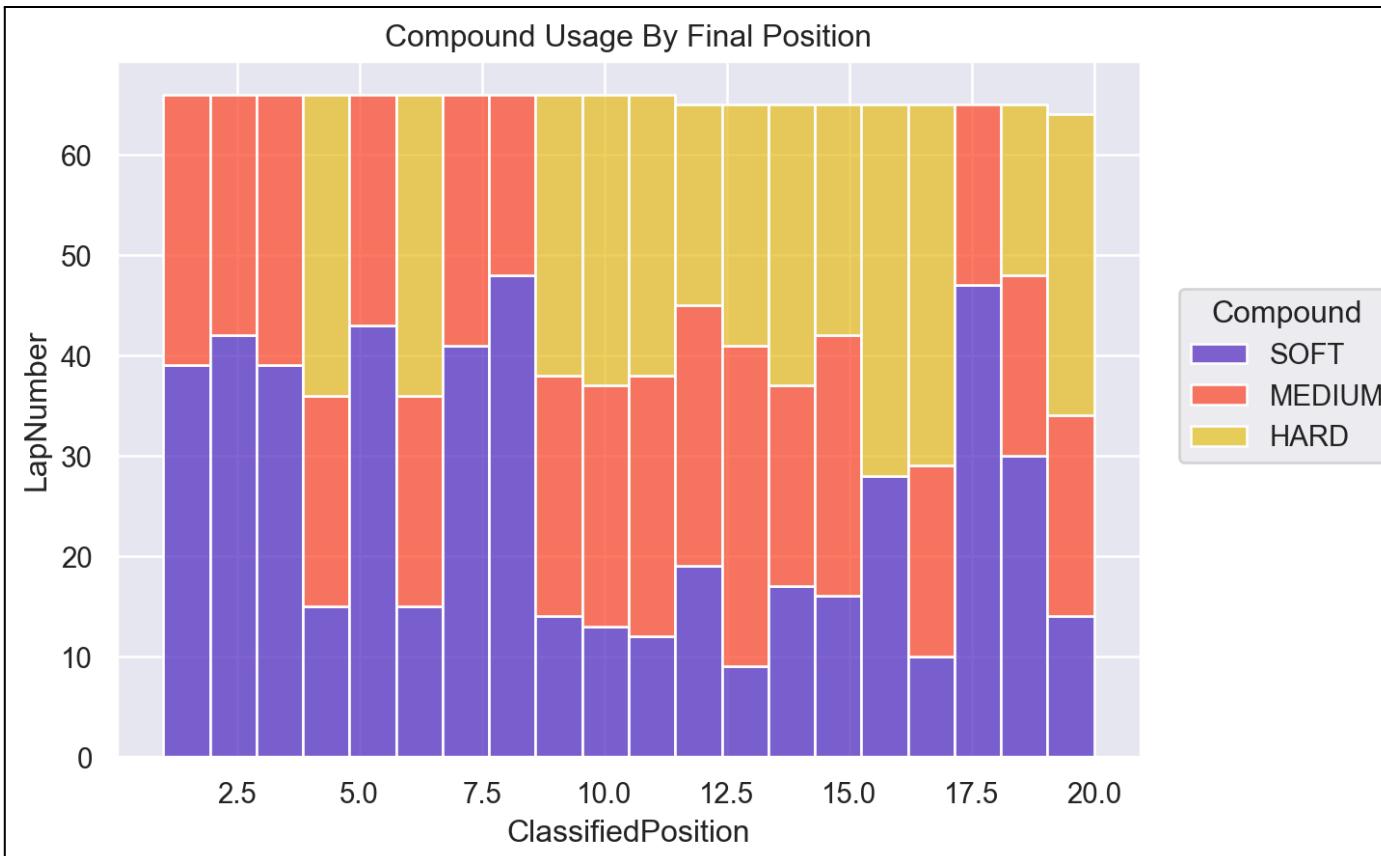
Spanish Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Here we see a standard non-correlation of this data, where generally higher pit stops is related to a worse position, but it's not a strong relationship

Spanish Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- Despite high variability in compound usage, the top positions tended to use a more limited set of tires (SOFT / MEDIUM) leaning towards more SOFT usage over the duration of the race
- Later positions used an even representation of SOFT / MEDIUM / HARD compounds, which is **not normal** - we usually see HARD compounds outperform MEDIUM and especially SOFT tires over time

Austrian Grand Prix - Basic Statistics

Teams

Alpine	GAS, OCO
Aston Martin	ALO, STR
Ferrari	SAI, LEC
Haas F1 Team	HUL, MAG
Kick Sauber	ZHO, BOT
McLaren	NOR, PIA
Mercedes	HAM, RUS
RB	RIC, TSU
Red Bull Racing	PER, VER
Williams	ALB, SAR

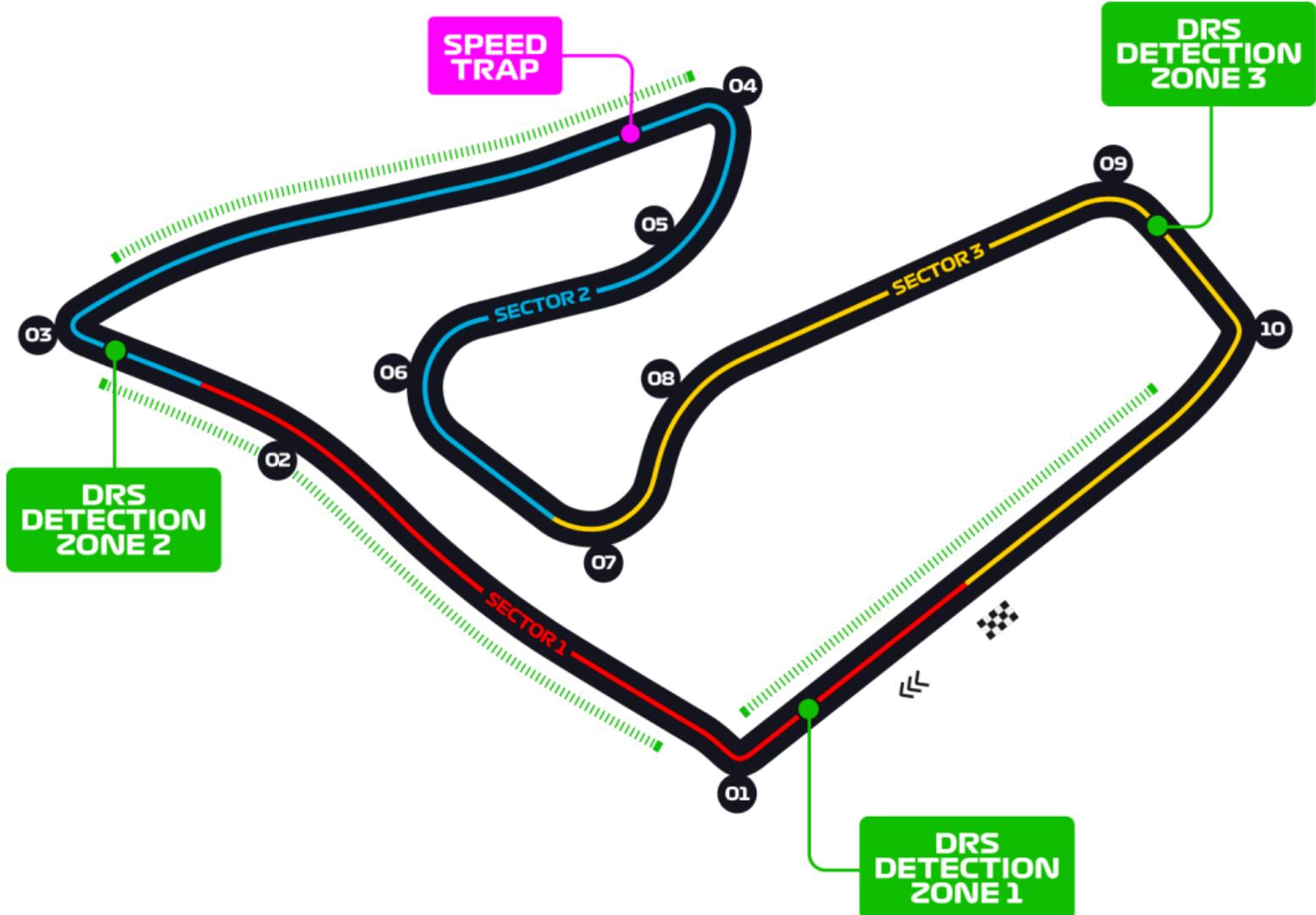
Total Statistics

Pit Stops	46
Pit Time	00:17:05
Laps Completed	1405
Lap Time	1 days 04:10:20
Race Laps	71
Compounds	[MEDIUM, HARD, SOFT]

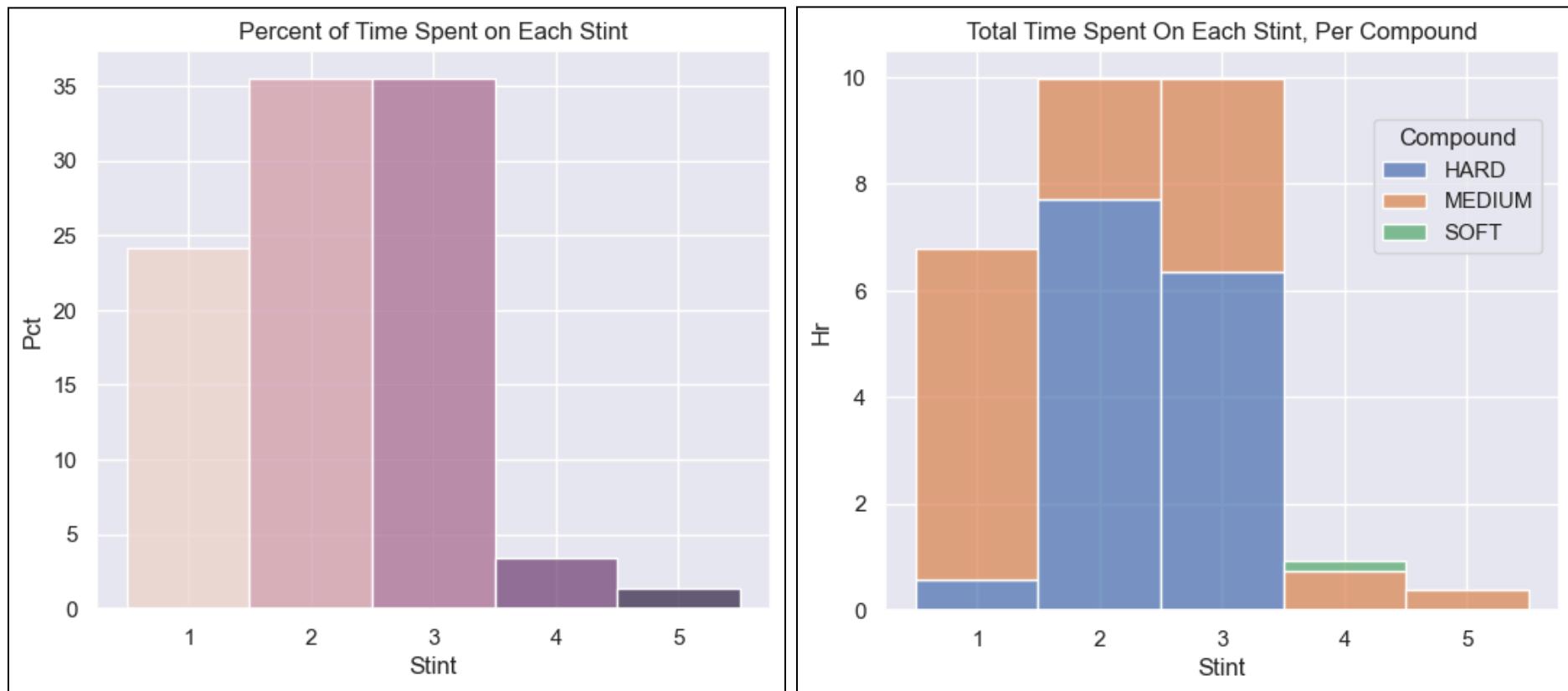
Average Statistics

Pit Stops	2.3
Pit Time	22.794
Laps Completed	70.25
Lap Time	0:01:12

[Austrian Grand Prix Link](#)



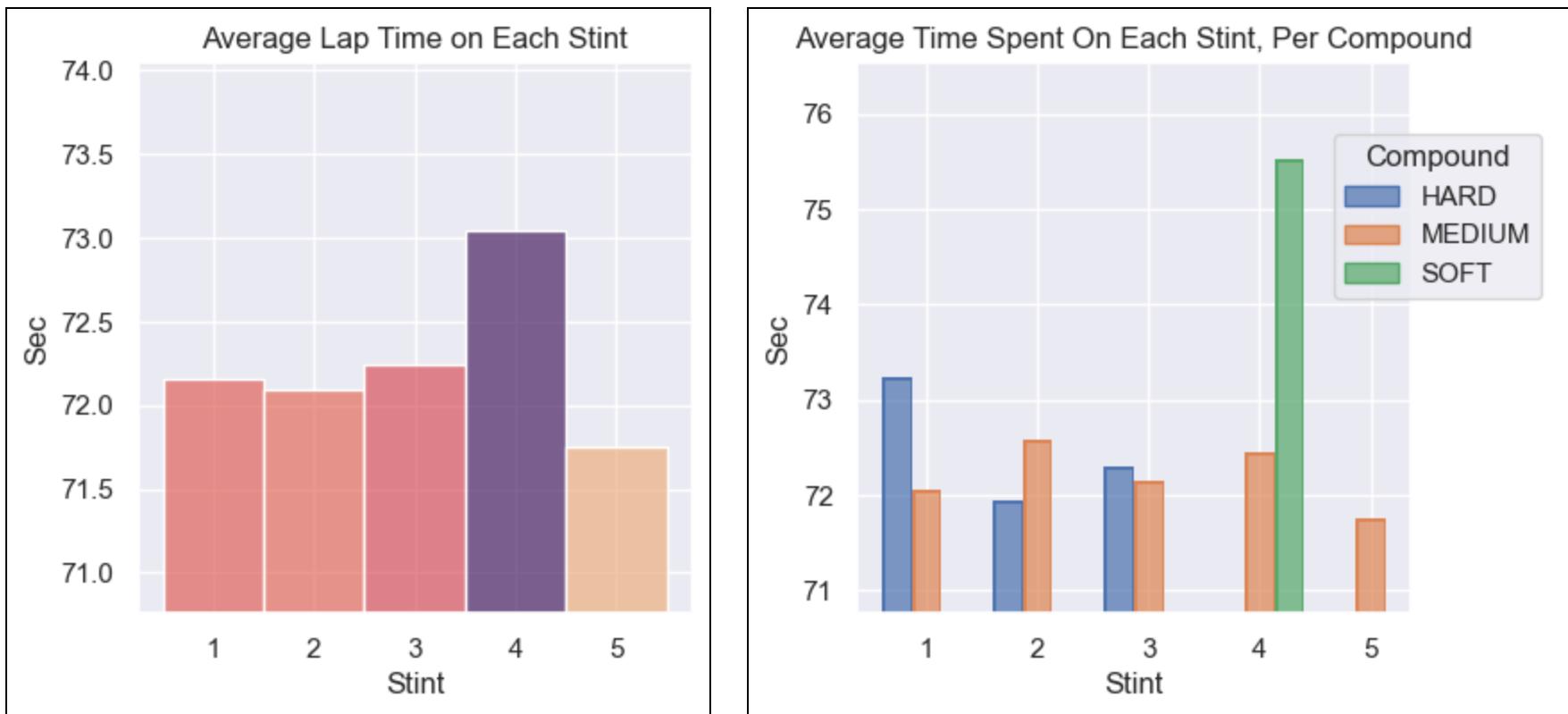
Austrian Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stints 1 through 3 have roughly equal representation, although Stint 1 can be characterized as a "Sprint Stint" because of the lower time and high MEDIUM tire usage
- Stints 2 and 3 somehow have completely equal time representation
- We see a shift in stints 2 and 3 to higher HARD tire bias, although MEDIUM tires are still represented
 - Usually one or another tire compound takes the huge majority, but here the minority tire (MEDIUM) is non-negligible
 - MEDIUM tires are probably used more as an even tradeoff between traction on straightaways and cutting turns more tightly
- Stint 4 and 5 are under represented in this race, and see some of the only SOFT compound representation

Austrian Grand Prix - Average Lap Time Per Stint / Per Compound



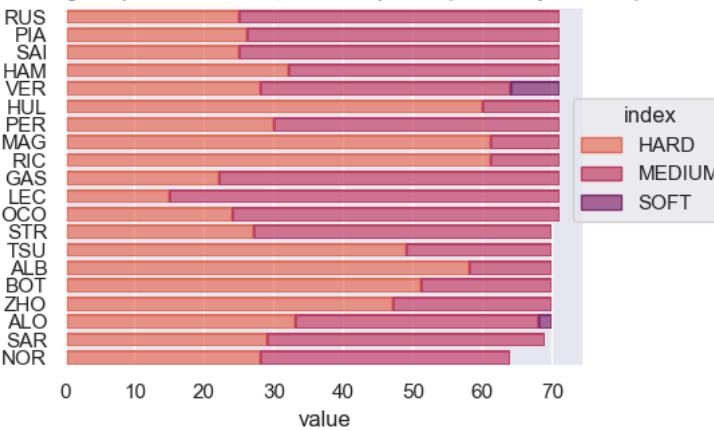
Insights

- Despite the disproportionate use of tire compounds between Stint 1 and 2 / 3, we see roughly equal lap times between these Stints
- Stint 4 is likely higher because it is under-represented by a driver that was in the back half of the race
- MEDIUM tires see roughly equal times across all stints
- HARD tire times decrease slightly as the race continues, although this isn't strongly represented here
 - Likely because the amount of time saved on straightaways is less than on a very turn-heavy track where softer compounds excel

Austrian Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
RUS	2	42.894	71	1:24:23	0:01:11	1	LEC	4	96.589	71	1:25:30	0:01:12	11
PIA	2	41.689	71	1:24:25	0:01:11	2	OCO	2	43.454	71	1:25:31	0:01:12	12
SAI	2	42.353	71	1:24:27	0:01:11	3	STR	2	43.002	70	1:24:33	0:01:12	13
HAM	2	48.929	71	1:24:46	0:01:12	4	TSU	2	44.927	70	1:24:36	0:01:13	14
VER	3	70.762	71	1:24:50	0:01:12	5	ALB	2	43.397	70	1:24:34	0:01:12	15
HUL	2	44.117	71	1:25:17	0:01:12	6	BOT	2	43.864	70	1:24:42	0:01:13	16
PER	2	48.646	71	1:25:17	0:01:12	7	ZHO	3	44.702	70	1:25:08	0:01:13	17
MAG	2	43.306	71	1:25:23	0:01:12	8	ALO	3	77.967	70	1:25:10	0:01:13	18
RIC	2	42.353	71	1:25:24	0:01:12	9	SAR	3	76.349	69	1:24:29	0:01:13	19
GAS	2	43.551	71	1:25:25	0:01:12	10	NOR	2	42.918	64	1:16:31	0:01:12	20

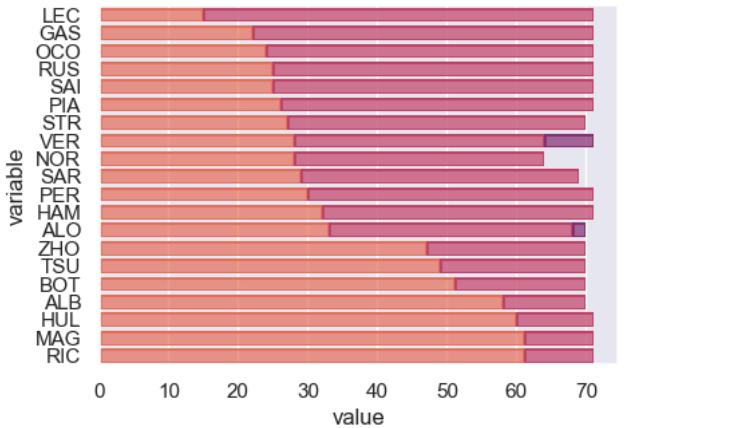
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- Average lap time is within +/- 1 second for drivers in this race
- Most drivers elected to use two pit stops, and the most pit stops was LEC with 4
- Despite NOR not finishing the race at 64 laps and ending at a pit stop, they did not DNF and placed 20th
- Top drivers chose to use a roughly 1:2 proportion of HARD:MEDIUM, although this performance was consistent across both middle and last place drivers as well
 - Observation:** This may suggest that this race relied more heavily on driver skill and less on tire strategy
- SOFT compounds are only used in small proportions this race, by ALO and VER

Average Laps in Each Stint, Per Compound (Sorted by Compound)

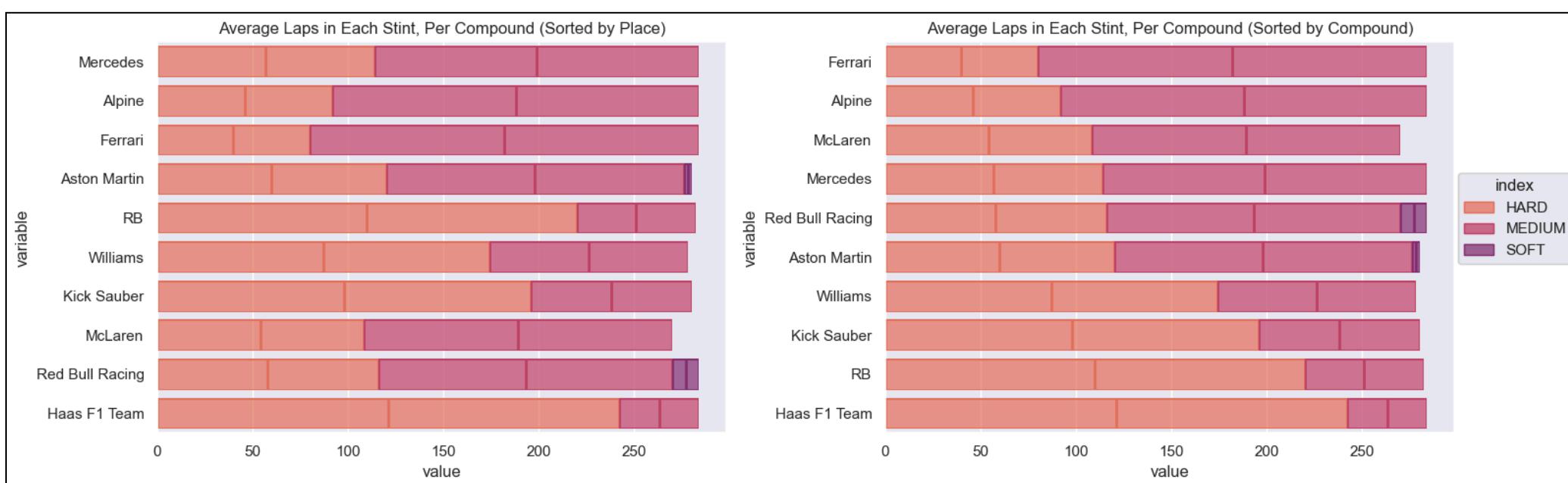


Austrian Grand Prix - Team Data

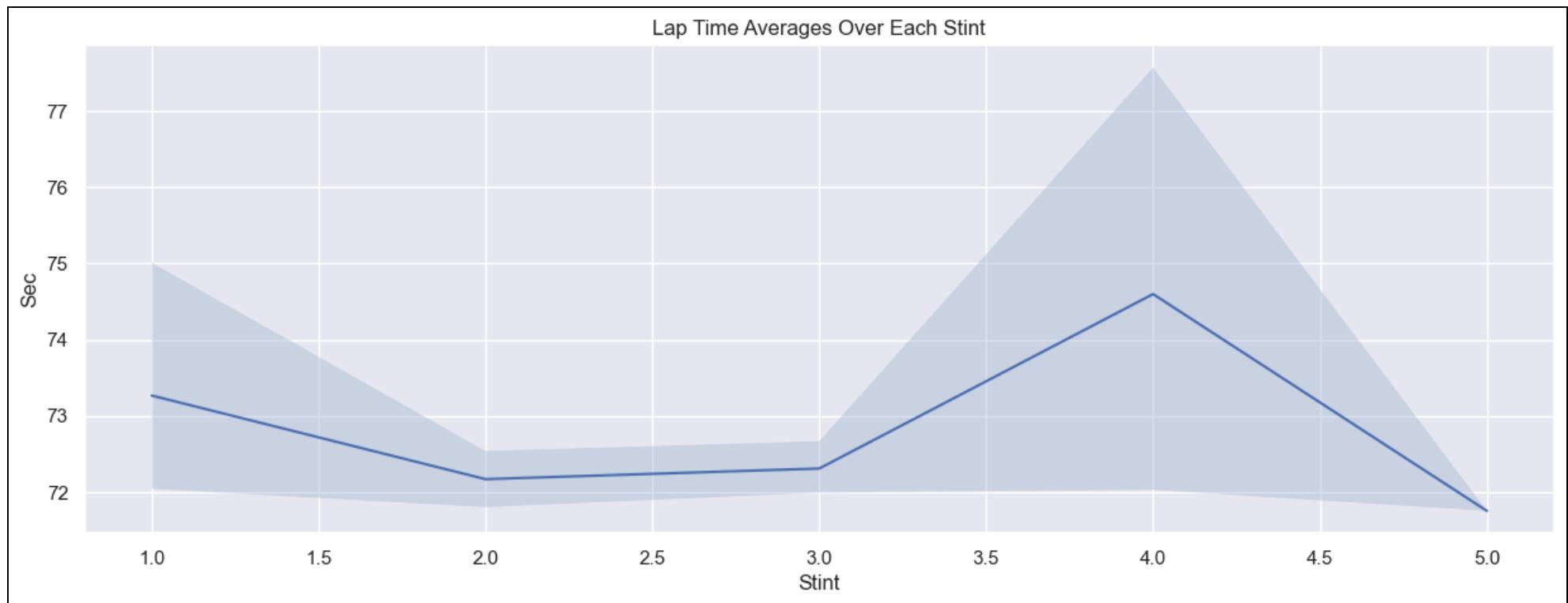
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
McLaren	2	4	84.607	64	2:40:56	0:01:12
Williams	2	5	119.746	69	2:49:03	0:01:13
Mercedes	2	4	91.823	71	2:49:09	0:01:11
Aston Martin	2	5	120.969	70	2:49:43	0:01:13
Kick Sauber	2	5	88.566	70	2:49:50	0:01:13
Ferrari	2	6	138.942	71	2:49:57	0:01:12
RB	2	4	87.28	70	2:50:00	0:01:12
Red Bull Racing	2	5	119.408	71	2:50:08	0:01:12
Haas F1 Team	2	4	87.423	71	2:50:40	0:01:12
Alpine	2	4	87.005	71	2:50:56	0:01:12

Insights

- Ferrari saw the most pit stops, at 6
- McLaren lost a member to DNF, sort of, even though all drivers placed in the race
- Alpine had the shortest pit time and Ferrari had the longest
- Among top placing teams, they elected to use less HARD compounds and more MEDIUM compounds. Other teams also had this strategy, or the reverse, with more HARD compounds and less MEDIUM compounds



