# Formula 1 Race Position Performance-Stock Price Analysis

## Milestone 1: Data Collection, Preprocessing, and Exploratory Data Analysis

### Project Objective:

To develop an interactive dashboard that analyzes Formula 1 race performance metrics and their potential correlation with team market performance. The project aims to uncover patterns in race performance metrics and lay the groundwork for future analysis of how these metrics might influence team company stock price.

### Technical Stack:

- **Programming Language**: Python 3.x
- **Key Libraries**:
  - Data Manipulation: pandas, numpy
  - Visualization: matplotlib, seaborn
  - Statistical Analysis: scipy
  - Machine Learning (future): scikit-learn
  - Dashboard Development (future): Streamlit
- **Development Environment**:
  - IDE: Jupyter Notebook
  - Version Control: Git/GitHub
  - Documentation: Markdown

- **ML Models :**
  - Logistic Regression, Random Forest Classifier, Gradient Boosting, Voting Classifier (ensemble)

### Dataset Description

The analysis uses the Formula 1 World Championship dataset, which includes:

- Races data (1950-2024)
- Driver information
- Lap times
- Pit stops
- Constructor details
- Each Team's Stock Price in the race period. Historic Stock Data is collected from Yahoo Finance using Python Module "**YFinance**" .
- Data set link can be found here.

### Data Preprocessing Steps

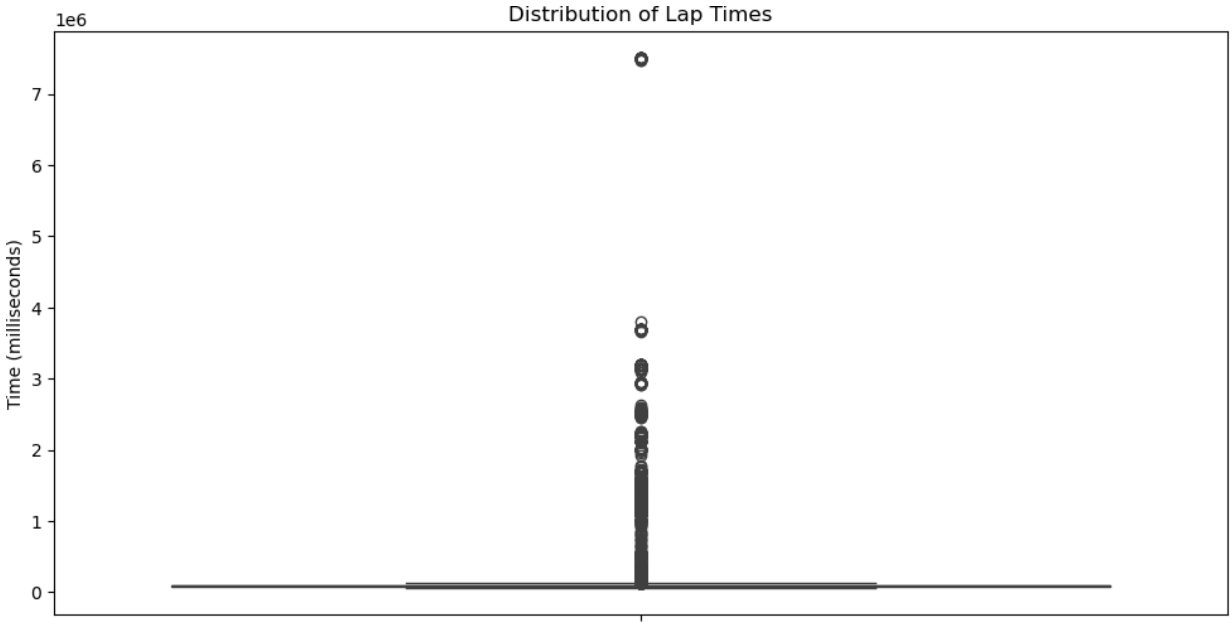
1. **Missing Data Handling**
   - Numerical values: Median imputation