Austrian Grand Prix - Lap Time Averages

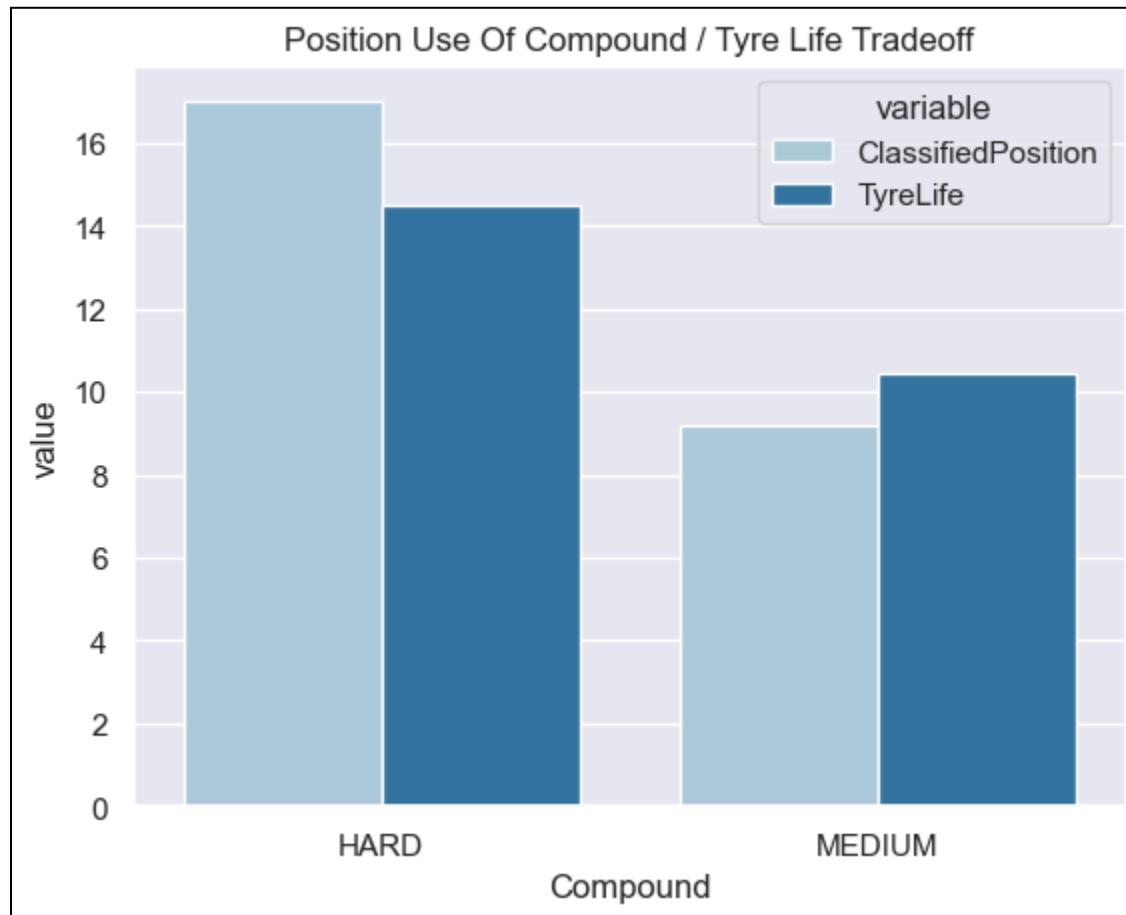


Insights

- Stints 4 and 5 are under represented for this race, hence the high variation in those stints
- From Stint 1 to Stint 2 we see a typical downward slope
- From Stint 2 to Stint 3 we see a slight upward increase in time

Austrian Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

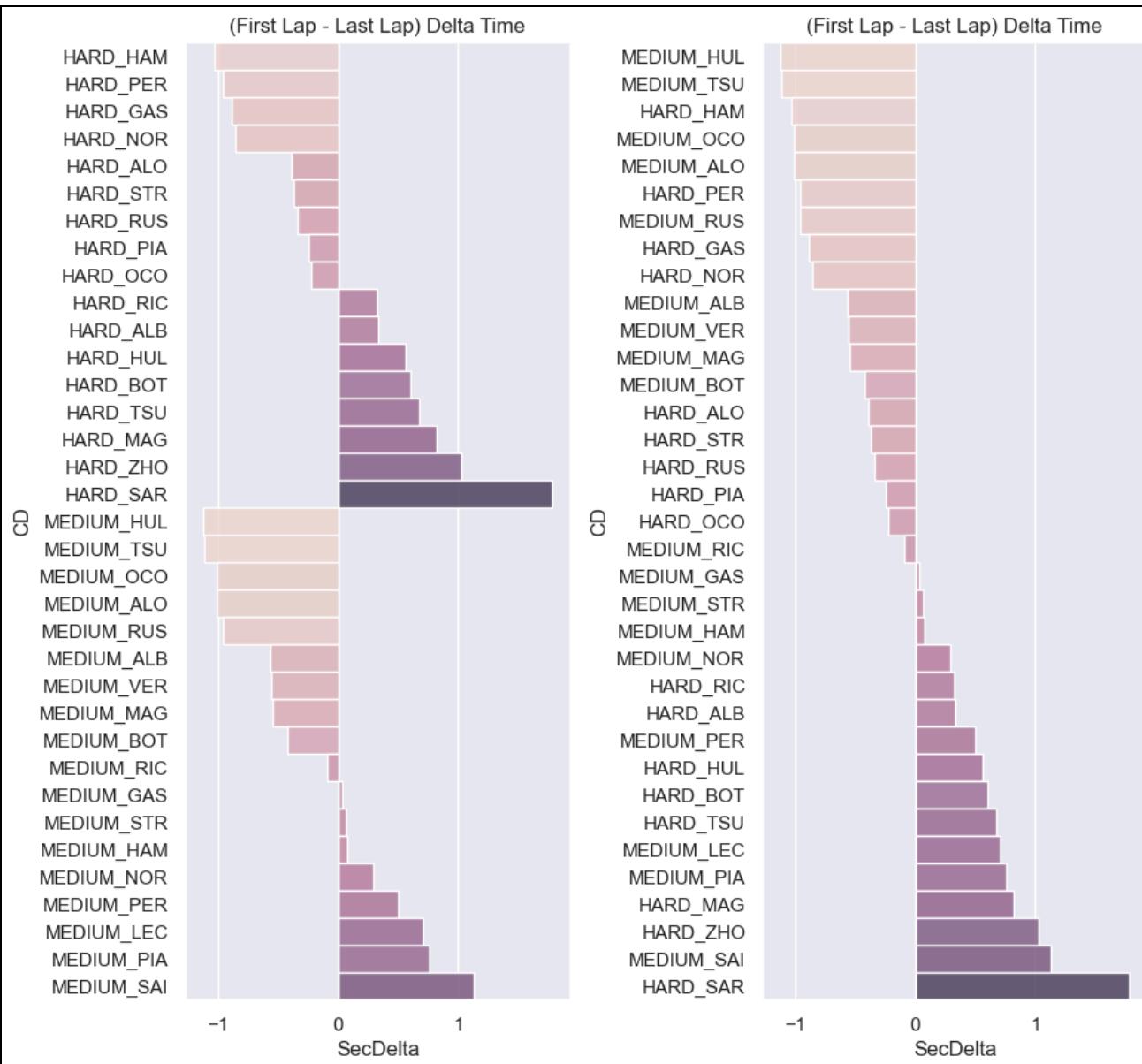
Compound	Position	ClassifiedPosition	TyreLife
HARD	16.1786	17	14.5
MEDIUM	7.8269	9.2115	10.4199



Insights

- Drivers that start with HARD tires tend to see a relative decrease in position of 0.8 and an absolute position that places in the last quarter of the race
- Drivers that start with MEDIUM tires see a greater decrease in relative position but are much higher placed than other compounds
- Tire life obviously sees a much higher increase with HARD tires than MEDIUM tires
 - Observation:** In this race we see that the classification increase with MEDIUM tires is greater than MEDIUM tire life, and the opposite is true for HARD tires, suggesting that MEDIUM tires are the better option this race

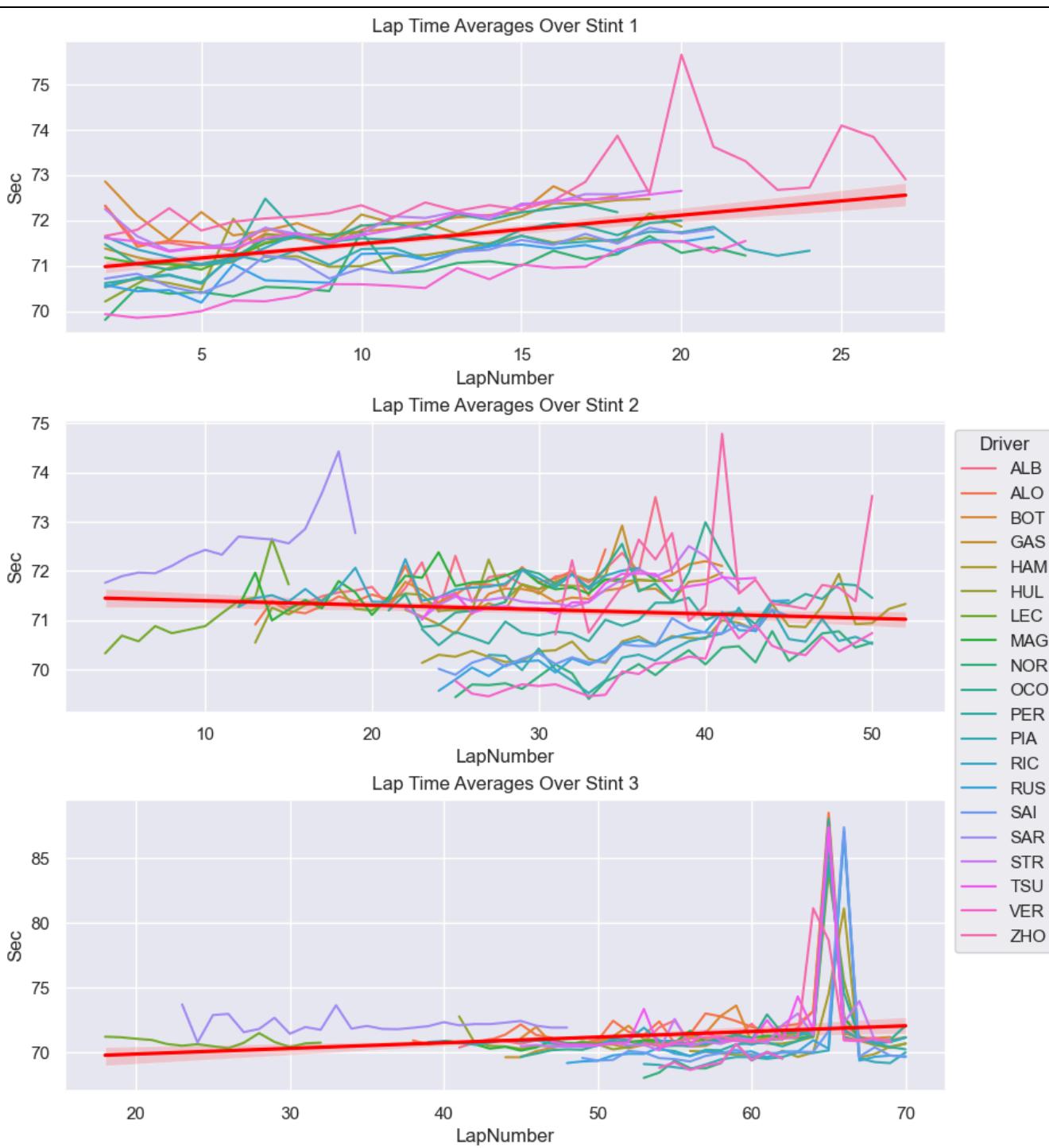
Austrian Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- Time deltas are fairly evenly represented over all compounds
- HARD tires saw the best average lap split at -1.9s and the worst at +1s
- MEDIUM tires saw a range of +1.1 to -1.1, which was more evenly distributed

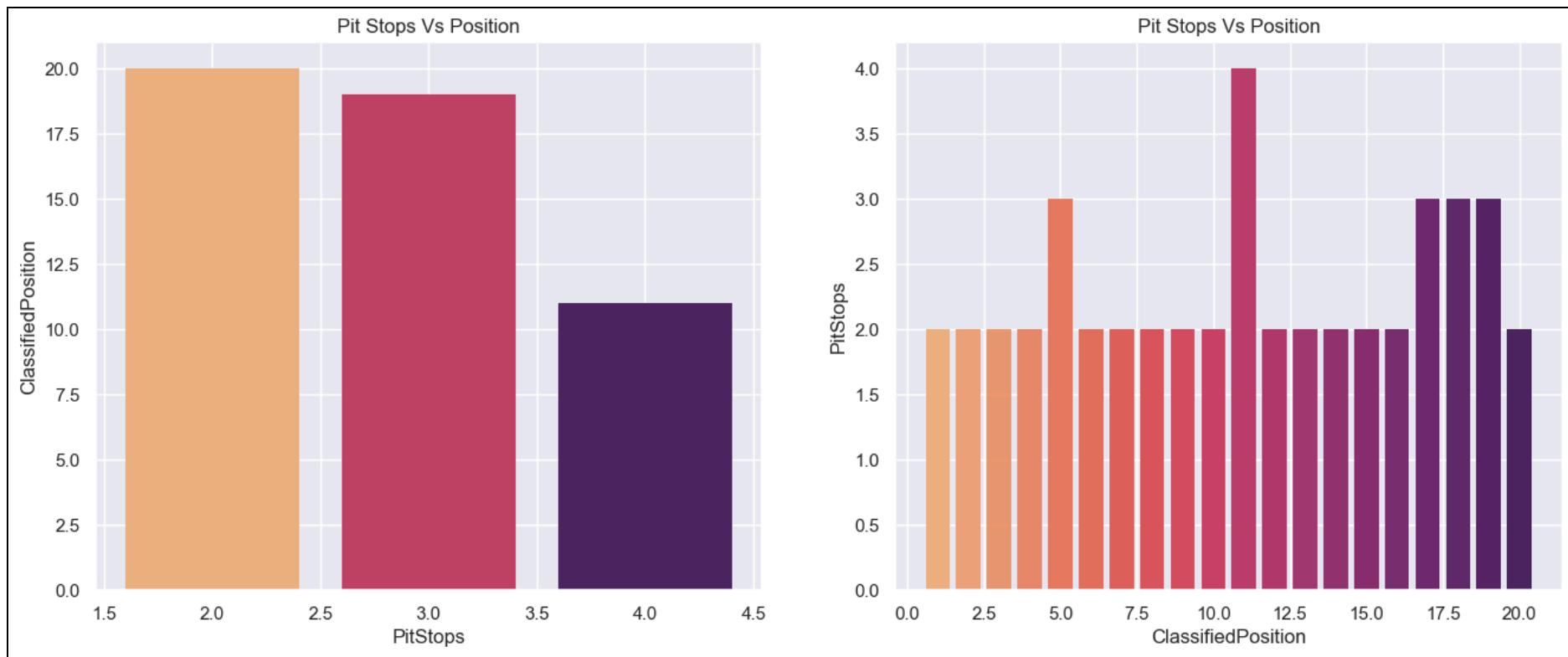
Austrian Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Stint 1 lap times saw a general increase in times which is interesting. We might expect to see one or two drivers messing up the average, but instead everyone lost time throughout the stint
- **Observation:** SAI was penalized for a Turn 1 penalty, and most drivers were still dealing with car adjacency throughout the first stint due to the long straightaways, unlike many other races with more twists and turns that funnel drivers into a single line more effectively
- **Observation:** Most drivers lost lap time because they were directly racing one or two other drivers during the first stint
- Lap times evened out in Stint 2
- Due to some collisions in lap 64, several drivers lost time from the collisions themselves or getting stuck behind those drivers

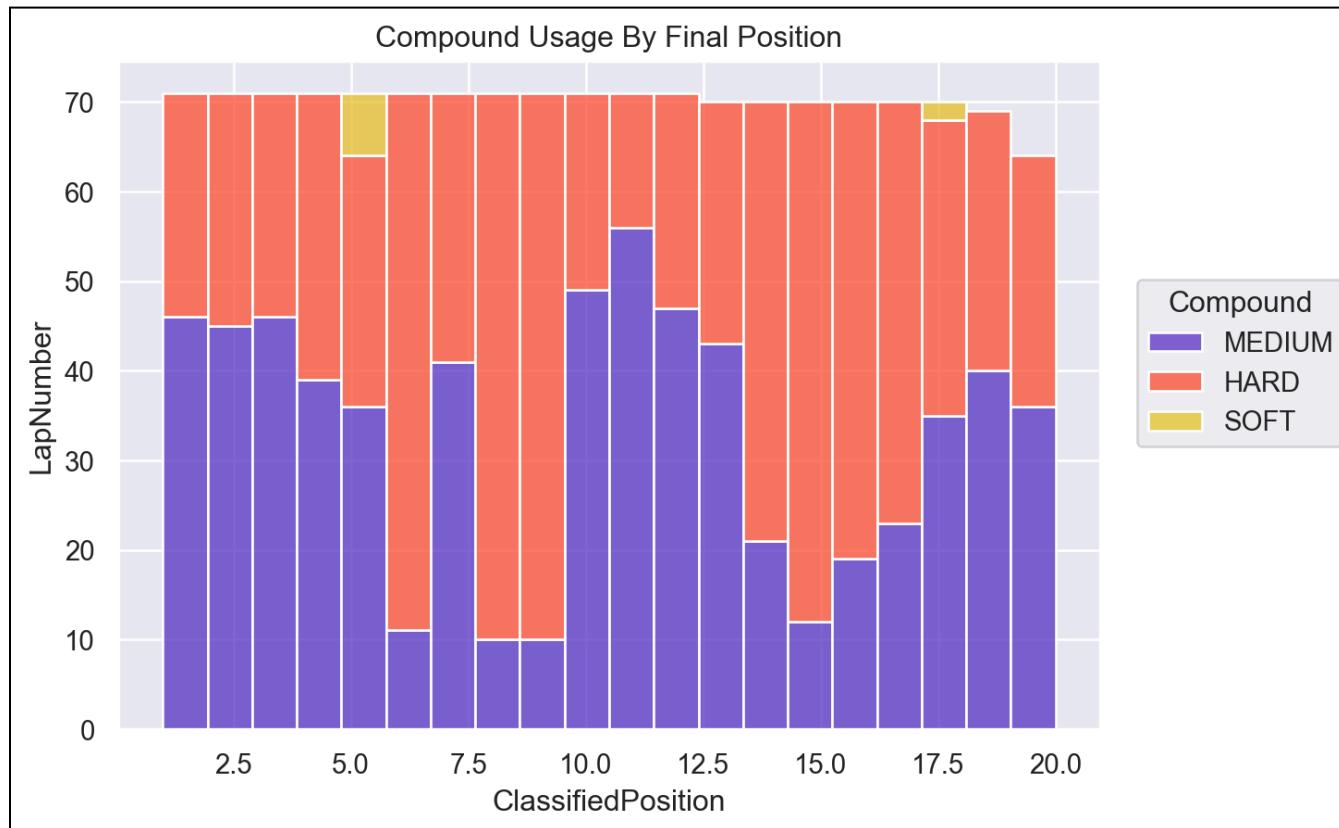
Austrian Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- There is poor correlation between number of pit stops and placement in this race, although more pit stops was usually associated with worse performance

Austrian Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- The top tire strategy was represented at all positions (front / mid / back) of the race, and we don't see much difference between top and bottom drivers
- SOFT tires saw some usage by top drivers (VER) which is unusual for drivers at the top of a race. Usually we see SOFT tires being used by bottom performers

British Grand Prix - Basic Statistics

Teams

Alpine	GAS, OCO
Aston Martin	STR, ALO
Ferrari	SAI, LEC
Haas F1 Team	HUL, MAG
Kick Sauber	ZHO, BOT
McLaren	NOR, PIA
Mercedes	HAM, RUS
RB	RIC, TSU
Red Bull Racing	PER, VER
Williams	SAR, ALB

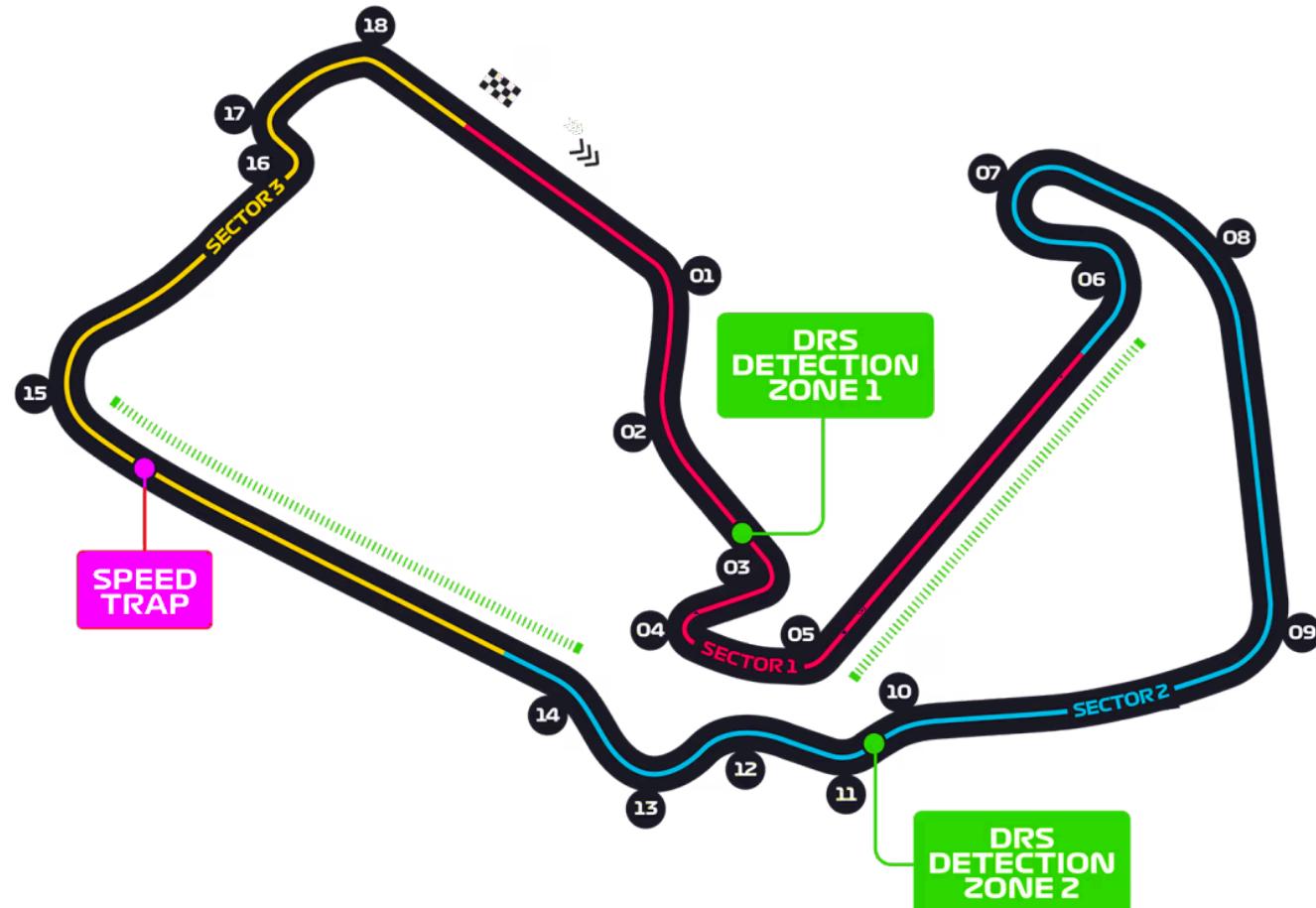
Total Statistics

Pit Stops	46
Pit Time	00:22:20
Laps Completed	961
Lap Time	1 days 01:49:25
Race Laps	52
Compounds	[MEDIUM, INTERMEDIATE, SOFT, HARD]

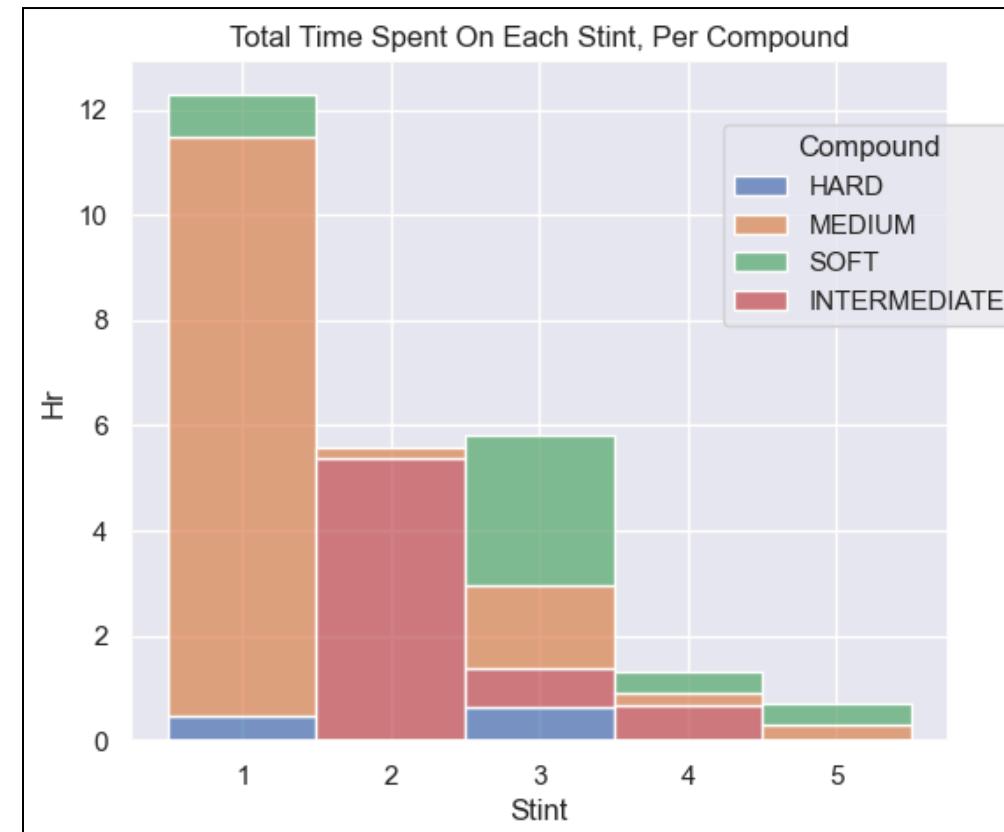
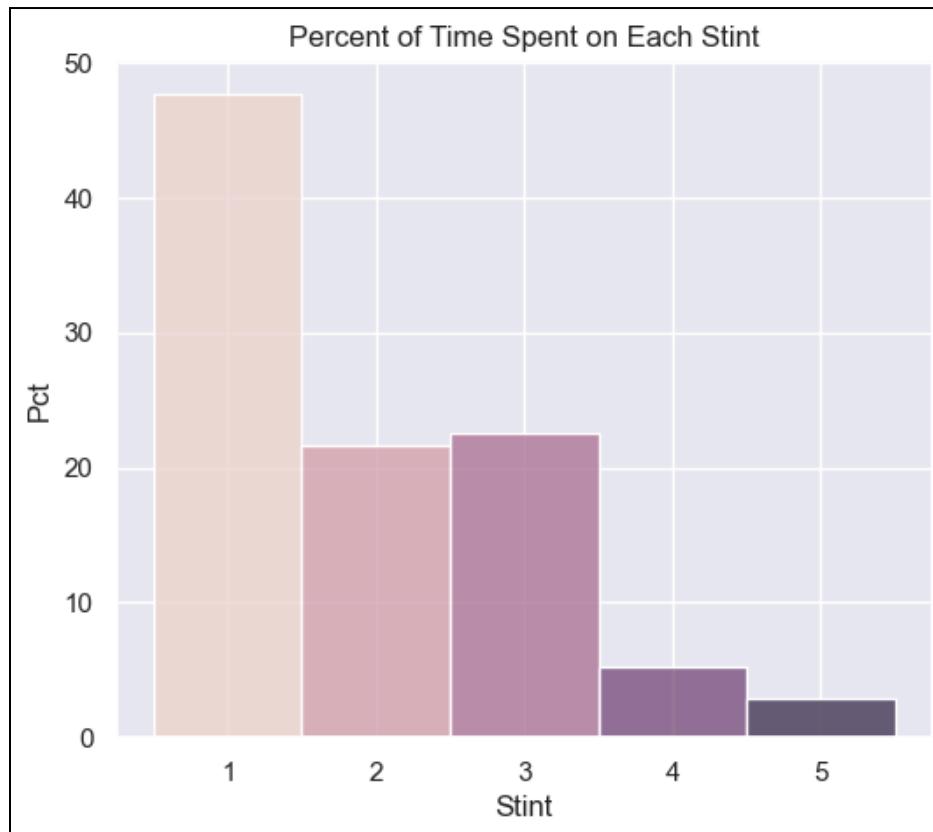
Average Statistics