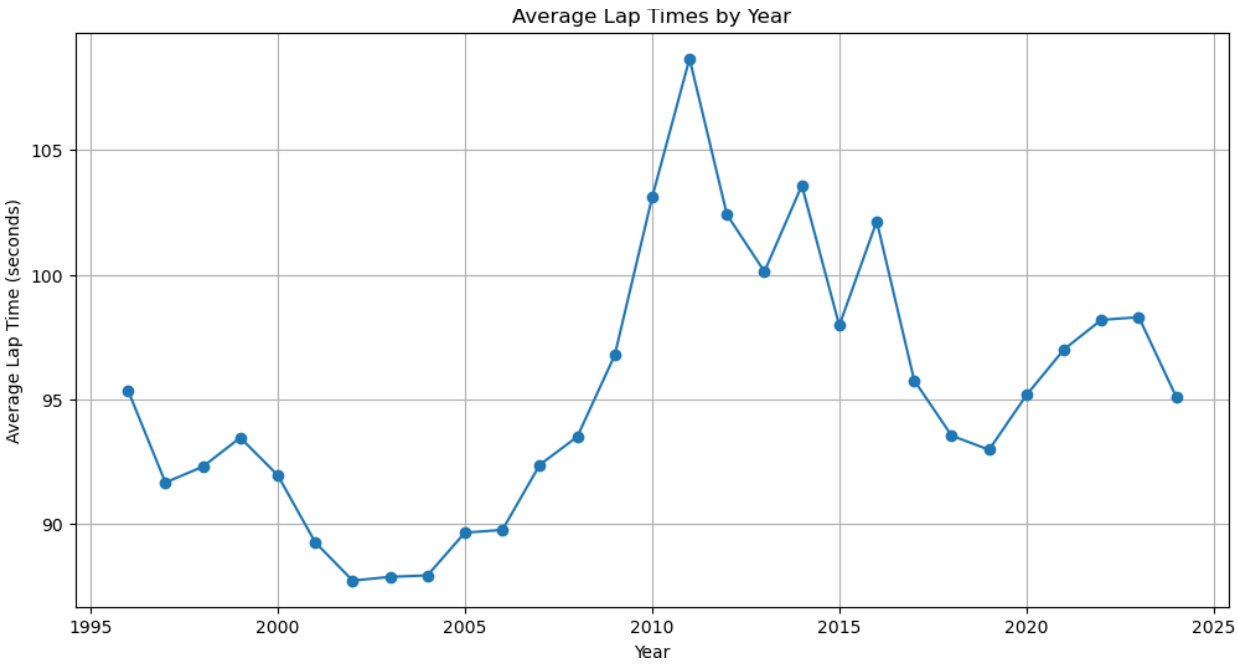
- Categorical values: Mode imputation

2. **Outlier Detection and Treatment**
   - Z-score method for lap times
   - IQR method for pit stop durations
3. **Feature Engineering**
   - Created derived metrics for performance analysis
   - Standardized time-based features