Pit Stops	2.4211
Pit Time	29.781
Laps Completed	48.05
Lap Time	0:01:37

[British Grand Prix Link](#)



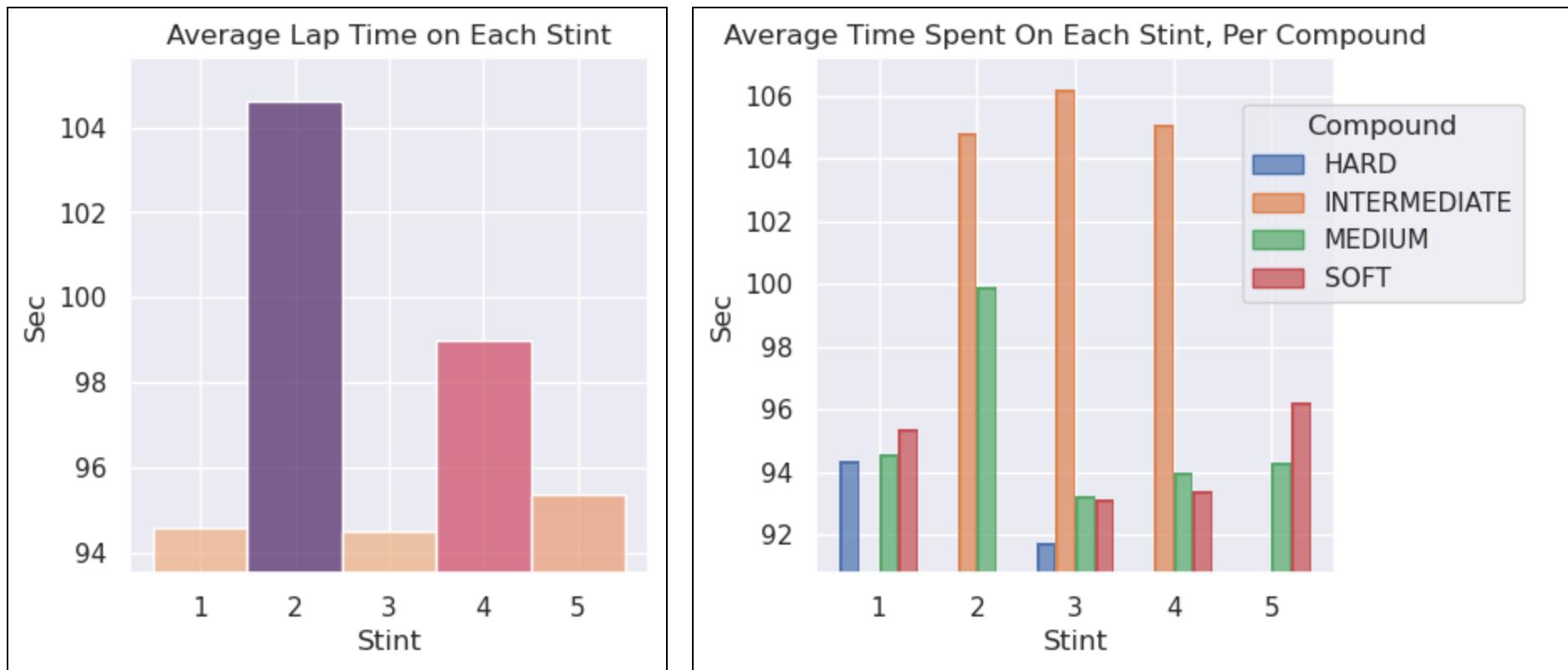
British Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- Stint 1 saw the highest time by more than half of any other Stint
 - Drivers were forced to switch tires due to weather more often than they otherwise would have
- Stint 1 is mostly MEDIUM tires with some SOFT and HARD representation
 - **Observation:** We don't usually see HARD tires in the first stint unless there is rain on the track
 - **Observation:** Mid-race showers saw a hard switch into INTERMEDIATE tires, suggesting that the HARD usage at the beginning of the track was not related to the weather
- Despite the long straightaways in this track, we don't see that much HARD tire usage as we normally do on tracks with long straightaways
 - This is likely because of the extreme turns in sectors 2 and 3
- **Observation:** WET tires were not used at all during this race
- The weather cleared up in the last half of the race, where we see more SOFT / MEDIUM / HARD tire representation over INTERMEDIATE

British Grand Prix - Average Lap Time Per Stint / Per Compound



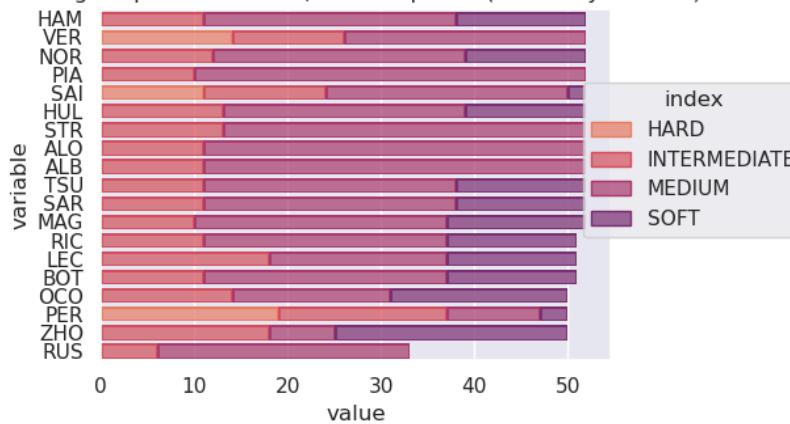
Insights

- The average lap time on Stint 2 was much higher, likely caused by the transition to INTERMEDIATE compounds during the rain
- INTERMEDIATE tires saw a roughly uniform average time when used
- INTERMEDIATE tires were generally much slower than any other compound by almost 10 seconds in the Stints with other tire representation
- Observation:** After the rains subsided, it would have been better for the INTERMEDIATE tires to be swapped out to something else, although around a quarter of drivers still decided to use INTERMEDIATE tires on Stint 3

British Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
HAM	2	59.026	52	1:22:27	0:01:35	1	SAR	2	62.292	52	1:23:56	0:01:37	11
VER	2	57.622	52	1:22:29	0:01:35	2	MAG	2	60.049	52	1:23:57	0:01:37	12
NOR	2	59.104	52	1:22:35	0:01:35	3	RIC	2	58.777	51	1:22:37	0:01:37	13
PIA	2	58.936	52	1:22:39	0:01:35	4	LEC	3	86.83	51	1:23:08	0:01:38	14
SAI	3	86.864	52	1:23:14	0:01:36	5	BOT	2	62.109	51	1:23:09	0:01:38	15
HUL	2	59.923	52	1:23:23	0:01:36	6	OCO	4	115.174	50	1:22:38	0:01:39	16
STR	2	58.489	52	1:23:24	0:01:36	7	PER	5	118.76	50	1:22:45	0:01:39	17
ALO	2	59.097	52	1:23:31	0:01:36	8	ZHO	4	121.095	50	1:23:22	0:01:40	18
ALB	2	64.268	52	1:23:35	0:01:36	9	RUS	1	32.139	33	0:52:52	0:01:36	99
TSU	2	59.621	52	1:23:46	0:01:37	10	GAS	0	0	1			99

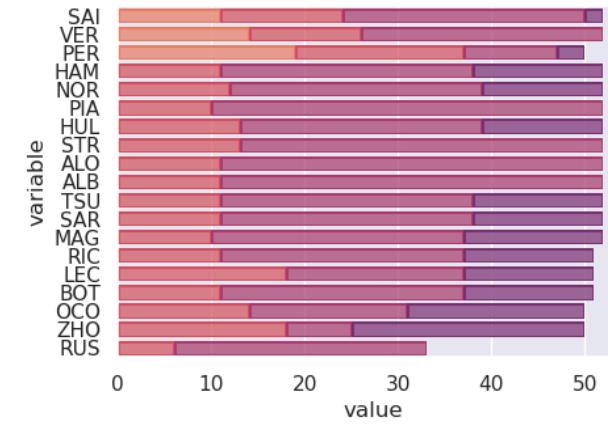
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- The compound use of drivers throughout the race was very consistent
- Drivers who elected to use HARD compounds (VER / SAI) tended to perform better in the last part of the race (except PER) when mixed evenly with other tire types
- GAS was DNF this race and it looks like they didn't get a chance to race at all
- RUS was able to complete 33 laps before DNF due to a suspected water system issue with their vehicle
- The average lap time for this race was slightly more varied than usual, with a +3 second time on average between drivers
- Most drivers elected for 2 pit stops, and the highest was PER with 5
 - Most of the pit stops here were because of indecision with which tires to use during the race, and a noticeable degradation on certain tires due to a wet track

Average Laps in Each Stint, Per Compound (Sorted by Compound)

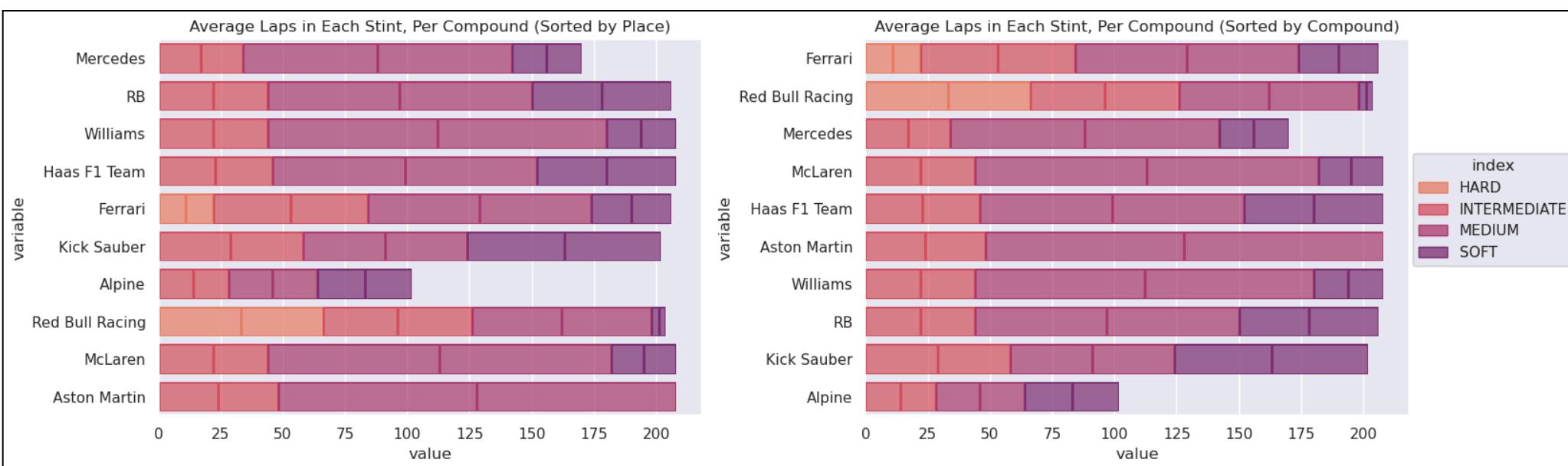


British Grand Prix - Team Data

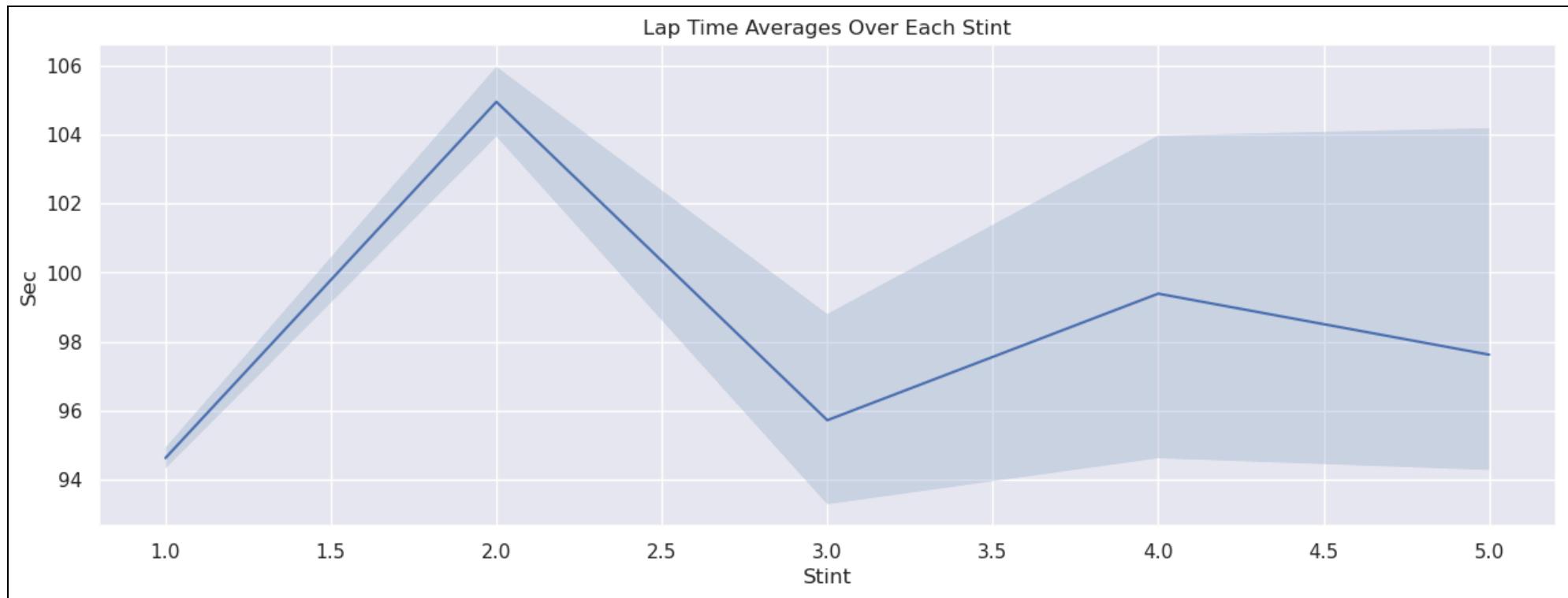
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Alpine	2	4	115.174	1	1:22:38	0:01:39
Mercedes	2	3	91.165	33	2:15:19	0:01:36
Red Bull Racing	2	7	176.382	50	2:45:14	0:01:37
McLaren	2	4	118.04	52	2:45:14	0:01:35
Ferrari	2	6	173.694	51	2:46:22	0:01:37
RB	2	4	118.398	51	2:46:23	0:01:37
Kick Sauber	2	6	183.204	50	2:46:30	0:01:39
Aston Martin	2	4	117.586	52	2:46:54	0:01:36
Haas F1 Team	2	4	119.972	52	2:47:20	0:01:37
Williams	2	4	126.56	52	2:47:31	0:01:37

Insights

- Red Bull pulled behind with a stark 7 pitstops during this race, with Kick Sauber and Ferrari not far behind at 6
- Alpine and Mercedes both has players DNF
- Kick Sauber had the most pit time and Aston Martin had the least
- Winning teams tended to use about 25% each of INTERMEDIATE & SOFT, and about 50% MEDIUM compounds with 0% HARD usage
 - Unlike other races, we see limited HARD usage here, likely because they are affected significantly by the rain



British Grand Prix - Lap Time Averages

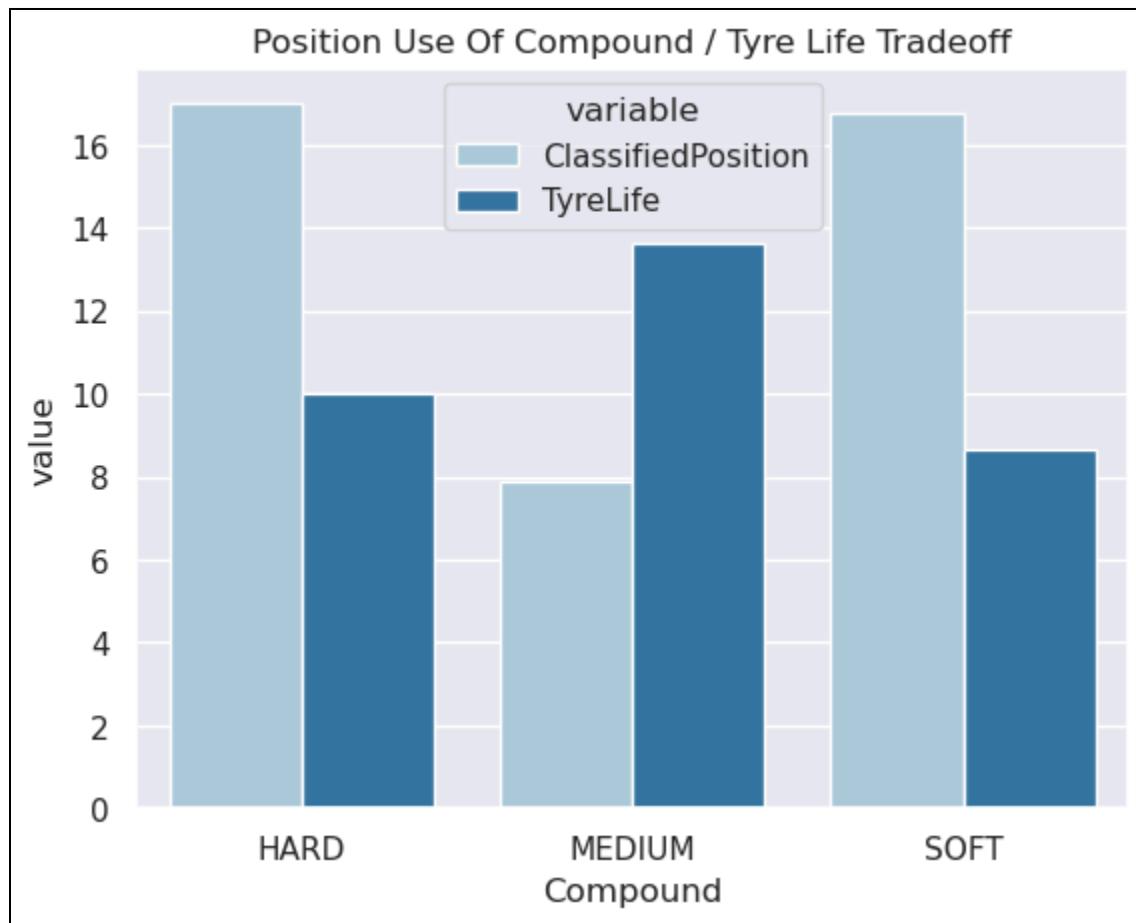


Insights

- Lap time averages were generally all over and we can see the effect that rain had on the track, **increasing times on average by about 12 seconds**
- In the later half of the race the lap times decreased, but time variation within each Stint increased significantly since Stints 4 and 5 were under-represented

British Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

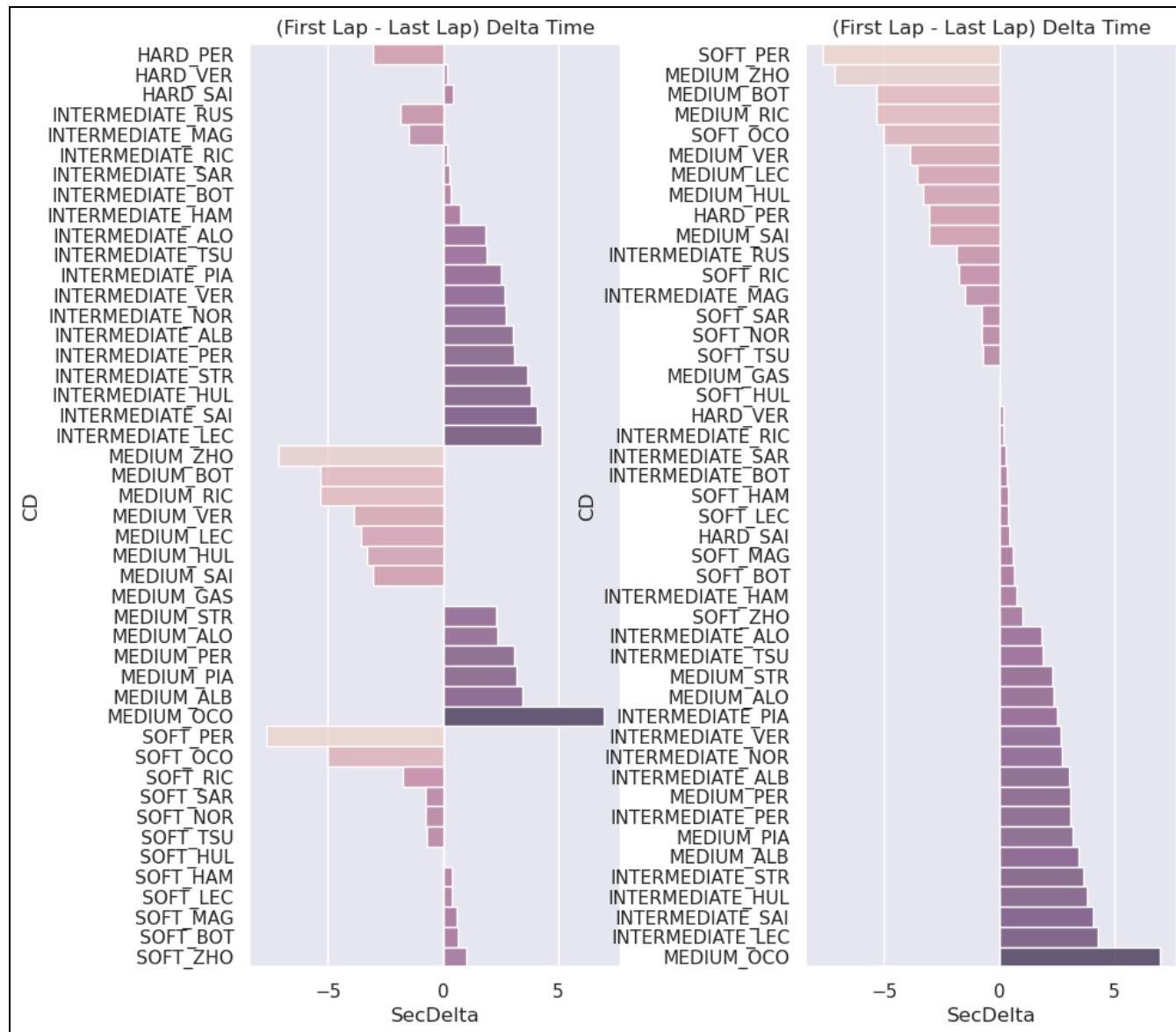
Compound	Position	ClassifiedPosition	TyreLife
HARD	16.7368	17	10
MEDIUM	8.9337	7.8673	13.6429
SOFT	16.7097	16.7742	8.6452



Insights

- Drivers that started with HARD or SOFT compounds generally didn't see much movement in relative or absolute position during the race
- Drivers who used MEDIUM tires to begin with saw about 1 position increase and a higher absolute position
- This data is skewed because of the rain, and it's clear that tire common strategy was ruined this race
- Tire life for HARD tires was limited this race and less than MEDIUM tires, based on how HARD tires were used in each Stint

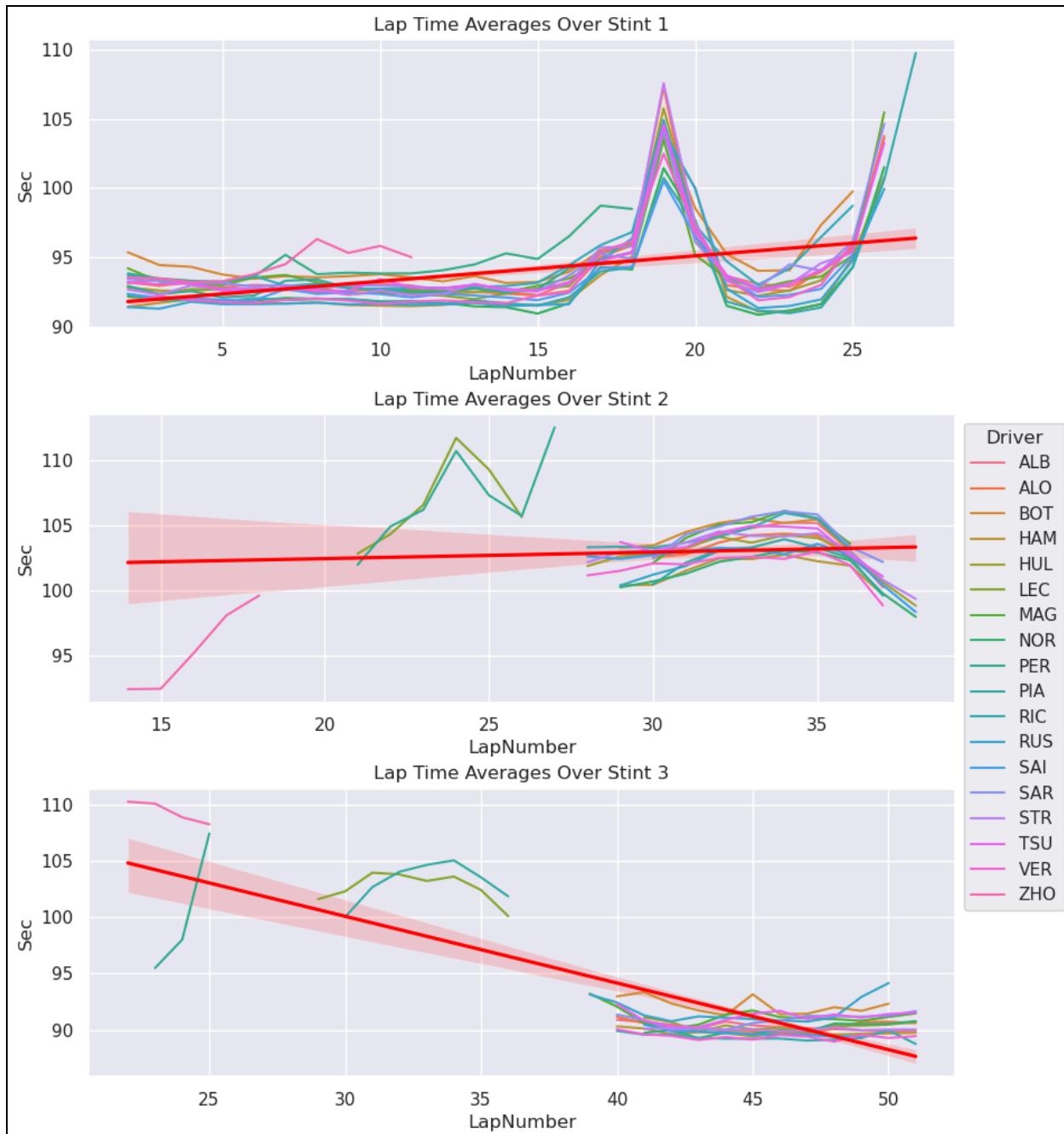
British Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- HARD tires are under-represented in this race, but generally saw a positive split of up to 4 seconds
- INTERMEDIATE tires almost totally saw a negative split up to -5 seconds
- MEDIUM tires see a lap split between +8s and -8s, for a roughly even distribution of times. No MEDIUM drivers saw a time below or above +3/-3s
- SOFT tires generally saw a positive split at around +4s on average, PER's soft tires saw a +8 split on average

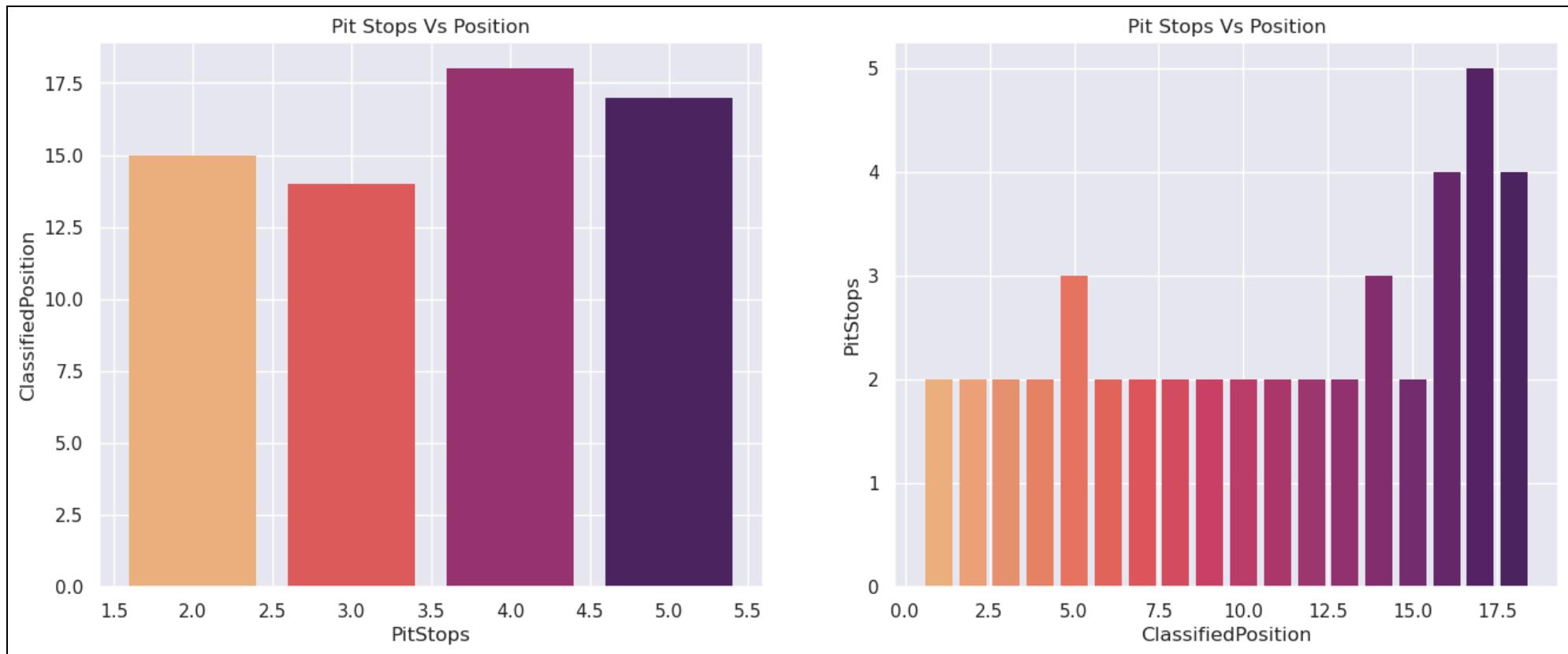
British Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Rain began on lap 18 but most drivers did not decide to pit stop until lap 25
- Most drivers struggled significantly at lap 18 and 19 when the rain first started and saw a significant decrease in time for all drivers on the order of about +15 seconds
- It wasn't until lap 24 or 25 when drivers began performing worse than average when they decided to pit stop at 26 or 27
- Stint 2 sees a comparison of some drivers who pit stopped earlier around lap 20 and generally their performance is worse
- Stint 3 lap times transition quickly out of INTERMEDIATE tires into standard tire compounds and see a significant decrease in times on average, back down -15 seconds as normal

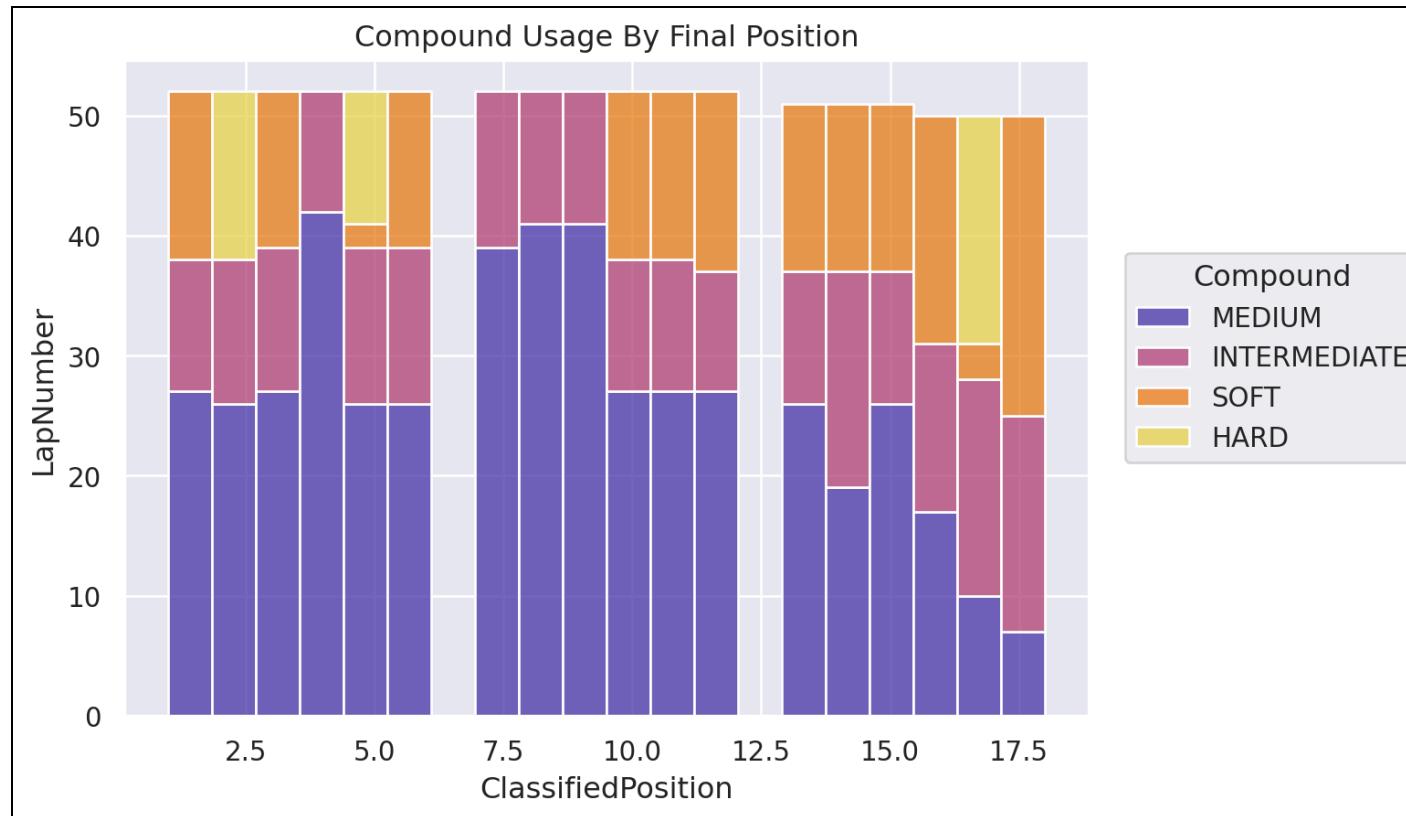
British Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Pit stops in this case tended to favor drivers that only stopped twice, and frowned upon those who stopped 3 or more times

British Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- Top drivers used approximately the same tire representations across the board for MEDIUM and INTERMEDIATE but switched things up with HARD / SOFT usage
 - This is consistent for most drivers
- Low scoring drivers used less MEDIUM compounds than the rest of the drivers in this race

Hungarian Grand Prix - Basic Statistics

Teams

Alpine	GAS, OCO
Aston Martin	ALO, STR
Ferrari	SAI, LEC
Haas F1 Team	HUL, MAG
Kick Sauber	ZHO, BOT
McLaren	NOR, PIA
Mercedes	RUS, HAM
RB	TSU, RIC
Red Bull Racing	VER, PER
Williams	ALB, SAR

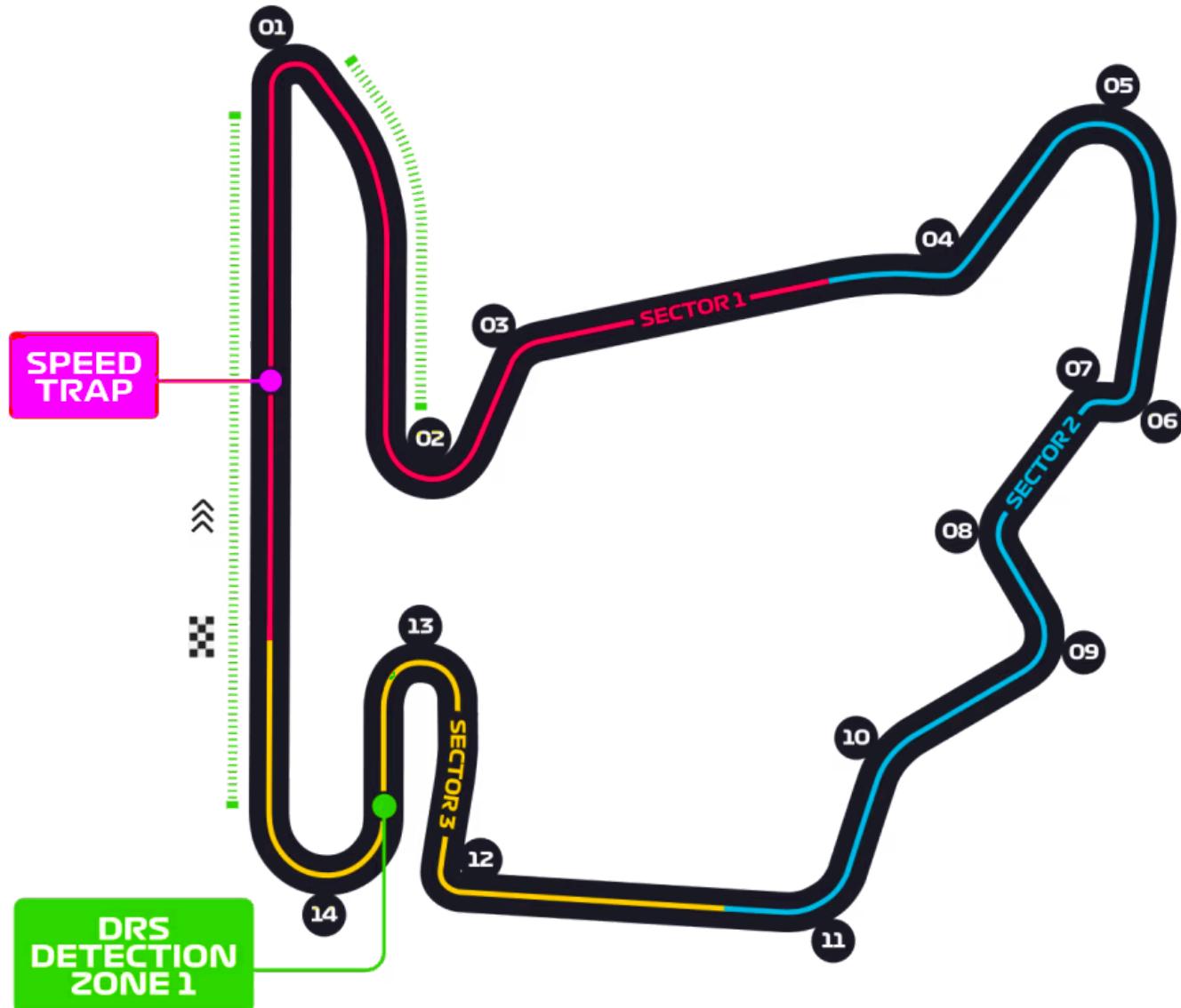
Total Statistics

Pit Stops	41
Pit Time	00:14:33
Laps Completed	1355
Lap Time	1 days 08:02:53
Race Laps	70
Compounds	[MEDIUM, HARD, SOFT]

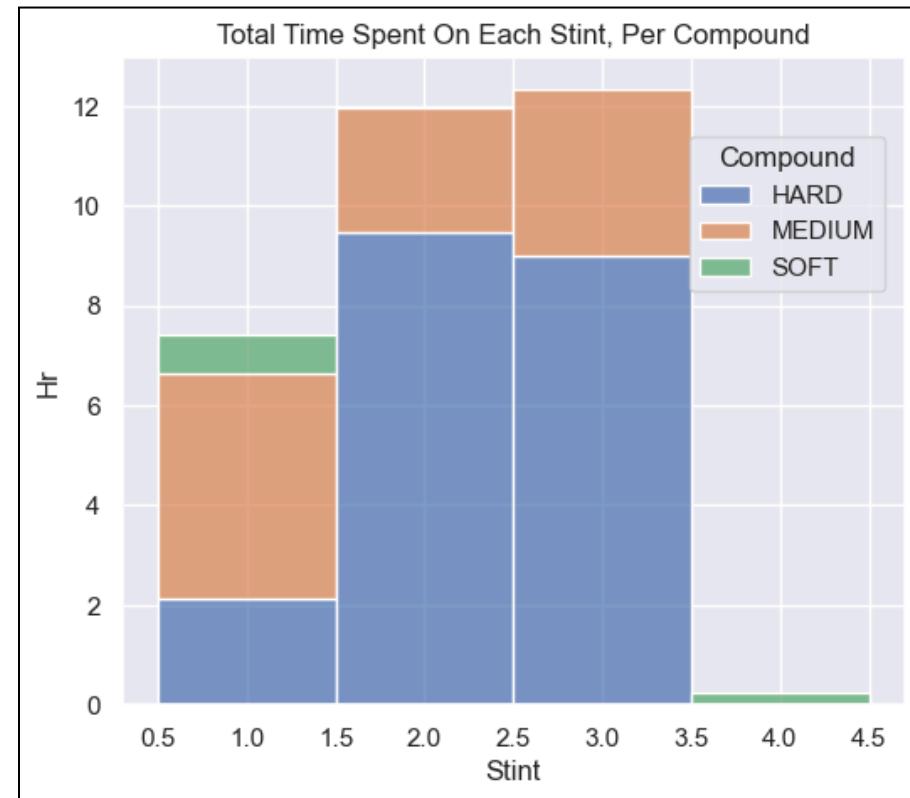
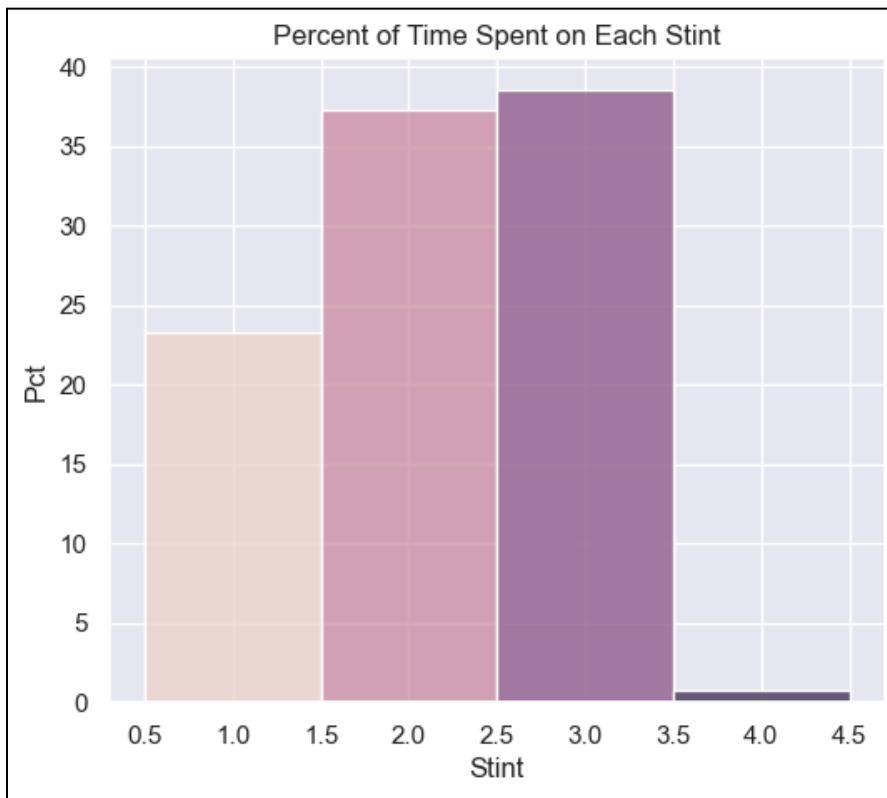
Average Statistics

Pit Stops	2.05
Pit Time	21.826
Laps Completed	67.75
Lap Time	0:01:25

[Hungarian Grand Prix Link](#)



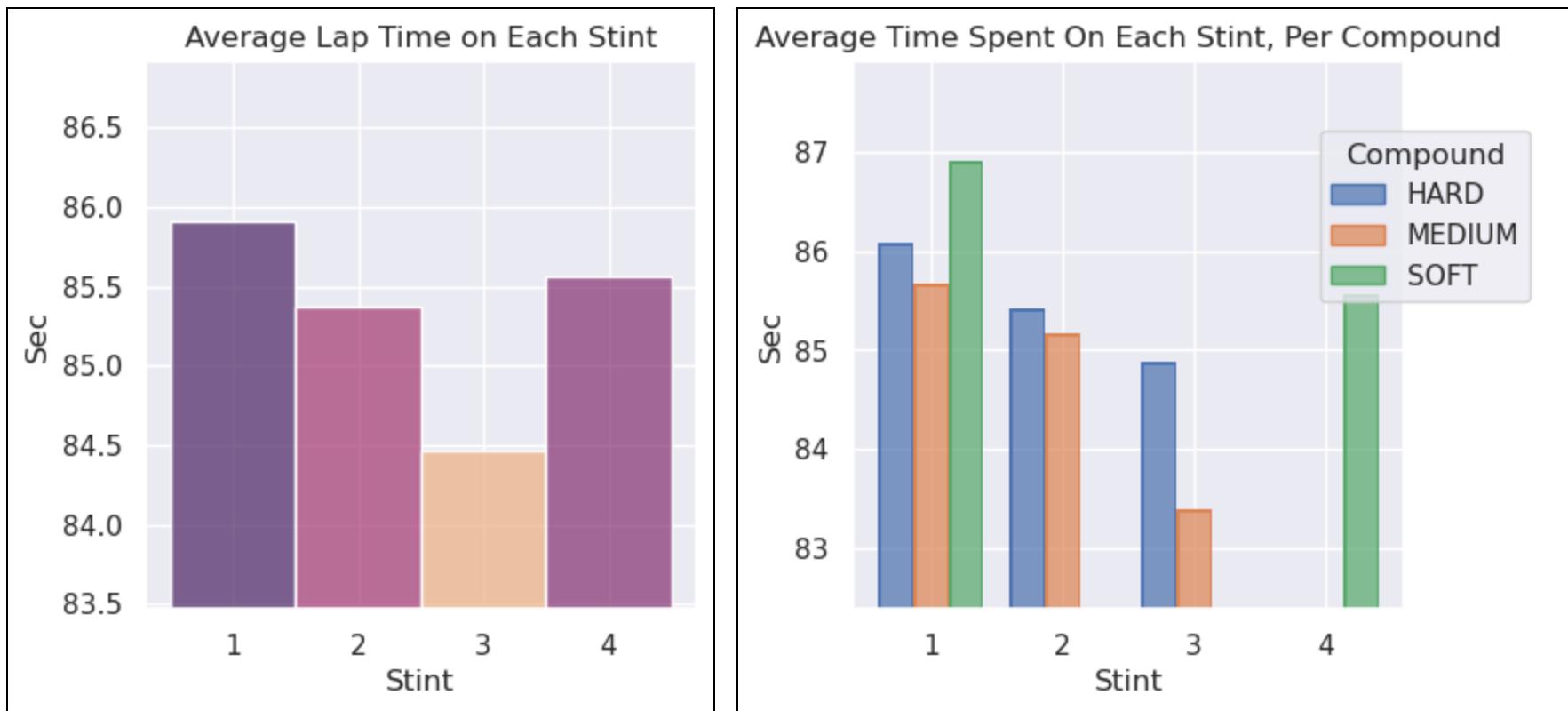
Hungarian Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insight

- Stint 1 was a Sprint Stint because it is characterized by high SOFT / MEDIUM compound usage and is shorter than other Stints
 - It's interesting to see HARD tires being used in the first Stint, since for Sprint Stints we usually see softer compounds
- MEDIUM tires see highest use in the first stint, but see non-negligible representation in the other Stints too
 - Usually we don't see equal representation of a tire compound across all stints
- Stints 2 and 3 see very similar time representations

Hungarian Grand Prix - Average Lap Time Per Stint / Per Compound



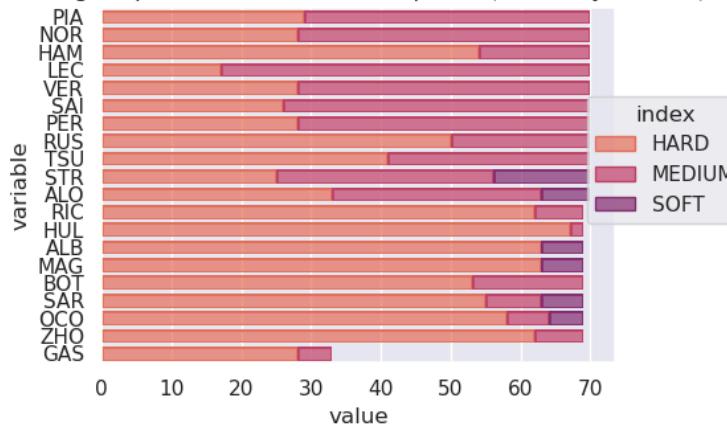
Insights

- Lap time averages are fairly similar across all stints
- HARD and MEDIUM tires see a steady decrease in times through Stints 1 to 3
- SOFT tires see a higher time than other tires, likely because of car adjacency

Hungarian Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
PIA	2	43.528	70	1:38:02	0:01:24	1	ALO	2	44.417	70	1:39:24	0:01:25	11
NOR	2	43.005	70	1:38:04	0:01:24	2	RIC	2	42.474	69	1:38:20	0:01:26	12
HAM	2	43.243	70	1:38:17	0:01:24	3	HUL	2	44.93	69	1:38:35	0:01:26	13
LEC	2	43.525	70	1:38:22	0:01:24	4	ALB	2	45.662	69	1:38:39	0:01:26	14
VER	2	43.572	70	1:38:23	0:01:24	5	MAG	2	44.376	69	1:38:47	0:01:26	15
SAI	2	43.032	70	1:38:25	0:01:24	6	BOT	2	44.033	69	1:38:47	0:01:26	16
PER	2	42.383	70	1:38:42	0:01:25	7	SAR	3	64.978	69	1:38:55	0:01:26	17
RUS	2	42.691	70	1:38:44	0:01:25	8	OCO	3	64.486	69	1:39:03	0:01:26	18
TSU	1	21.478	70	1:39:19	0:01:25	9	ZHO	2	44.108	69	1:39:06	0:01:26	19
STR	2	45.753	70	1:39:20	0:01:25	10	GAS	2	21.397	33	0:47:39	0:01:27	99

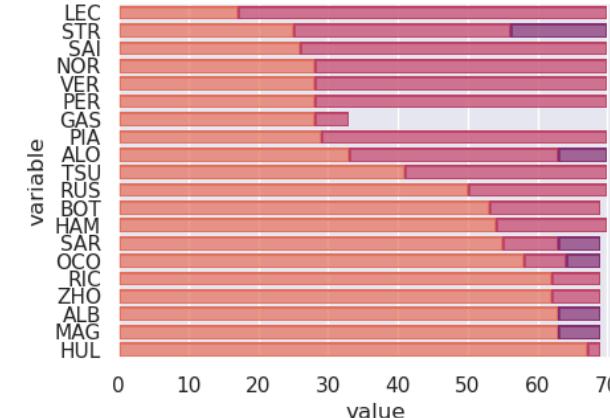
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- GAS was DNF this round after complications on lap 33
- Most drivers elected to do 2 stints, TSU was the only driver who did 1 stint and took 9th place
- Average times were within +/- 1s
- Tire compounds for top drivers were about 60/40 MEDIUM / HARD compounds, with a slightly higher bias towards MEDIUM compounds
- Bottom drivers overwhelmingly used SOFT tires and mostly HARD tires