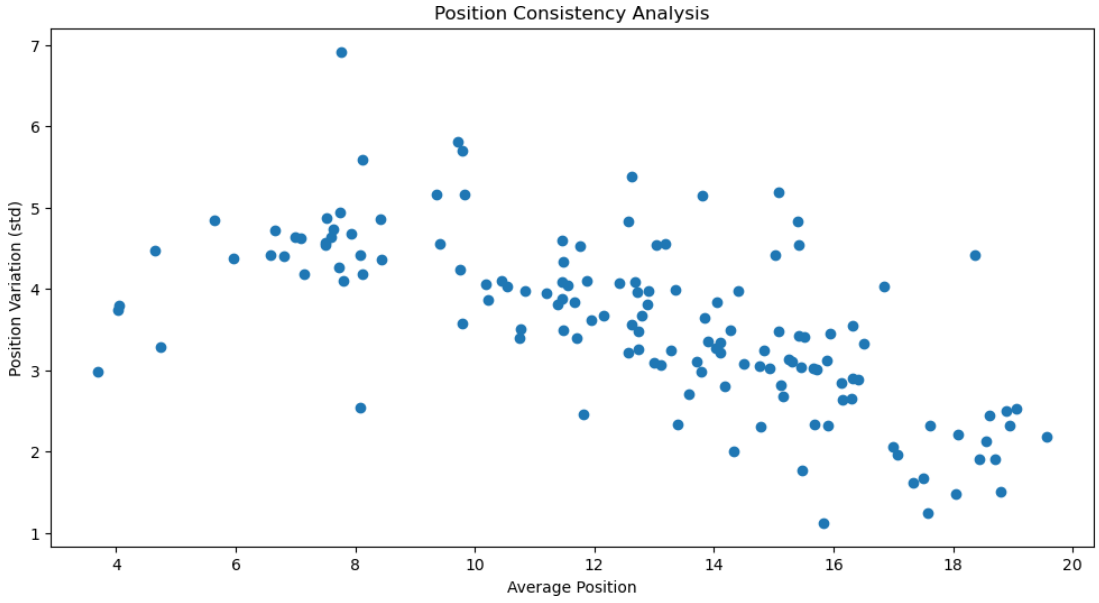
## Key Insights from EDA

1. **Lap Time Analysis**
   - Notable improvement in lap times from 2000-2004, reaching fastest period (~87-88 seconds)
   - Significant slowdown from 2008-2010, peaking around 108 seconds in 2010
   - Gradual improvement post-2010 with some fluctuations
   - Recent years (2020-2024) show relatively stable lap times around 95-98 seconds
   - The variations likely correspond to major regulation changes and technological developments in F1