Average Laps in Each Stint, Per Compound (Sorted by Compound)

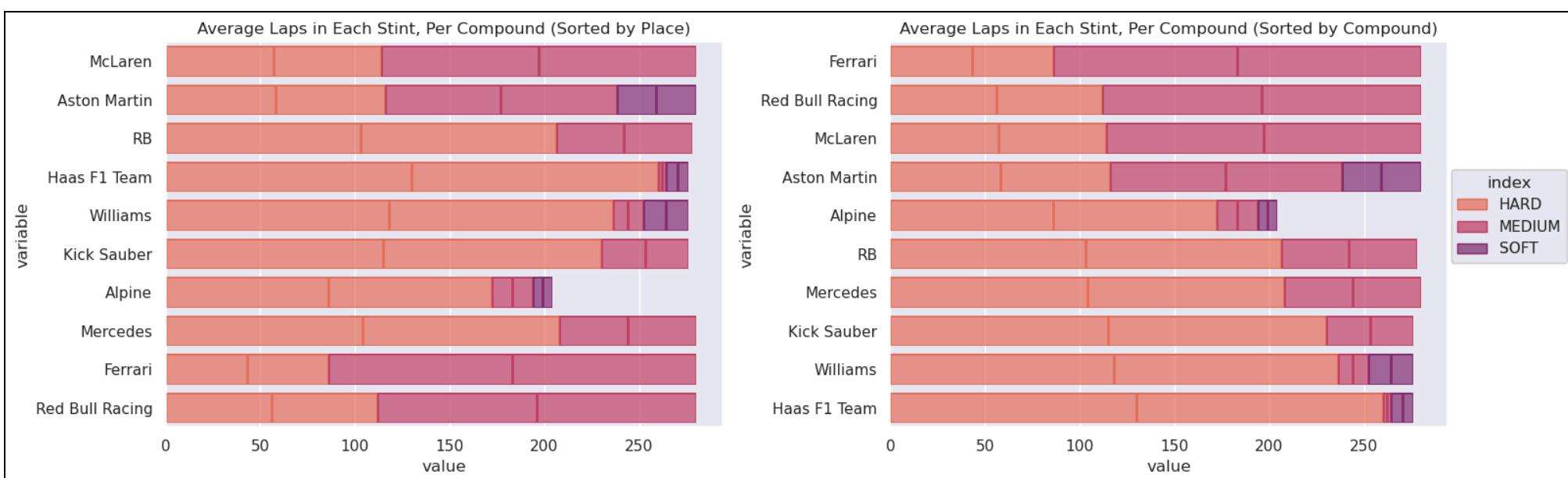


Hungarian Grand Prix - Team Data

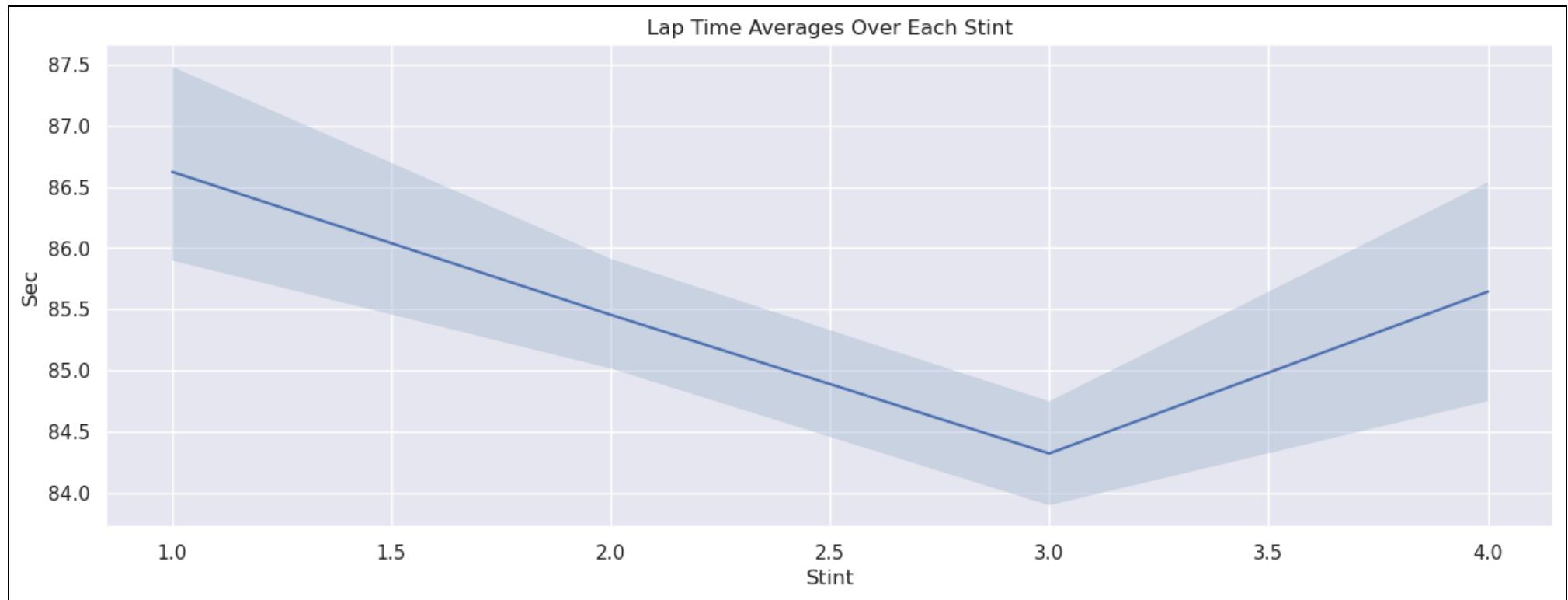
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Alpine	2	5	85.883	33	2:26:42	0:01:26
McLaren	2	4	86.533	70	3:16:06	0:01:24
Ferrari	2	4	86.557	70	3:16:47	0:01:24
Mercedes	2	4	85.934	70	3:17:01	0:01:24
Red Bull Racing	2	4	85.955	70	3:17:05	0:01:24
Haas F1 Team	2	4	89.306	69	3:17:22	0:01:26
Williams	2	5	110.64	69	3:17:33	0:01:26
RB	2	3	63.952	69	3:17:39	0:01:25
Kick Sauber	2	4	88.141	69	3:17:53	0:01:26
Aston Martin	2	4	90.17	70	3:18:44	0:01:25

Insights

- Most teams had 4 pit stops, two teams had 5 and one had 3
- Average lap time within teams was also +-1s
- Top teams had the same compound usage as the top drivers (no surprise)
 - Increased use of HARD tires was correlated with lower performance



Hungarian Grand Prix - Lap Time Averages

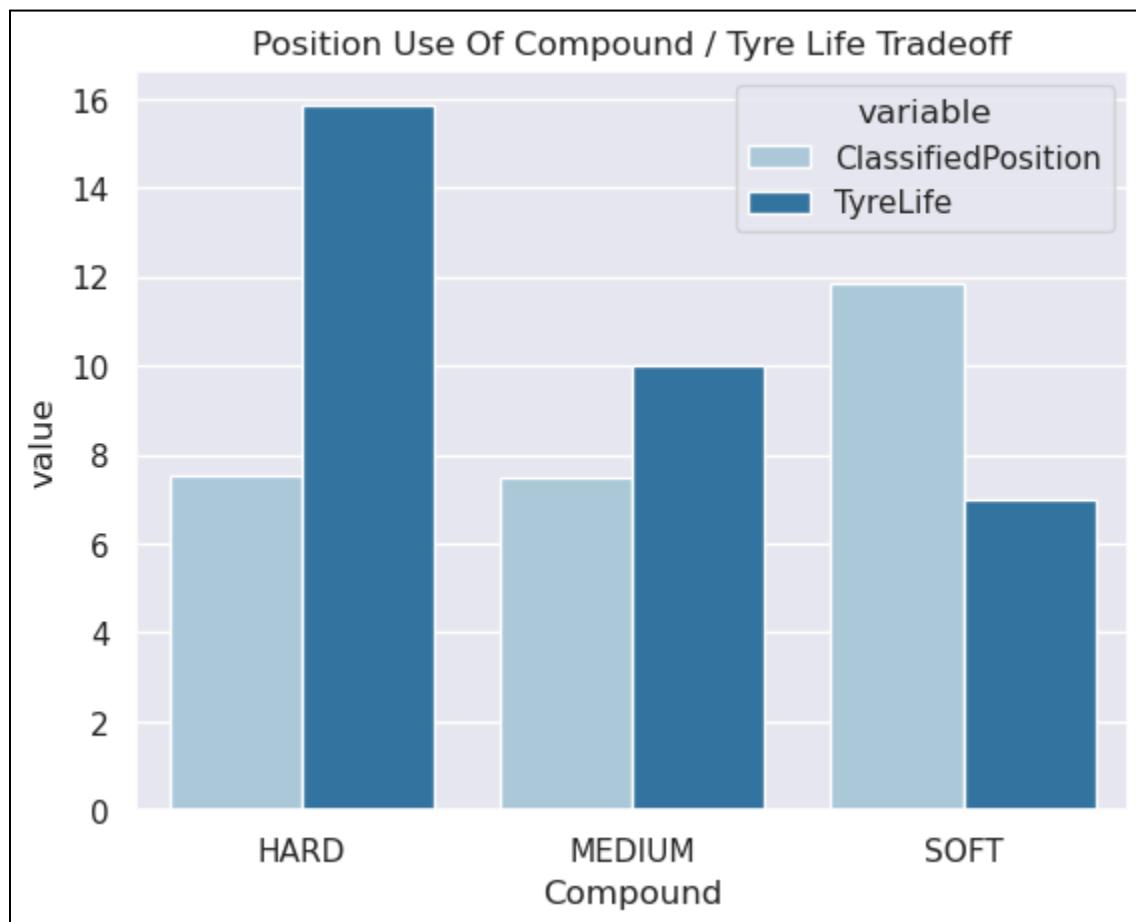


Insights

- Stint 4 is under-represented
- Stints 1 to 3 have a standard negative slope in lap times

Hungarian Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

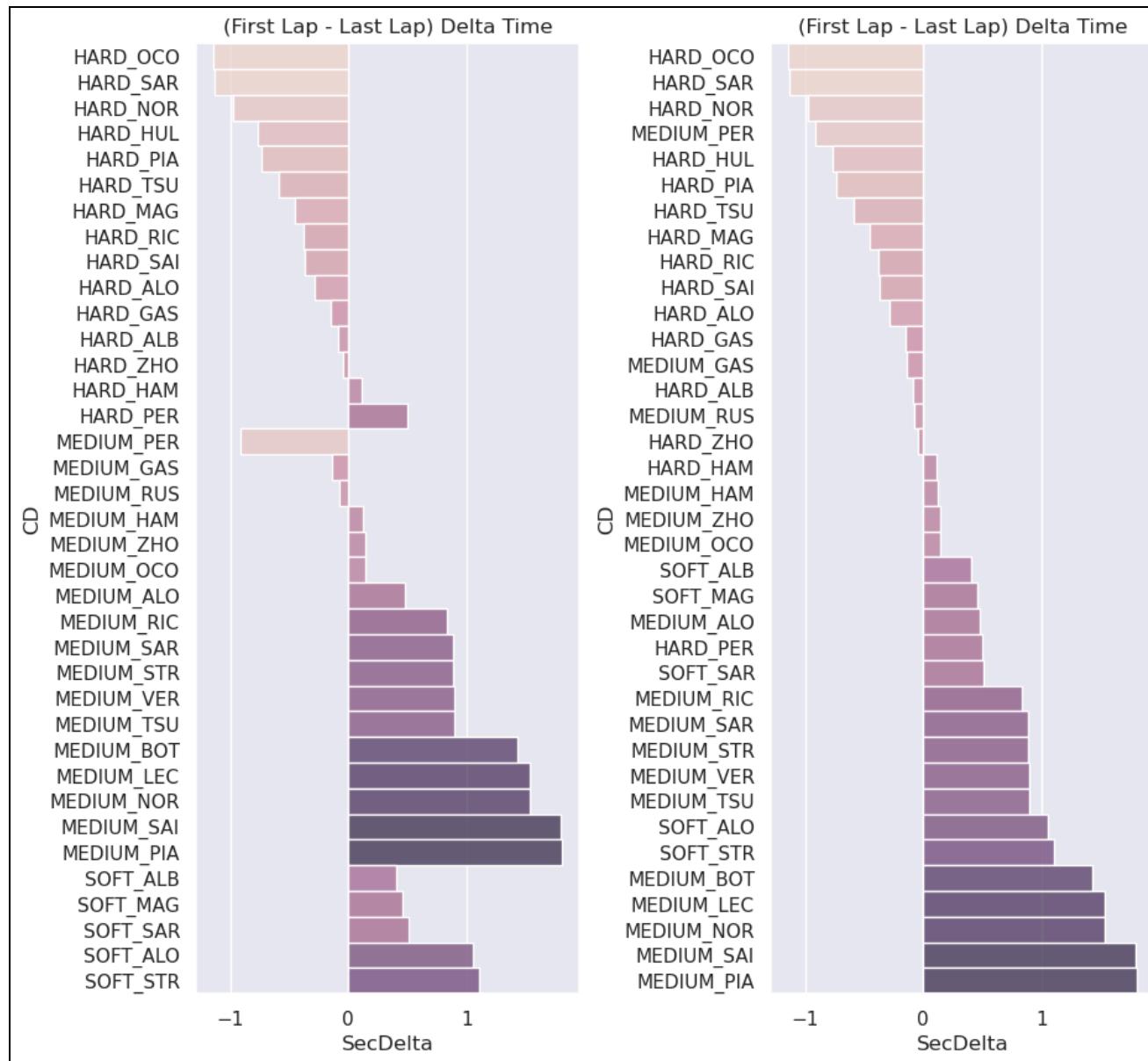
Compound	Position	ClassifiedPosition	TyreLife
HARD	10.4098	7.541	15.8525
MEDIUM	6.4346	7.4712	9.9895
SOFT	8.2424	11.8485	7



Insights

- Drivers that started with HARD tires saw a relative increase in position of about 3
- Drivers that started with MEDIUM tires saw a relative positional decrease of about 1, and also had the highest absolute positional performance
- Drivers that started with SOFT tires decreased positions by about 2.6 positions and had the lowest absolute position
- HARD and MEDIUM compounds seemed to perform approximately equally (when starting with these compounds) so if a driver is prioritizing tire life, go for the hard tires first
 - This does not account for speed or the Sprint Stint methodology

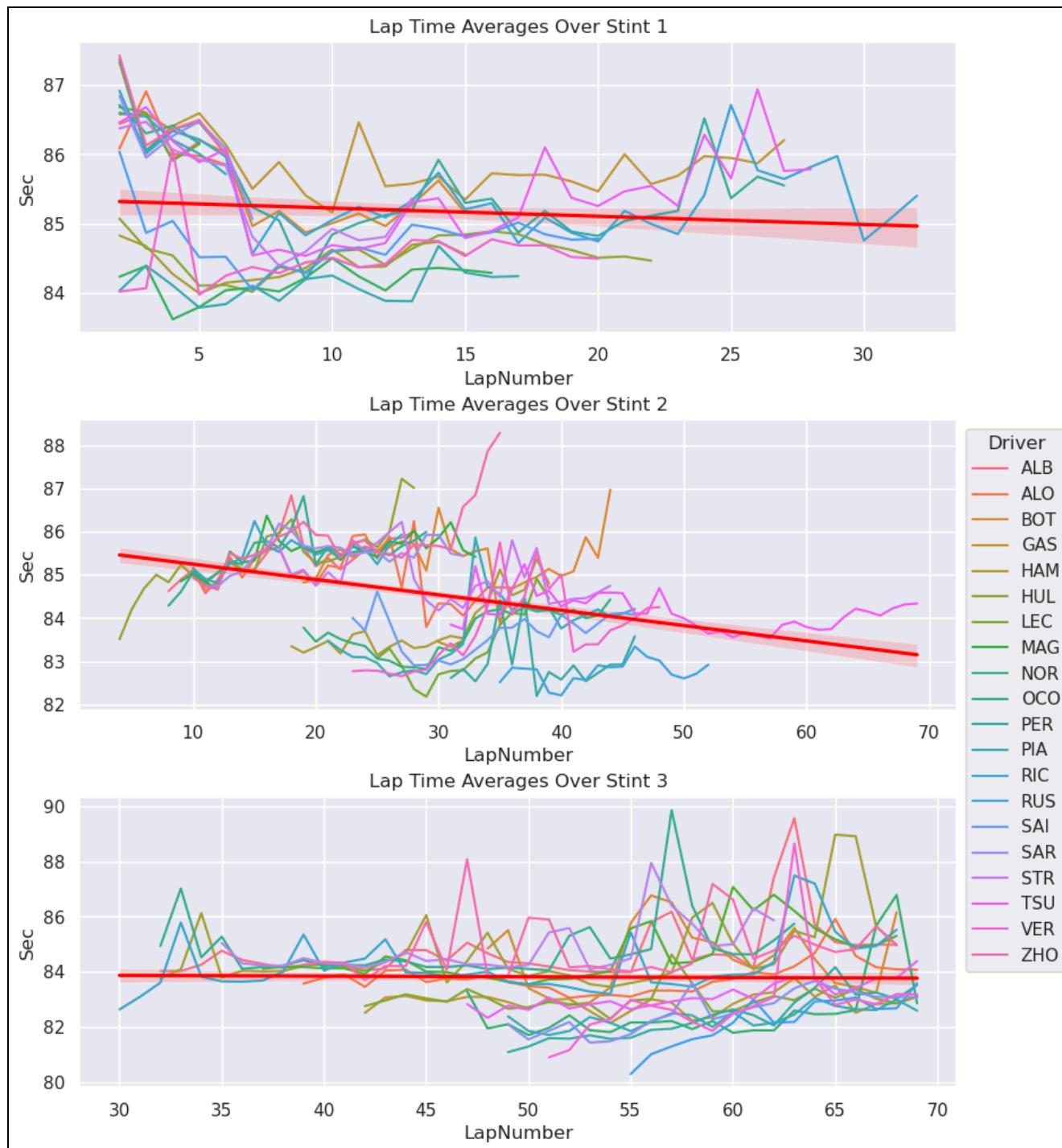
Hungarian Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- HARD tires see on average of +0.5 second splits
- MEDIUM tires for the most part saw a negative lap split of about -0.8s
- SOFT tires saw an average negative split of about -0.6s

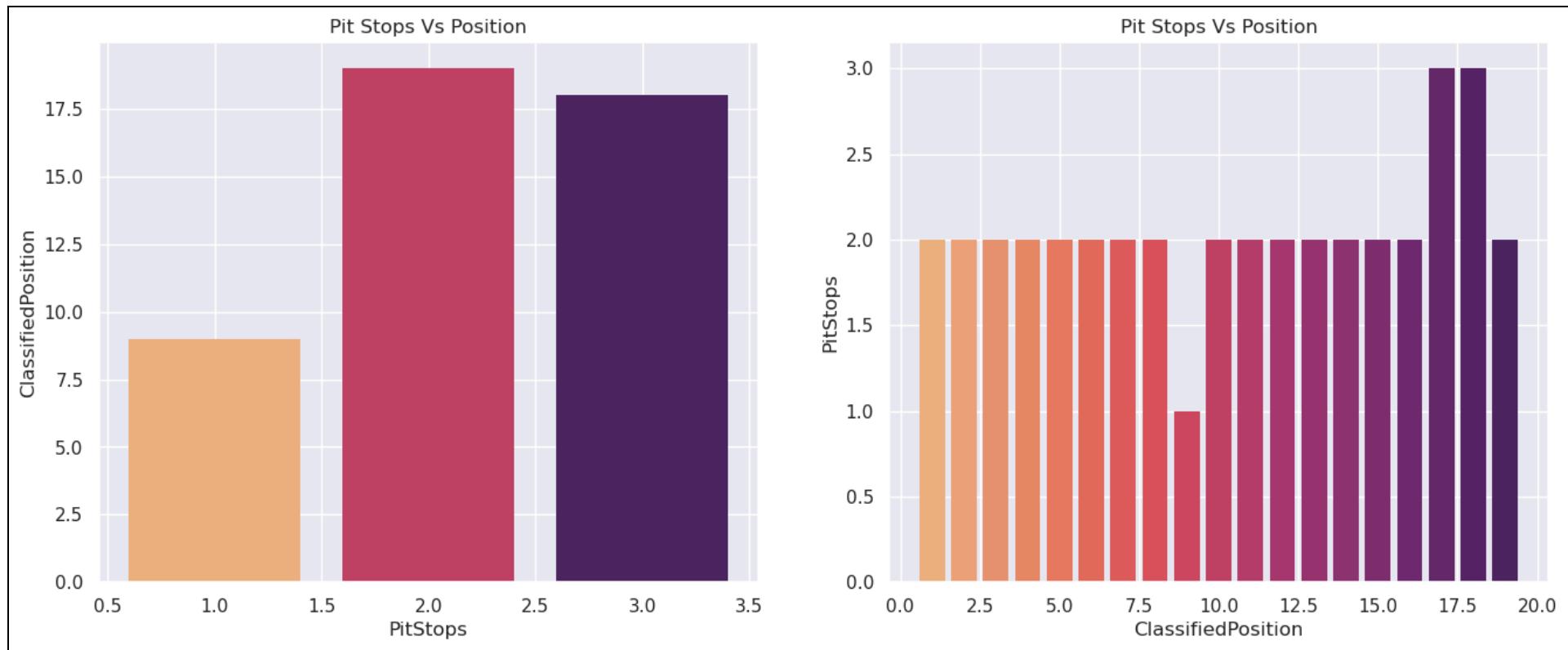
Hungarian Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Stint 1 saw a average / slightly negative trend in lap time
- Stint 2 was all over the place, but saw a mostly negative trend in times, though this was mostly due to absolute time differences and not trends in individual driver times. Most drivers tended to increase their time slightly (by less than a second) over their second stint
- Stint 3 is almost perfectly neutral and on average sees no great increase or decrease, though top drivers saw an increase in times and bottom drivers saw a decrease

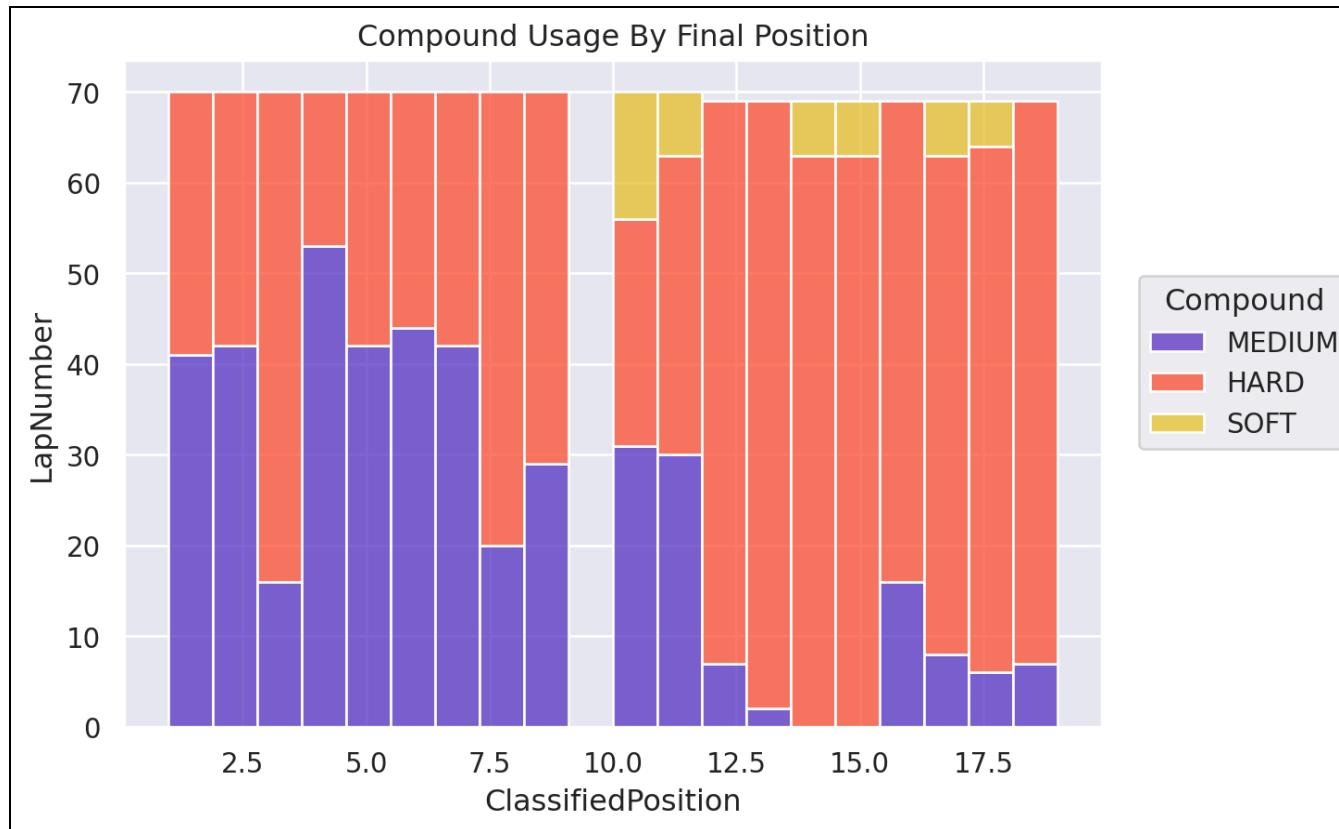
Hungarian Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- There is a weak correlation between pit stops and place this race, but an observation could be made that greater / fewer than two pit stops was associated with worse race performance

Hungarian Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- Top drivers saw a mostly even representation of compounds across the board
- Worse drivers used way more HARD compounds relative to top drivers
- SOFT compound usage was associated with worse performance this race, as top drivers did not use them at all

Belgian Grand Prix - Basic Statistics

Team

Alpine	OCO, GAS
Aston Martin	ALO, STR
Ferrari	LEC, SAI
Haas F1 Team	HUL, MAG
Kick Sauber	BOT, ZHO
McLaren	PIA, NOR
Mercedes	HAM, RUS
RB	TSU, RIC
Red Bull Racing	PER, VER
Williams	SAR, ALB

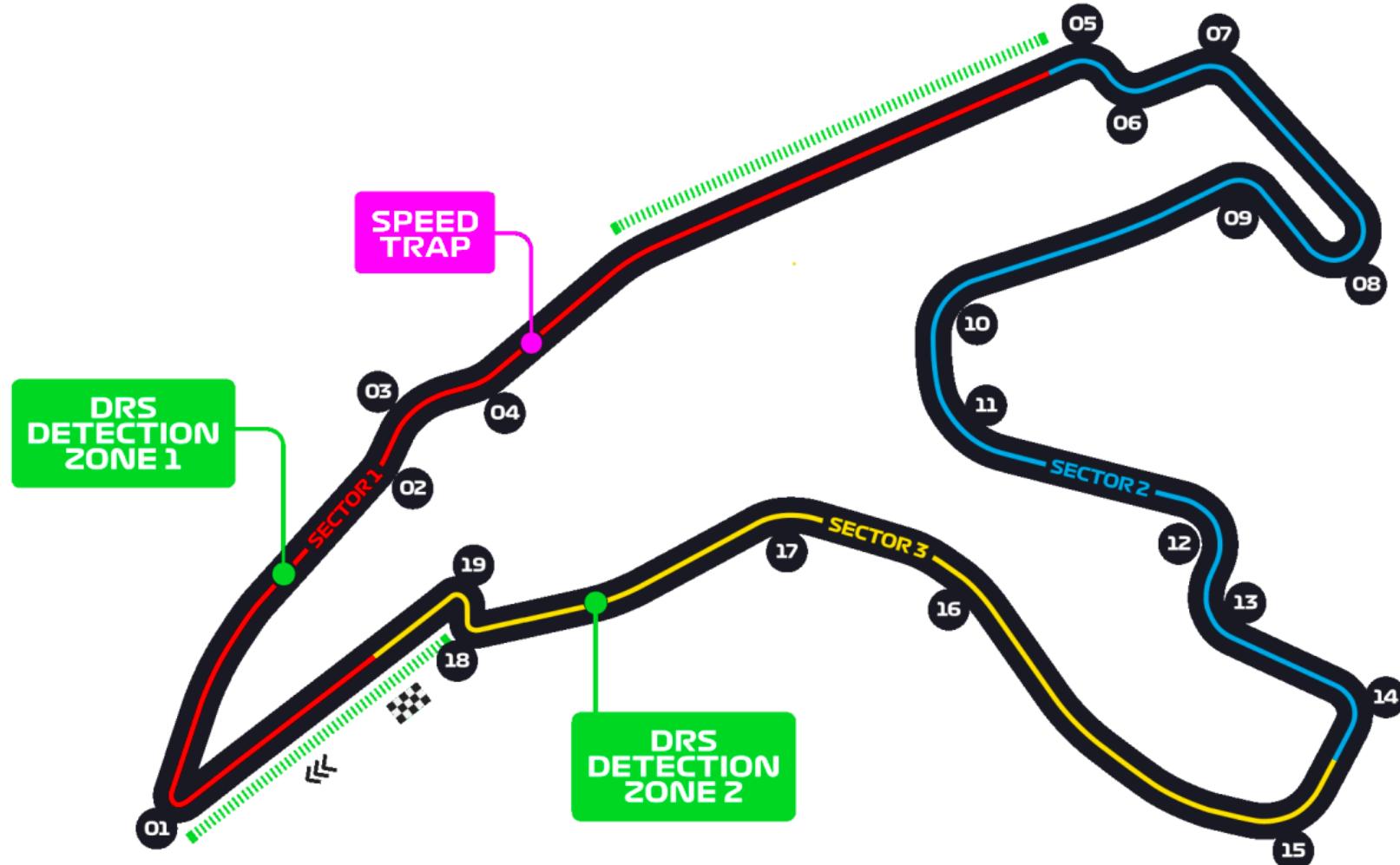
Total Statistics

Pit Stops	34
Pit Time	00:13:04
Laps Completed	841
Lap Time	1 days 01:40:52
Race Laps	44
Compounds	[MEDIUM, HARD, SOFT]

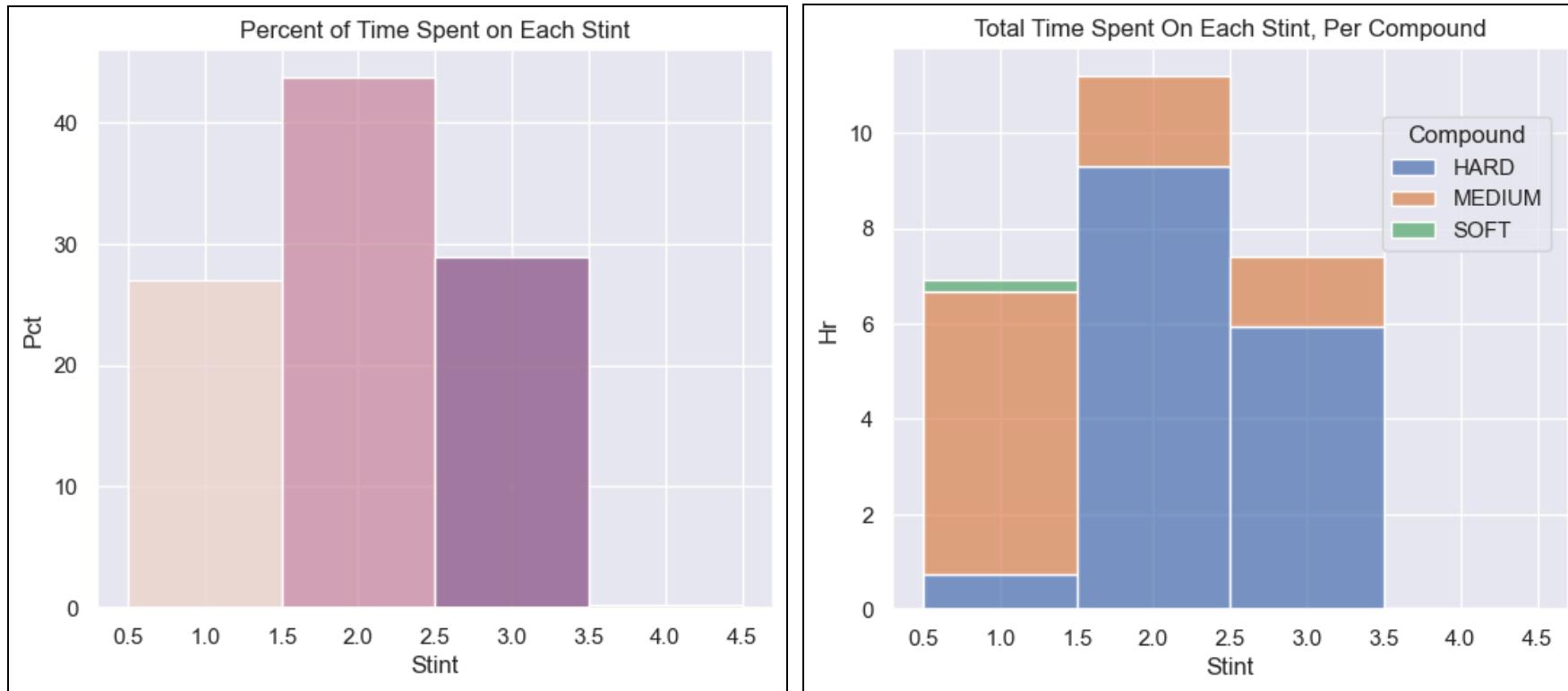
Average Statistics

Pit Stops	1.7895
Pit Time	23.077
Laps Completed	42.05
Lap Time	0:01:50

[Belgian Grand Prix Link](#)



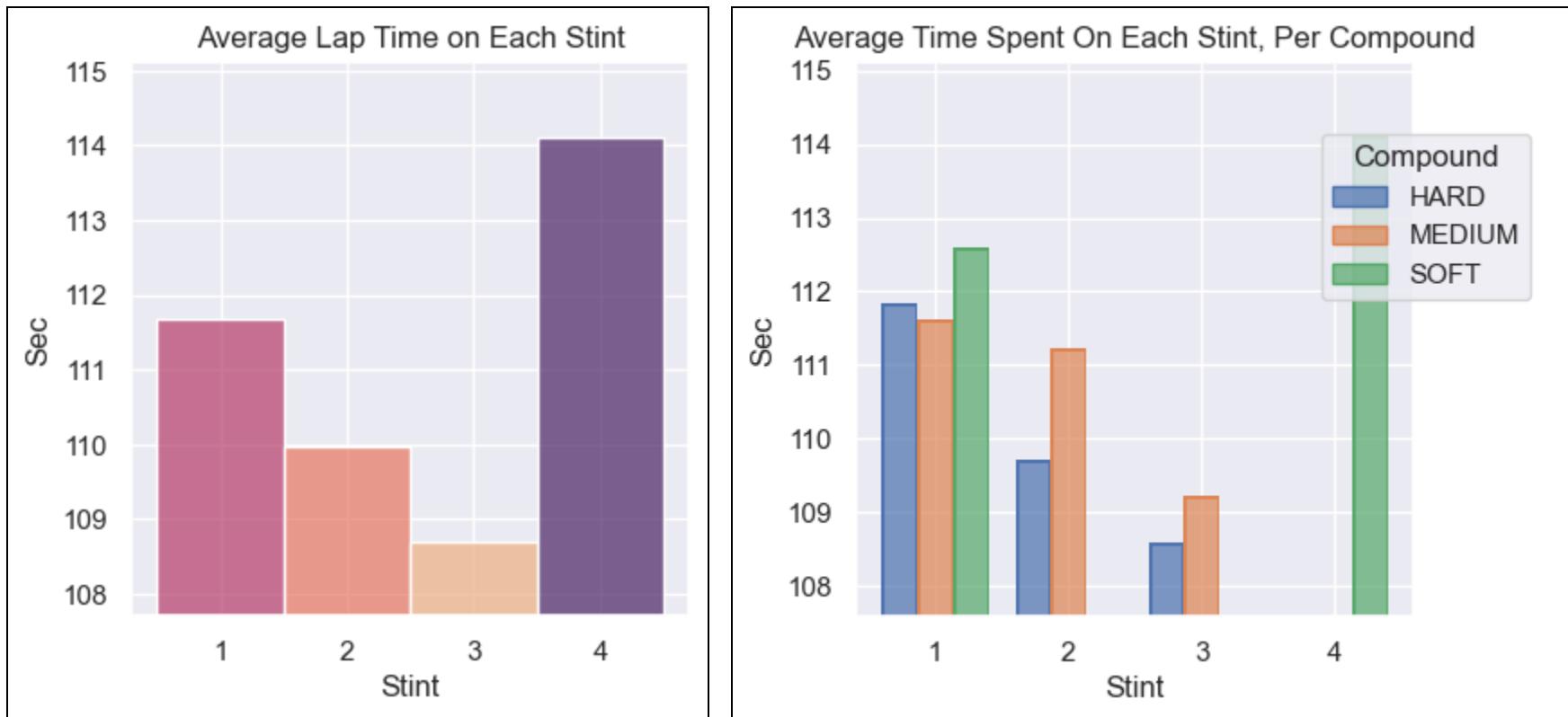
Belgian Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- This race can be characterized by having a Sprint Stint and then two maintenance stints following
- Stint 1 had mostly MEDIUM compound representation, with little HARD and SOFT tire use
 - **Observation:** It's interesting that we see HARD tire usage in the first stint since most drivers prefer a MEDIUM / SOFT tire compound usage over time
- Stint 4 has minimal representation this race
- MEDIUM compounds see continued use through Stints 2 and 3

Belgian Grand Prix - Average Lap Time Per Stint / Per Compound



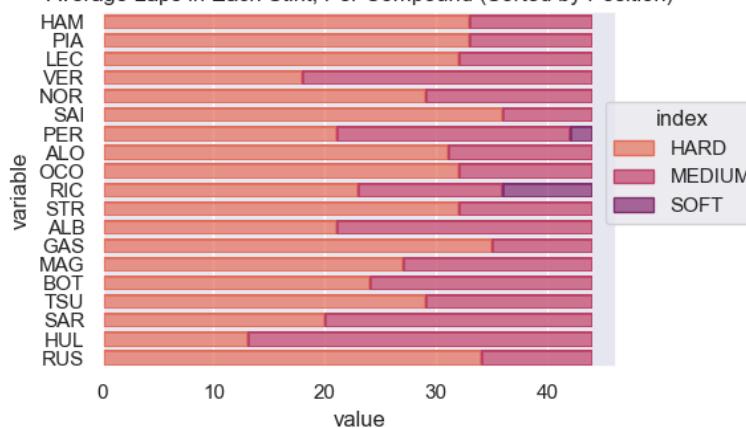
Insights

- Lap times over this race were interesting - on races where we see a Sprint Stint, the first stint is usually much higher average time
 - This is likely because driver adjacency wasn't as big of a problem at the start of this race as it has been in some others
- As usual, SOFT tires see slower average times because of driver adjacency in the first stint
- MEDIUM and HARD tires see a steady decrease in times, where HARD tires beat out MEDIUM tires by around -0.8s on average

Belgian Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
HAM	2	45.863	44	1:19:58	0:01:49	1	STR	1	22.884	44	1:21:00	0:01:50	11
PIA	2	46.928	44	1:19:58	0:01:49	2	ALB	2	46.373	44	1:21:01	0:01:50	12
LEC	2	46.771	44	1:20:06	0:01:49	3	GAS	2	45.879	44	1:21:01	0:01:50	13
VER	2	46.065	44	1:20:06	0:01:49	4	MAG	1	23.58	44	1:21:04	0:01:51	14
NOR	2	45.36	44	1:20:07	0:01:49	5	BOT	2	46.272	44	1:21:08	0:01:51	15
SAI	2	45.944	44	1:20:17	0:01:49	6	TSU	1	23.423	44	1:21:14	0:01:51	16
PER	3	67.905	44	1:20:40	0:01:50	7	SAR	2	46.841	44	1:21:23	0:01:51	17
ALO	1	23.116	44	1:20:47	0:01:50	8	HUL	2	46.896	44	1:21:26	0:01:51	18
OCC	2	46.951	44	1:20:50	0:01:50	9	ZHO	0	0	5	0:07:59	0:02:00	99
RIC	2	44.888	44	1:20:52	0:01:50	10	RUS	1	22.684	44	1:19:57	0:01:49	99

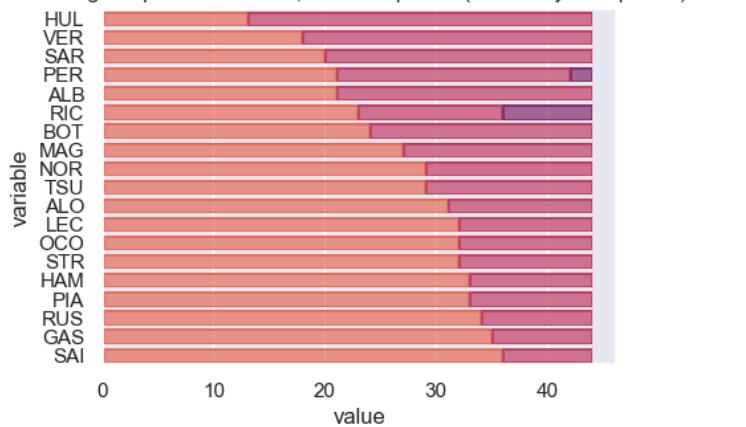
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- ZHO was DNF this race
- RUS was DNQ this race
- Average lap time between drivers in this race was +1s
- ALO scored 8th place with a 1 pit stop strategy on HARD tires for the remainder of the race after his first Stint
- Most drivers elected to do 2 pit stops
- Top drivers generally had a 75% HARD / 25% MEDIUM tire usage, although this isn't true for all top drivers

Average Laps in Each Stint, Per Compound (Sorted by Compound)

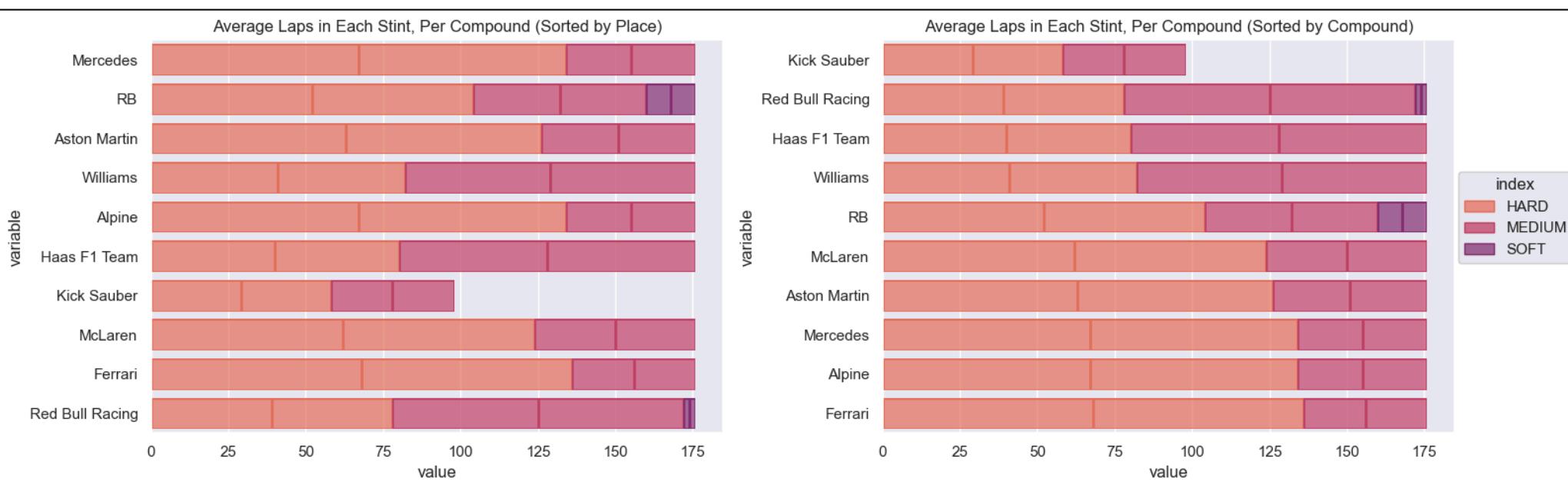


Belgian Grand Prix - Team Data

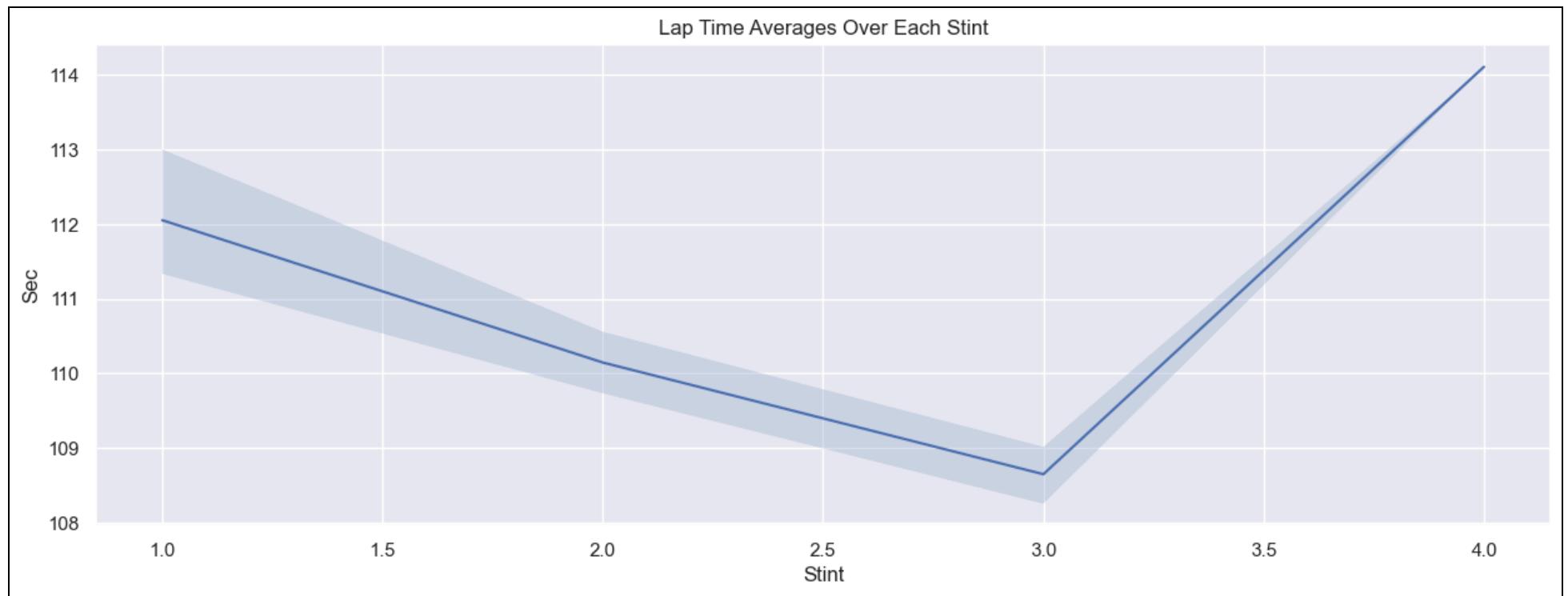
Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
Kick Sauber	2	2	46.272	5	1:29:07	0:01:51
Mercedes	2	3	68.547	44	2:39:55	0:01:49
McLaren	2	4	92.288	44	2:40:05	0:01:49
Ferrari	2	4	92.715	44	2:40:22	0:01:49
Red Bull Racing	2	5	113.97	44	2:40:47	0:01:50
Aston Martin	2	2	46	44	2:41:47	0:01:50
Alpine	2	4	92.83	44	2:41:51	0:01:50
RB	2	3	68.311	44	2:42:06	0:01:51
Williams	2	4	93.214	44	2:42:24	0:01:51
Haas F1 Team	2	3	70.476	44	2:42:30	0:01:51

Insights

- Red Bull had the most pit stops at 5
- Average times between teams were the same deviation as drivers with +- 1s
- Top teams elected for a heavier use of HARD compounds over MEDIUM compounds at a similar ratio seen in drivers



Belgian Grand Prix - Lap Time Averages



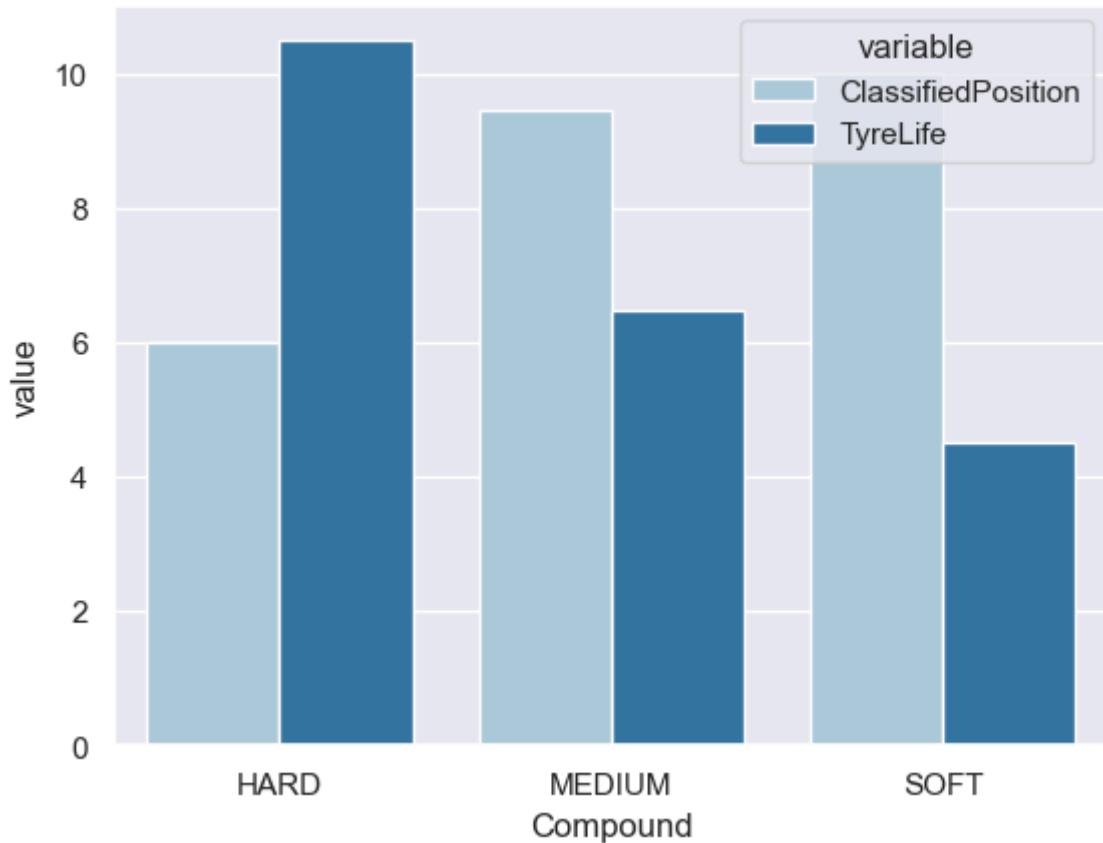
Insights

- Stint 4 is under-represented in this race, otherwise Stint 1 to 3 sees a standard decline in lap times as the race progresses

Belgian Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

Compound	Position	ClassifiedPosition	TyreLife
HARD	3.7	6	10.5
MEDIUM	9.522	9.467	6.4945
SOFT	14.375	10	4.5

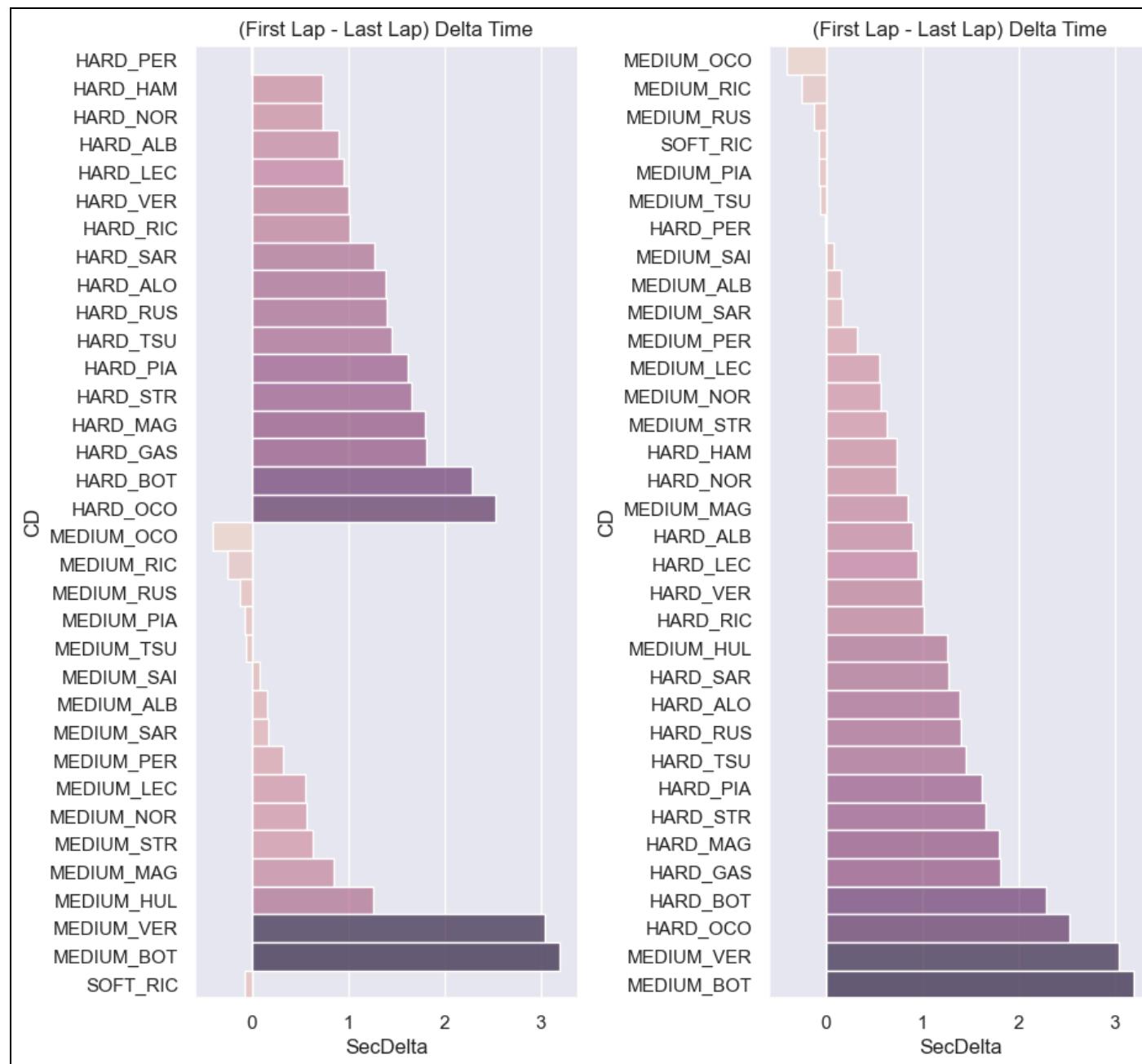
Position Use Of Compound / Tyre Life Tradeoff