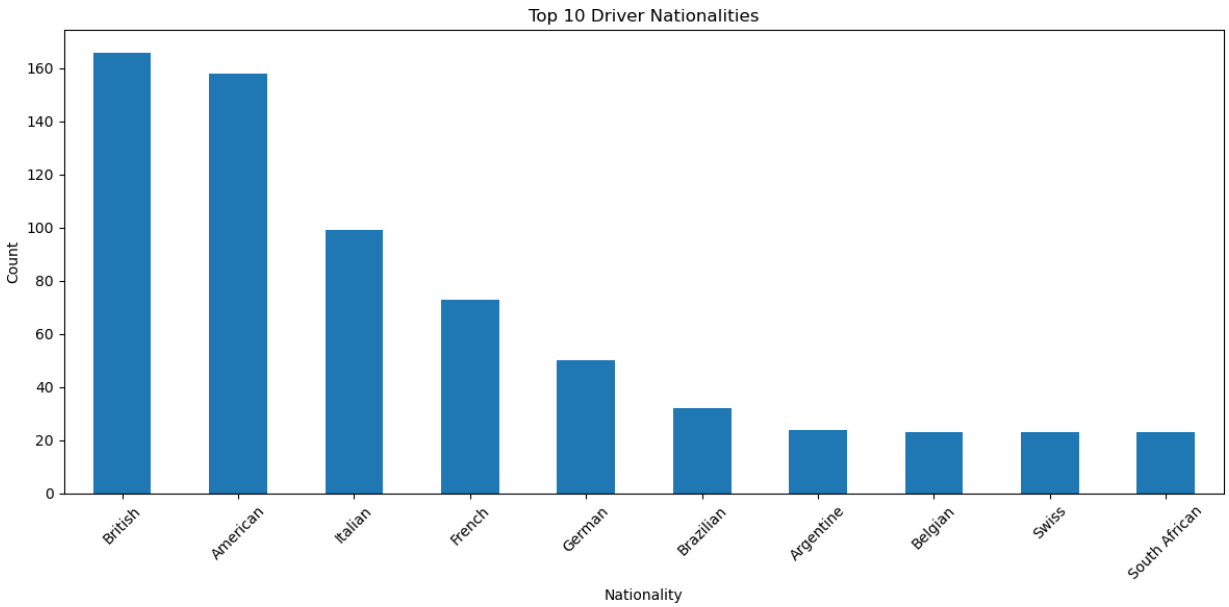




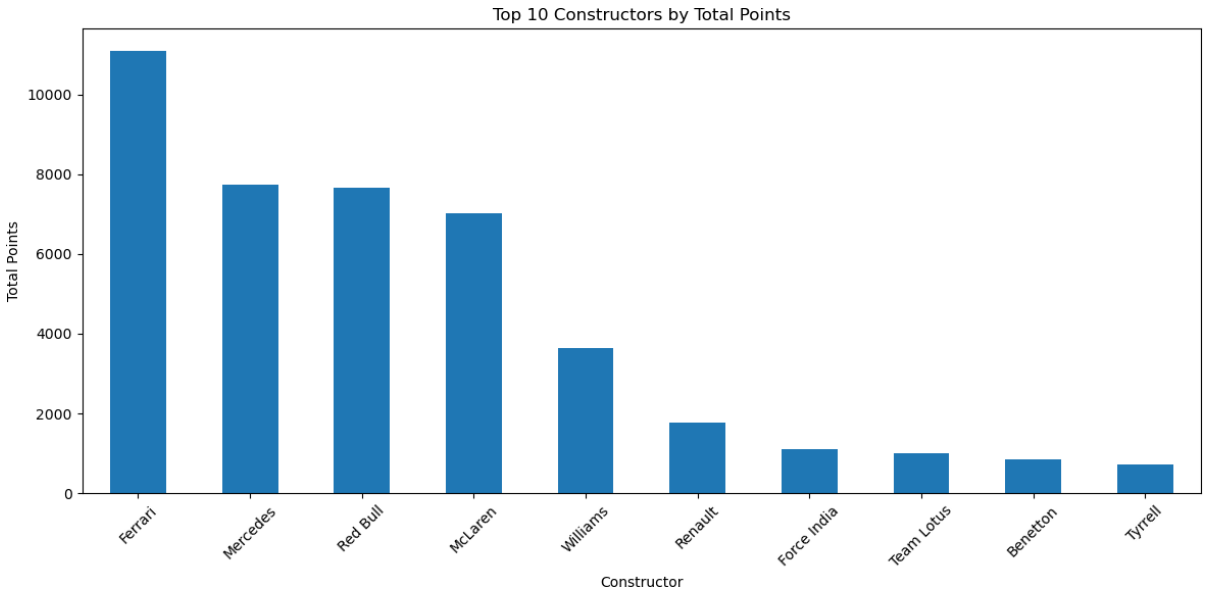

2. **Position Analysis**
    - Clear negative correlation between average position and position variation
    - Drivers with better average positions (lower numbers, 4-8) show higher position variation (3-7 std), indicating more dynamic racing and overtaking at the front of the grid
    - Back-markers (positions 16-20) show much lower position variation (1-3 std), suggesting they tend to remain in similar positions
    - Middle-field positions (10-14) show moderate variation, indicating competitive mid-pack racing
    - The scatter pattern suggests three distinct racing tiers: front-runners, mid-field, and back-markers.



3. **Driver Performance Patterns**
    - British drivers dominate Formula 1 with approximately 160 drivers, followed closely by American drivers
    - There's a significant drop after the top 2 nationalities, with Italian drivers being the third most common
    - European nations (British, French, German, Belgian, Swiss) make up the majority of the top 10
    - South African representation shows F1's global reach, though at a much lower count
    - The distribution suggests a historical European-centric nature of the sport, particularly British dominance.




4. **Constructor Performance**
    - Ferrari leads significantly with over 10,000 total points
    - Mercedes and Red Bull form a clear second tier with ~7,500 points each
    - McLaren stands alone in a third tier with ~7,000 points
    - Significant drop-off after the top 4 teams
    - Historical teams like Williams and Renault show decent point accumulation
    - Newer or smaller teams (Force India, Team Lotus, Benetton, Tyrrell) have significantly fewer points
    - The distribution suggests a clear hierarchy in F1 team success and resources


Top 10 Constructors by Total Points
Total Points
0
2000
4000
6000
8000
10000
Ferrari
Mercedes
Red Bull
McLaren
Williams
Renault
Force India
Team Lotus
Benetton
Tyrrell
Constructor