Insights

- Drivers who started the race with HARD tires saw a relative decrease in position by 2.3, but a high absolute position
 - Observation:** Drivers at the front of the race elected to start the race with HARD tires for the most part, likely relying on their ability to outlast other drivers in the front
- Drivers that started with MEDIUM tires saw a small increase in relative position (0.1)
- Drivers that started with SOFT compounds saw a significant increase in relative position (4.3 spots) but the worst absolute position

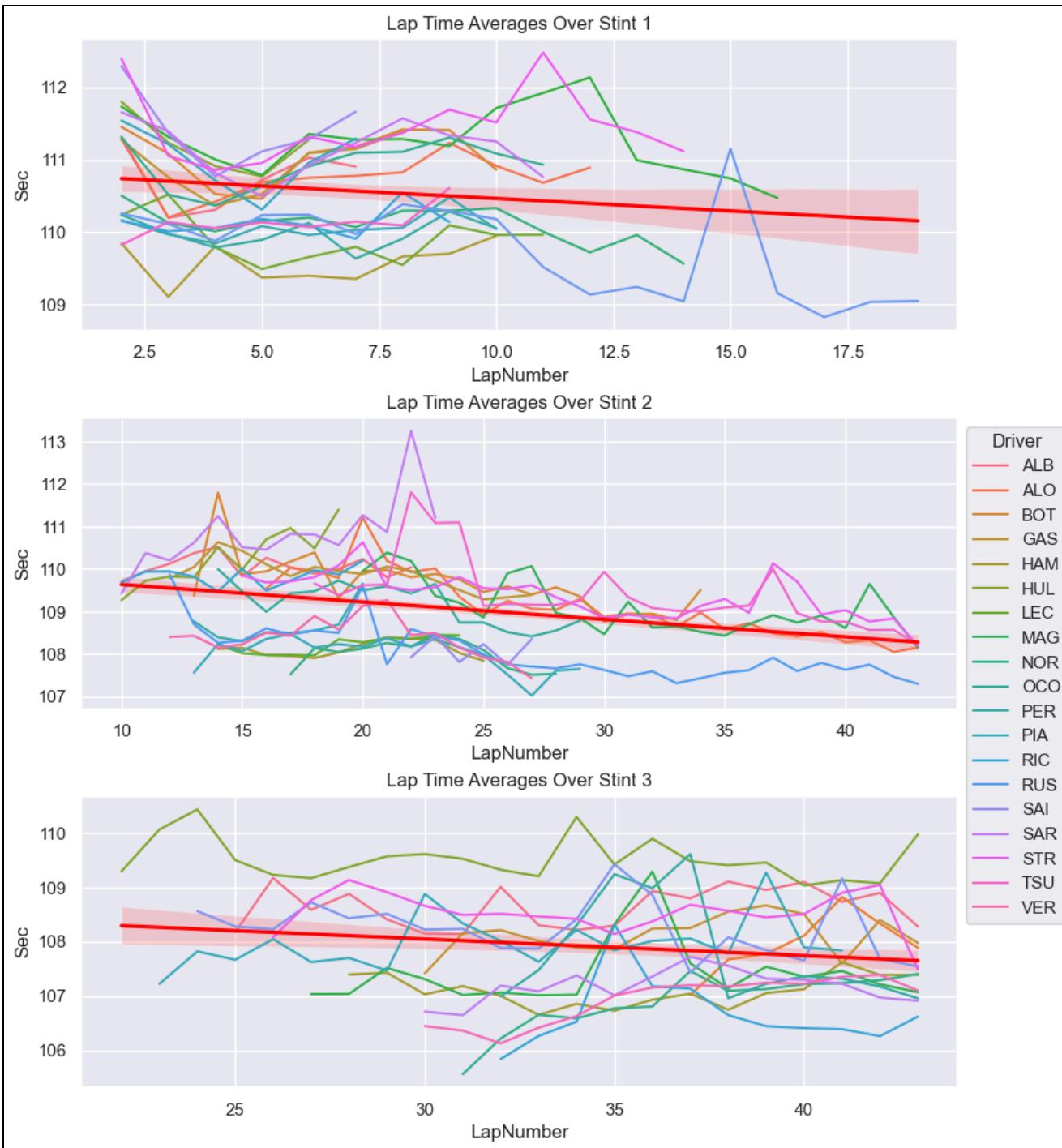
Belgian Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- For this race a majority of the drivers saw negative splits across the board, with minimal positive splits within their stints
- MEDIUM tires had the highest negative split at -3 but an average of around -1.2s
- HARD tires had the highest average negative split at around -1.4s

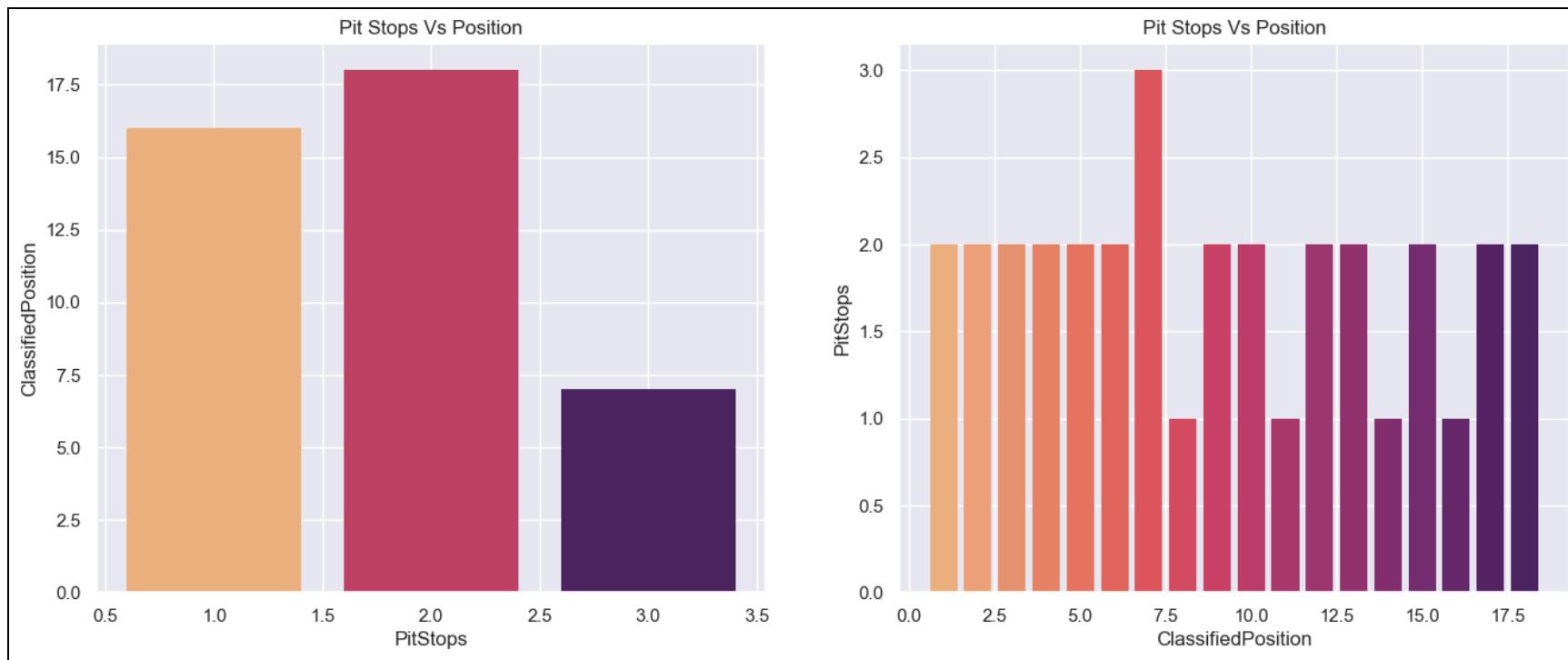
Belgian Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- About half of the drivers in Stint 1 saw a decrease in lap times and the other half saw increases
- Most drivers saw decreases in lap time in Stint 2 by around 1 second
- Stint 3 did not see a significant downward trend, although the general slope is negative

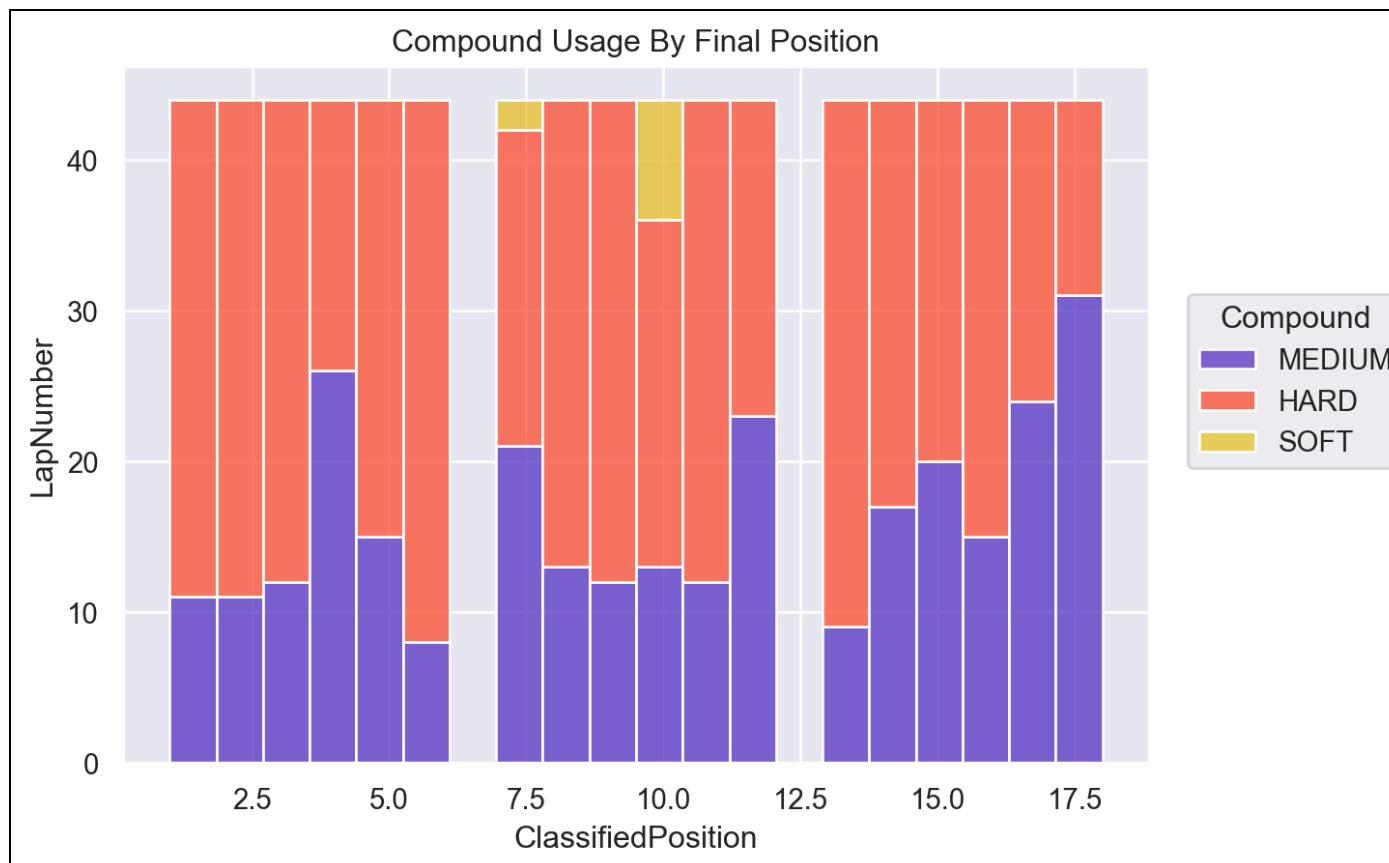
Belgian Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- We see the opposite trend in this race where less pit stops is associated with a *worse* final position in the race
 - **Observation:** The 1 pit stop strategy was a poor strategy

Belgian Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



Insights

- Driver compound usage was very similar across the board, with a slightly higher bias towards HARD tires
- Drivers used a more balanced HARD / MEDIUM proportion tended to do less well

Dutch Grand Prix - Basic Statistics

Teams

Alpine	OCO, GAS
Aston Martin	ALO, STR
Ferrari	LEC, SAI
Haas F1 Team	MAG, HUL
Kick Sauber	BOT, ZHO
McLaren	PIA, NOR
Mercedes	RUS, HAM
RB	RIC, TSU
Red Bull Racing	PER, VER
Williams	ALB, SAR

Total Statistics

Pit Stops	27
Pit Time	00:09:14
Laps Completed	1426
Lap Time	1 days 06:25:57
Race Laps	72
Compounds	[MEDIUM, HARD, SOFT]

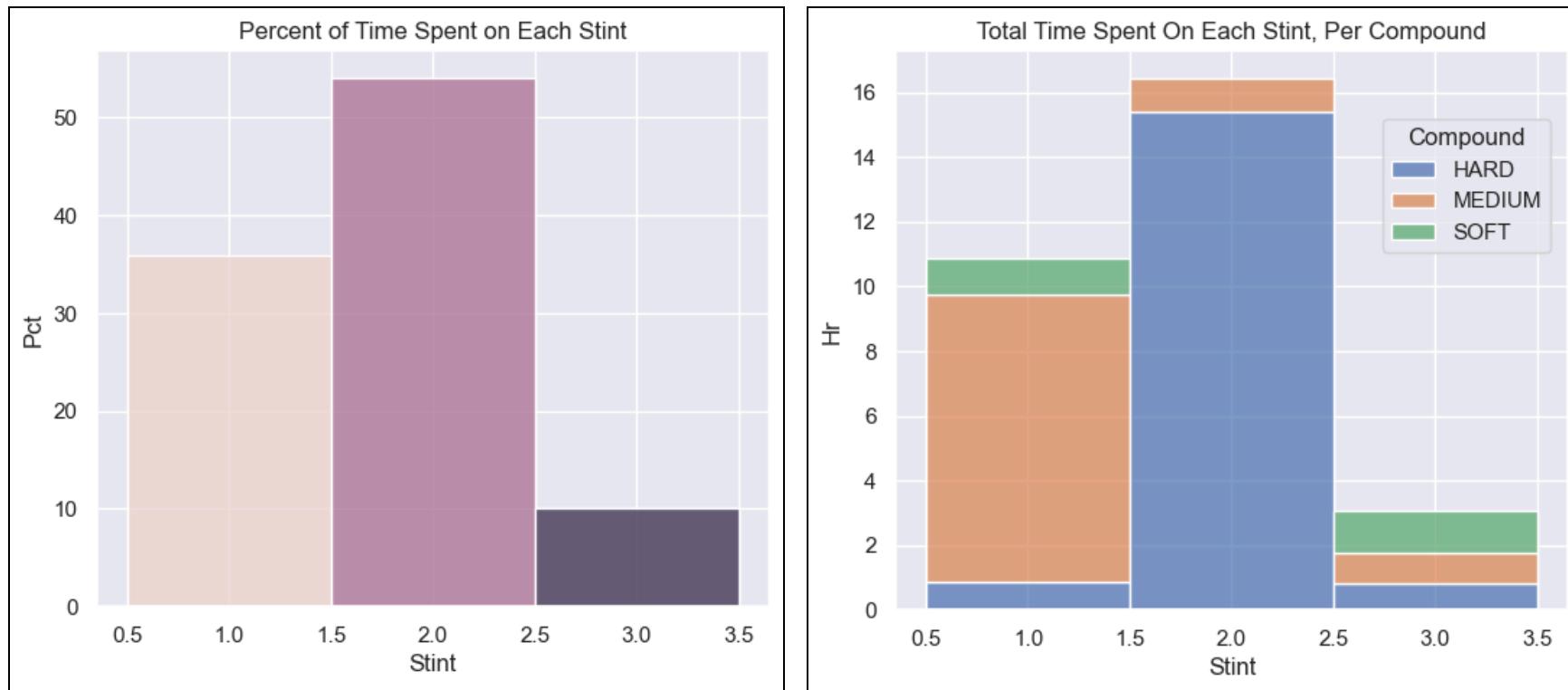
Average Statistics

Pit Stops	1.35
Pit Time	21.334
Laps Completed	71.3
Lap Time	0:01:17

[Dutch Grand Prix Link](#)



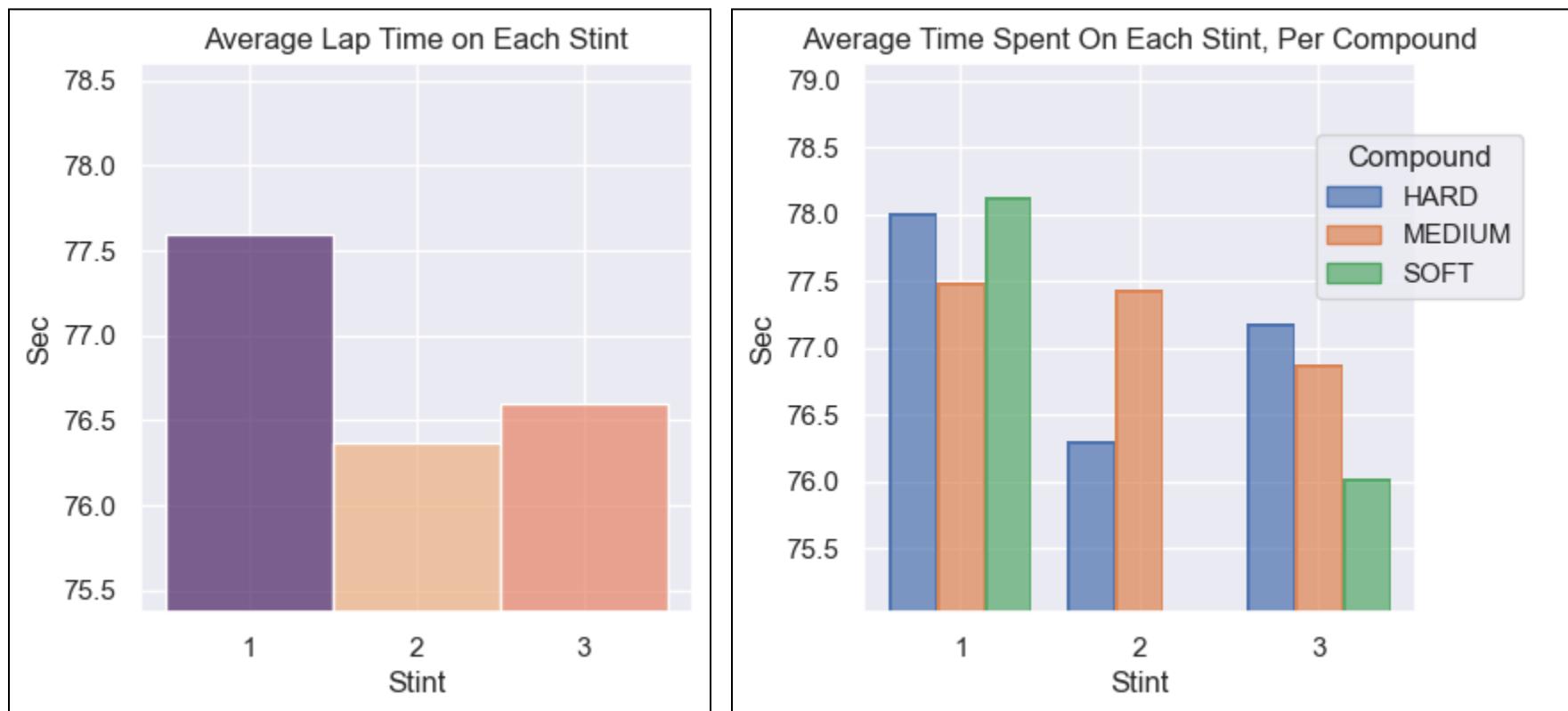
Dutch Grand Prix - Total Lap Time Per Stint / Per Compound / Compound Representation



Insights

- This track is characterized by long and frequent turns and various smaller straightaways, so both MEDIUM and HARD compounds see more usage throughout the race
- MEDIUM tires dominate Stint 1 and HARD tires dominate Stint 2, with some minor representation of SOFT and HARD in Stint 1 and some MEDIUM tires in Stint 2
- This race sees a "Sprint Stint" where the first stint is substantially shorter than the second, which usually showcases more HARD tire usage
- Stint 3 is under-represented but contains an even distribution of SOFT, MEDIUM, and HARD tires

Dutch Grand Prix - Average Lap Time Per Stint / Per Compound



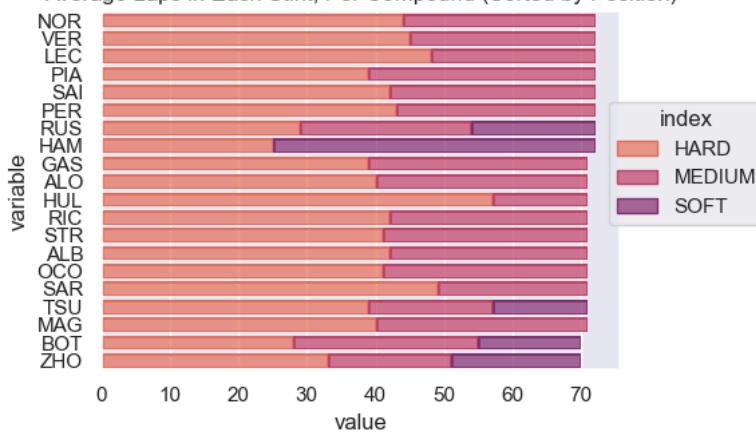
Insights

- Average lap time on the first stint was lower than the last two stints
 - This is consistent with the observation that HARD tires on a later Stint benefit from a worn-in track more so than other compounds
- MEDIUM tires see roughly the same lap average throughout this race
- SOFT tires see no usage throughout Stint 2

Dutch Grand Prix - Driver Data

Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos	Driver	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time	Pos
NOR	1	21.52	72	1:30:46	0:01:16	1	HUL	1	21.731	71	1:31:05	0:01:17	11
VER	1	20.749	72	1:31:08	0:01:16	2	RIC	1	20.706	71	1:31:07	0:01:17	12
LEC	1	20.821	72	1:31:11	0:01:16	3	STR	1	21.642	71	1:31:06	0:01:17	13
PIA	1	21.079	72	1:31:13	0:01:16	4	ALB	2	42.231	71	1:31:26	0:01:17	14
SAI	1	20.686	72	1:31:18	0:01:16	5	OCO	1	21.033	71	1:31:32	0:01:17	15
PER	1	22.992	72	1:31:25	0:01:16	6	SAR	1	22.098	71	1:31:50	0:01:18	16
RUS	2	42.711	72	1:31:30	0:01:16	7	TSU	2	42.108	71	1:31:51	0:01:18	17
HAM	2	42.237	72	1:31:35	0:01:16	8	MAG	2	21.391	71	1:31:51	0:01:18	18
GAS	1	22.581	71	1:30:54	0:01:17	9	BOT	2	41.895	70	1:30:49	0:01:18	19
ALO	1	21.279	71	1:30:59	0:01:17	10	ZHO	2	43.196	70	1:31:22	0:01:18	20

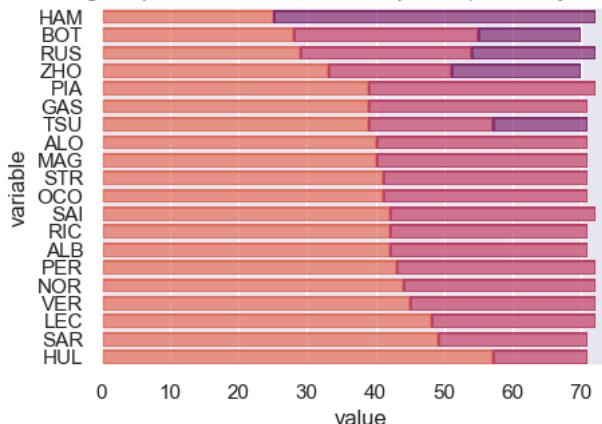
Average Laps in Each Stint, Per Compound (Sorted by Position)



Insights

- The lap time variation for this race was small, with +-1 second
- Most drivers had just one or two pit stops, top drivers had 1
- Unlike other races we've seen so far, the total time on this race for each driver was relatively close and we only see a roughly 1min difference between first and last place
- Tire strategy between drivers this race was pretty evenly about 50/50 on HARD and MEDIUM compounds with top drivers favoring a transition to HARD tires a little earlier in the race
- The SOFT tire usage we did see was associated with above-average performance

Average Laps in Each Stint, Per Compound (Sorted by Compound)



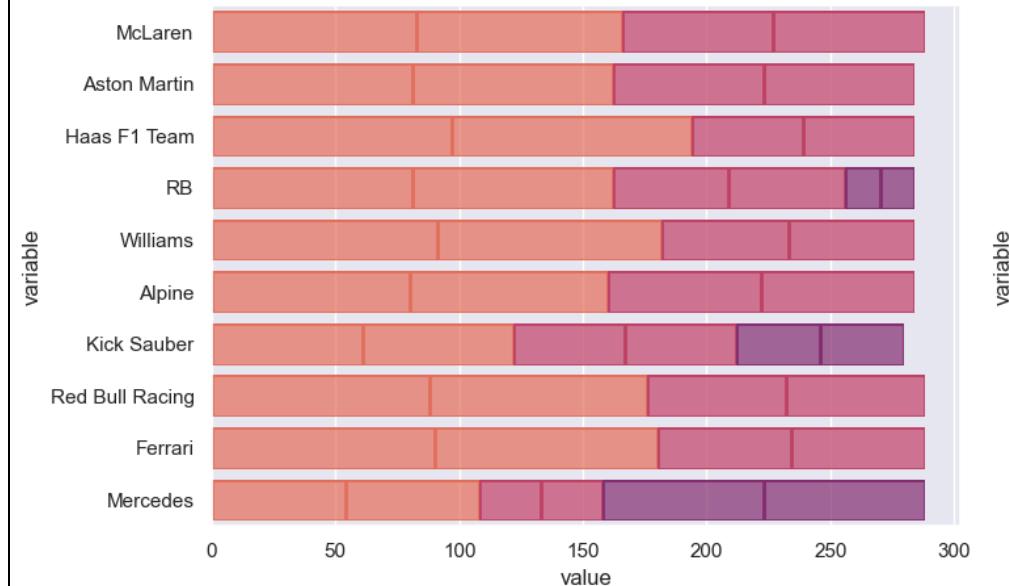
Dutch Grand Prix - Team Data

Team	Drivers	Pit Stops	Pit Time	Laps Driven	Total Time	Avg Time
McLaren	2	2	42.599	72	3:01:58	0:01:16
Aston Martin	2	2	42.921	71	3:02:05	0:01:17
Kick Sauber	2	4	85.091	70	3:02:10	0:01:18
Alpine	2	2	43.614	71	3:02:27	0:01:17
Ferrari	2	2	41.507	72	3:02:29	0:01:16
Red Bull Racing	2	2	43.741	72	3:02:33	0:01:16
Haas F1 Team	2	3	43.122	71	3:02:56	0:01:17
RB	2	3	62.814	71	3:02:57	0:01:17
Mercedes	2	4	84.948	72	3:03:05	0:01:16
Williams	2	3	64.329	71	3:03:16	0:01:17

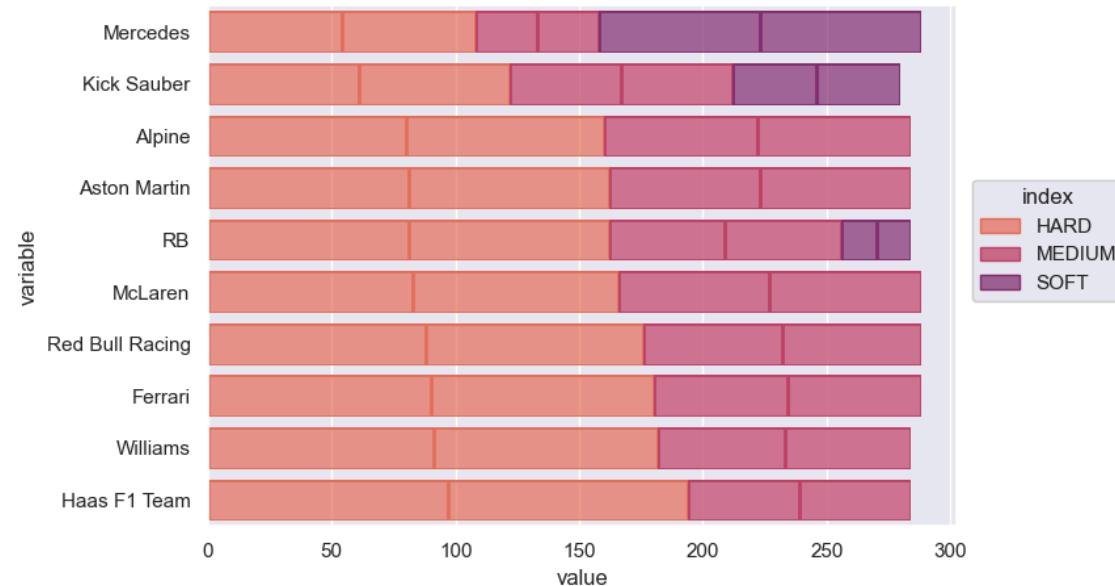
Insights

- Pit time, average lap time, and total lap time across teams was very consistent. This is one of the most consistent races of 2024
- With how consistent everything was, it's clear that driver skill was more important than tire strategy this race
- Top teams used a pretty even representation of MEDIUM / HARD tires with limited SOFT representation

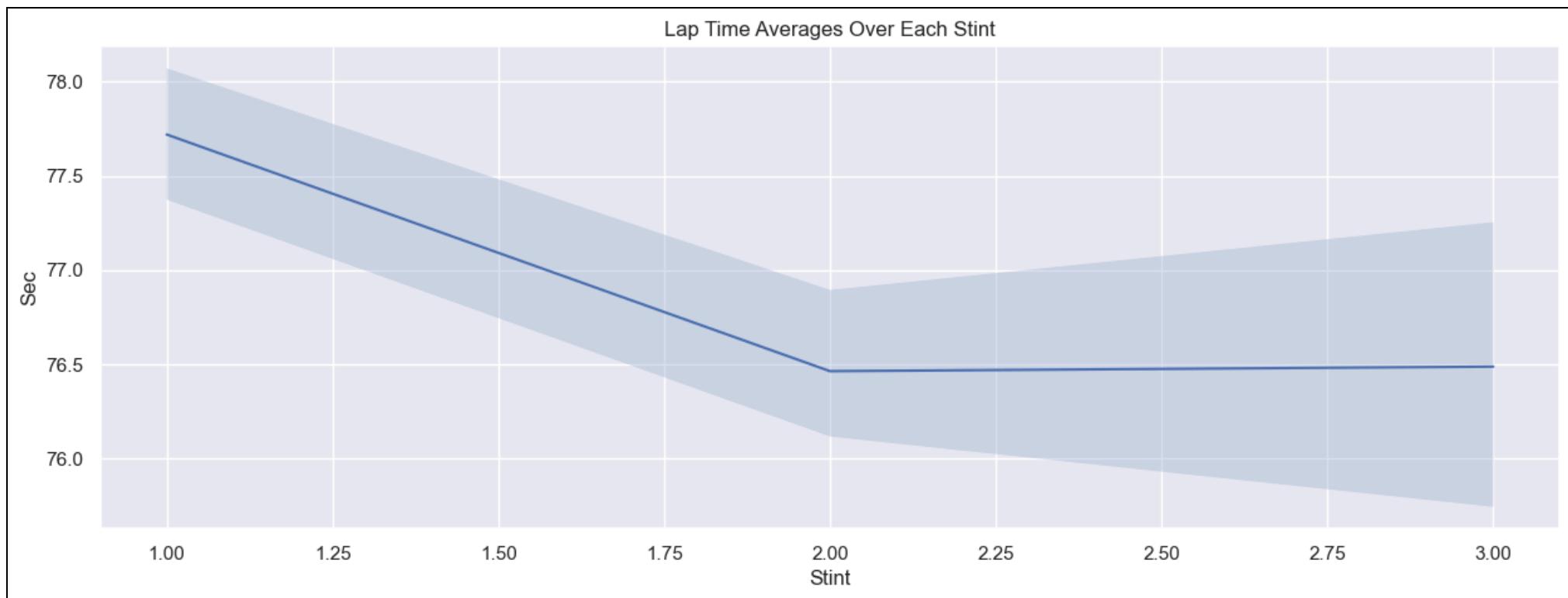
Average Laps in Each Stint, Per Compound (Sorted by Place)



Average Laps in Each Stint, Per Compound (Sorted by Compound)



Dutch Grand Prix - Lap Time Averages

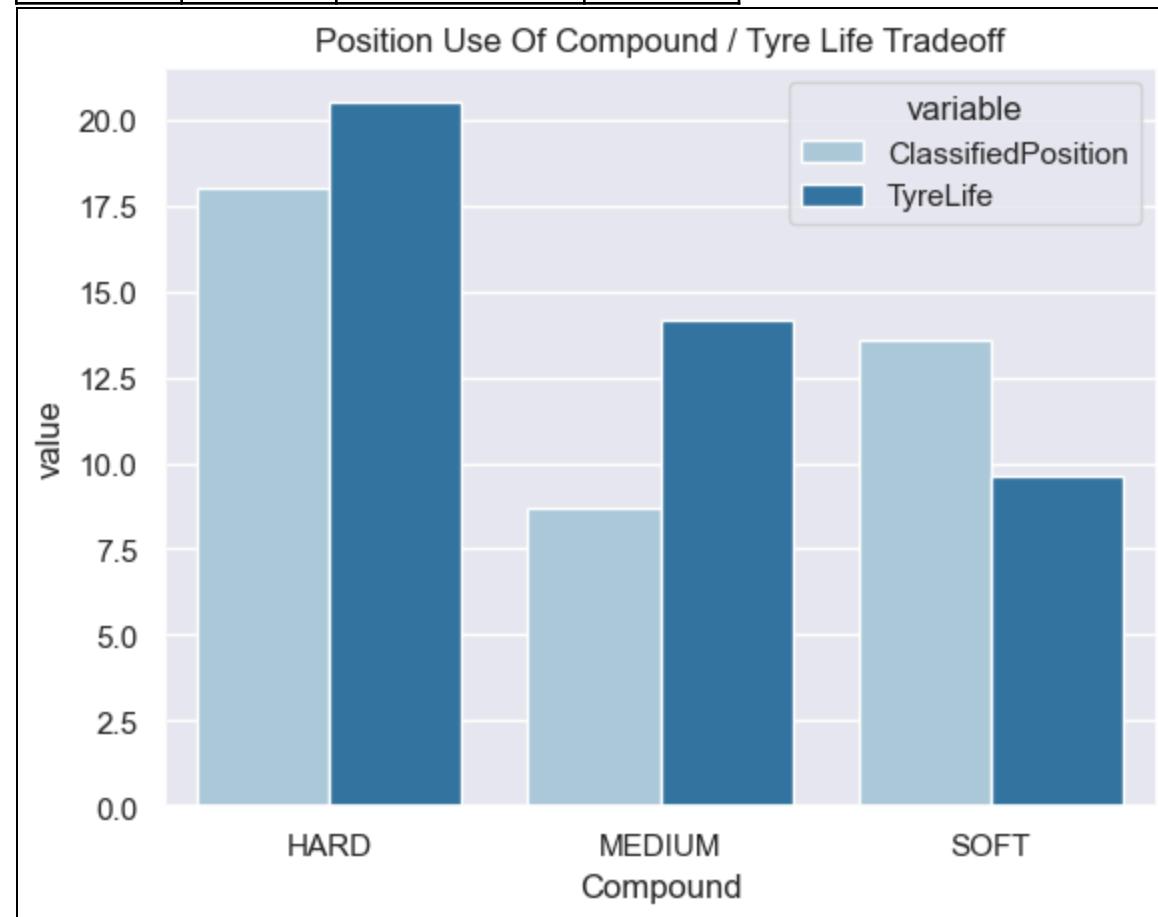


Insights

- Stint 3 was under represented this race
- Stint 1 > 2 saw a decrease in average lap times by about 1.5s
- **Observation:** Under ideal circumstances, and with all variables roughly equal (as we are seeing in this race), we see lap times decrease over time. This race is a great example of track times decreasing on average while a track gets worn in and tires warm up

Dutch Grand Prix - Starting Tire Type vs Final Classification (Relationship 2)

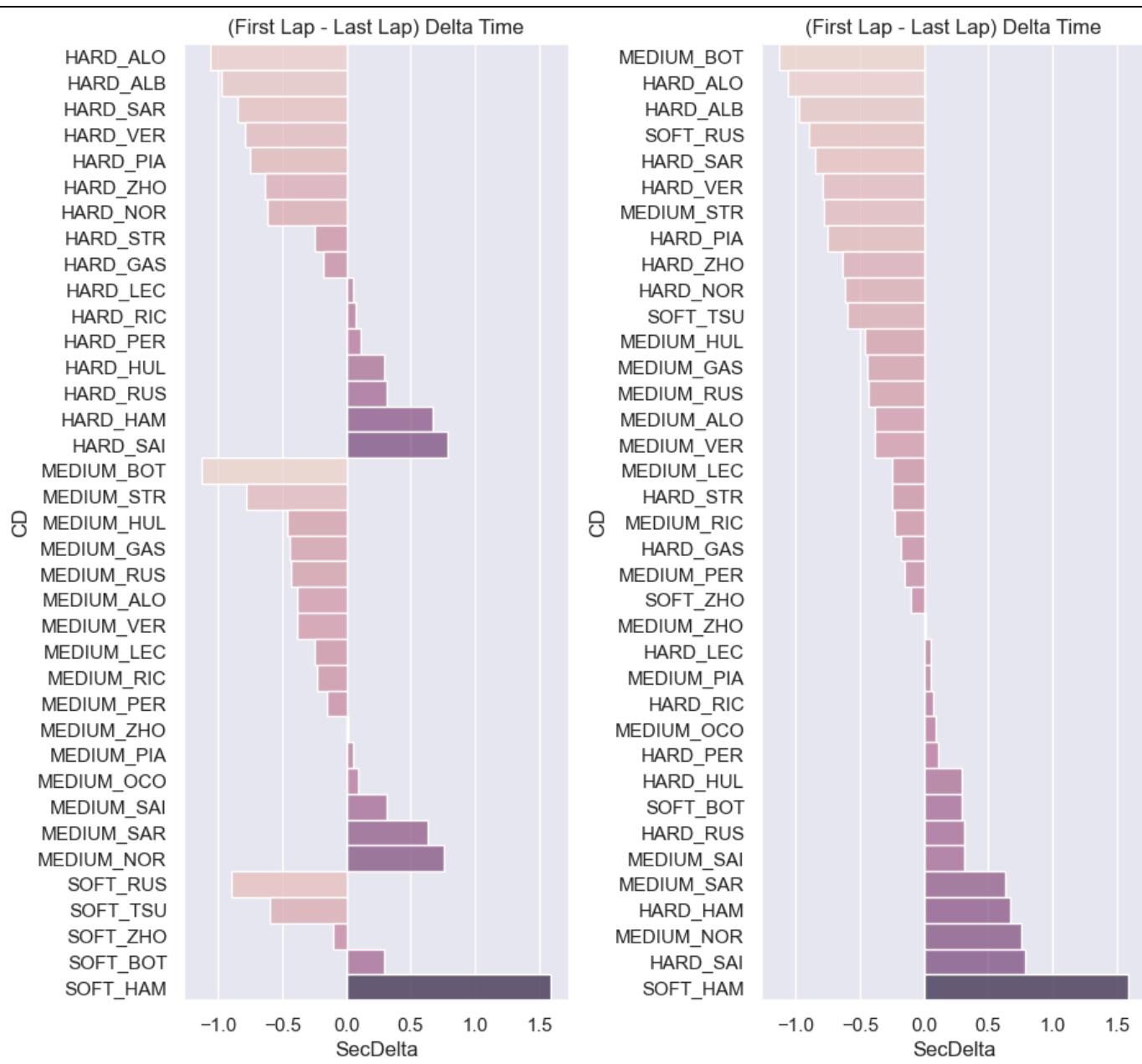
Compound	Position	ClassifiedPosition	TyreLife
HARD	14.725	18	20.5
MEDIUM	8.442	8.7077	14.1691
SOFT	12.2692	13.5962	9.6346



Insights

- Drivers that started with HARD compounds saw a decrease in relative position and a terrible overall position
 - Observation:** This is consistent with the idea that the first Stint was a Sprint Stint and most drivers elected for softer compounds
- Drivers that started with MEDIUM tires saw the smallest decrease in relative position (0.3) and the highest absolute position
- Drivers that started with SOFT tires saw a relative decrease of 1.3 positions and saw medium performance this race

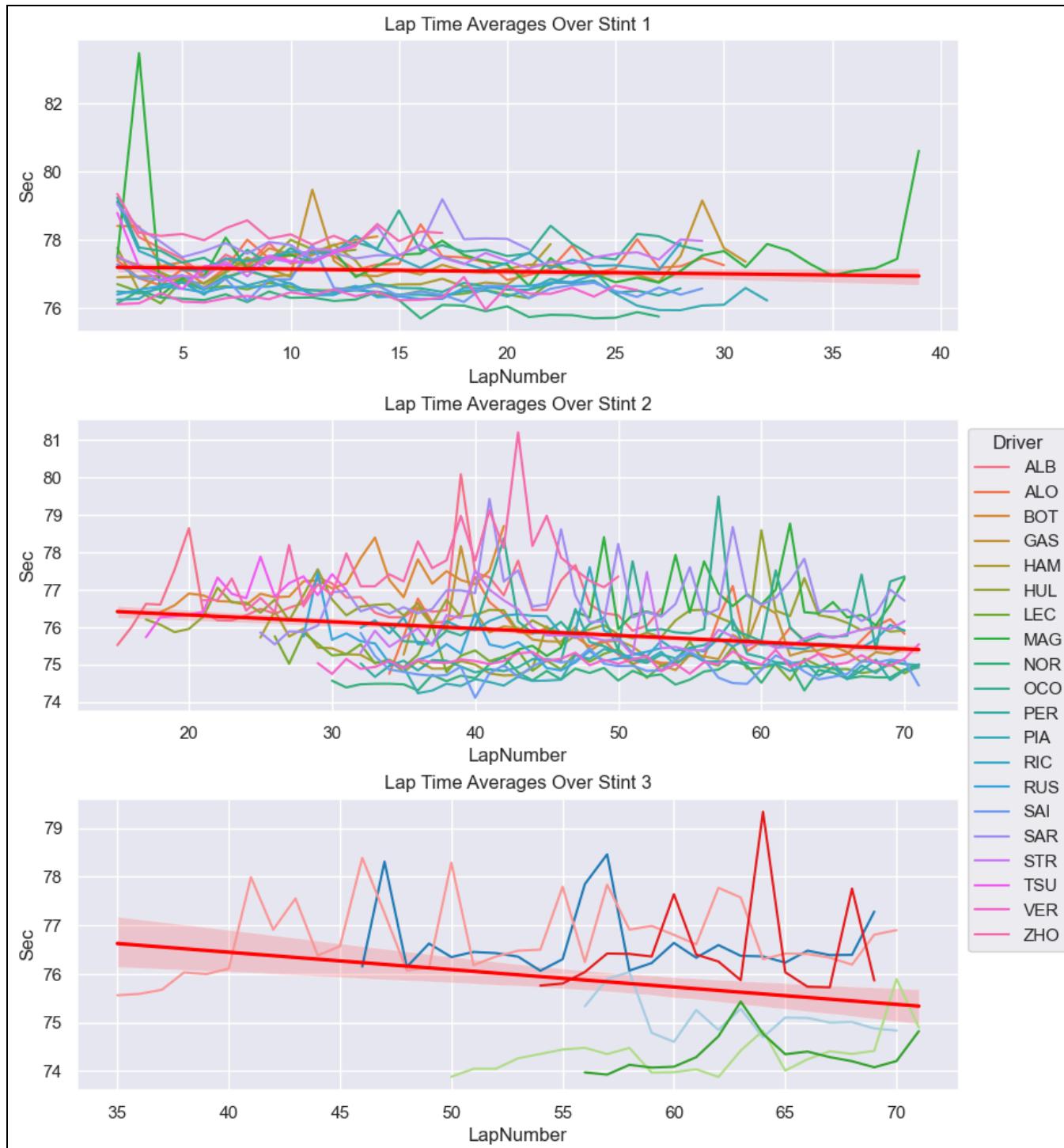
Dutch Grand Prix - Number of Laps on a Compound vs Delta Time (Relationship 3)



Insights

- HARD tires see a lap split between +1s to -0.8s
- MEDIUM tires see a lap split between +1.1s to -0.7s
- SOFT tires see a lap split between +0.9s to -1.5s
- SOFT tires see the best split time but are associated with only above average performance and are under-represented by drivers
- **Observation:** Lap split times are a good variable to consider in conjunction with actual performance - MEDIUM tires outperformed SOFT tires generally in this race

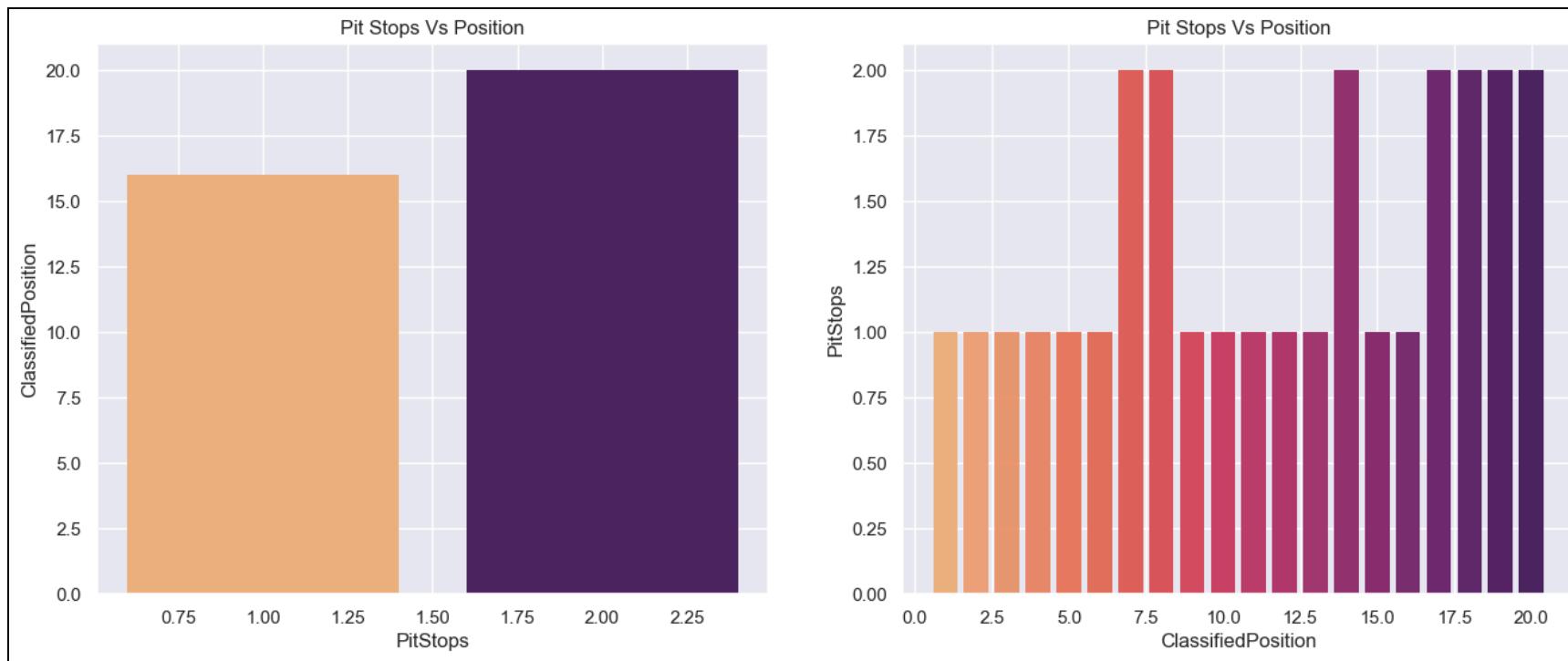
Dutch Grand Prix - Lap Times Over A Stint (Relationship 3.5)



Insights

- Lap times throughout the first Stint are very neutral and see very limited positive or negative changes overall
- Stint 2 has an incredible amount of variation and many drivers frequently spike up to +4 seconds, though still sees a general downward trend
- Stint 3 is under-represented

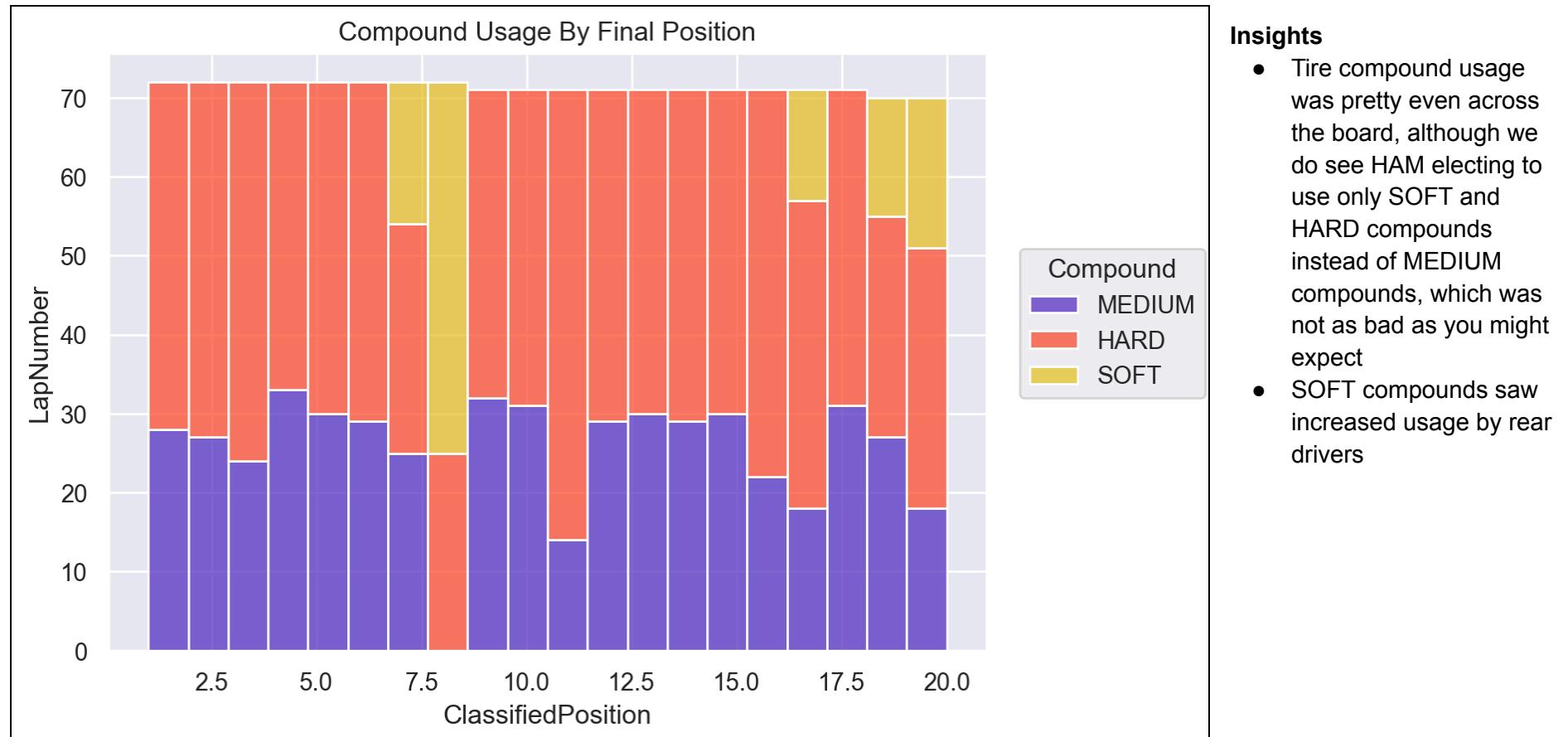
Dutch Grand Prix - Number of Stops vs Final Position (Relationship 4)



Insights

- Pit stops in this race fluctuate between 1 and 2, and the 1 pit stop strategy is weakly correlated with better performance

Dutch Grand Prix - What compounds do certain positions tend to use? (Relationship 6 bonus)



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Please direct any questions / comments / concerns to my github page.