# Milestone 2: Feature Engineering, Feature Selection, and Data Modeling

### TOTAL DATA SIZE:

- 1125 F1 races from 1950–2025
- Focus Years: 2015–2023 (post Ferrari IPO)
- Constructors: 212 total
- Ferrari Races Analyzed: 185 (2015–2023)
- **Stock Data Points**: 2062 trading days

## Feature Engineering:

### Created Features:

- position: final race position
- points: points earned per race
- round: race number in the season
- price_change_pct: % change in stock price (5-day post-race vs 5-day pre-race)
- price_up: target variable (1 if stock rose, else 0)

**Filtering Applied:** Removed outliers: stock changes > ±10%

## Feature Selection :

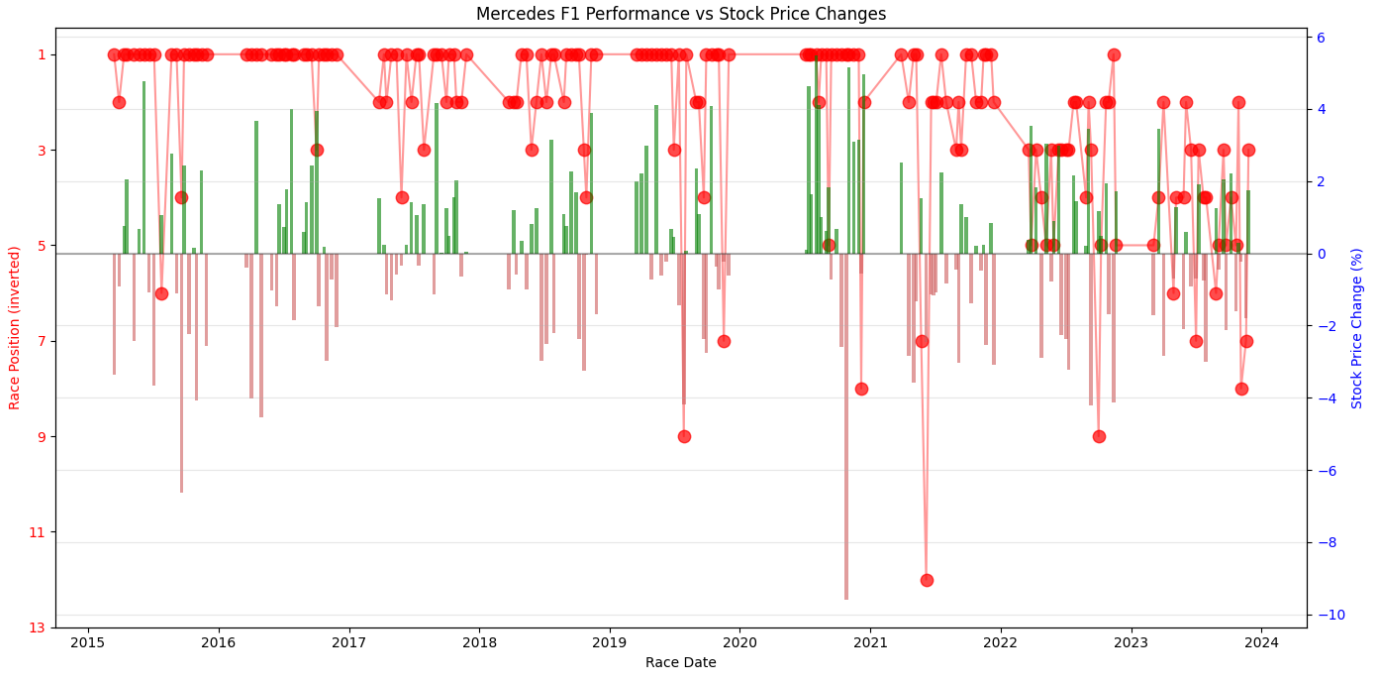
### Final Features Used:

- position
- points
- round

### Reasoning:

- These features have direct logical and statistical relevance to race outcomes.
- Simpler models performed better with fewer, cleaner inputs.

# Key Insights taken into consideration:



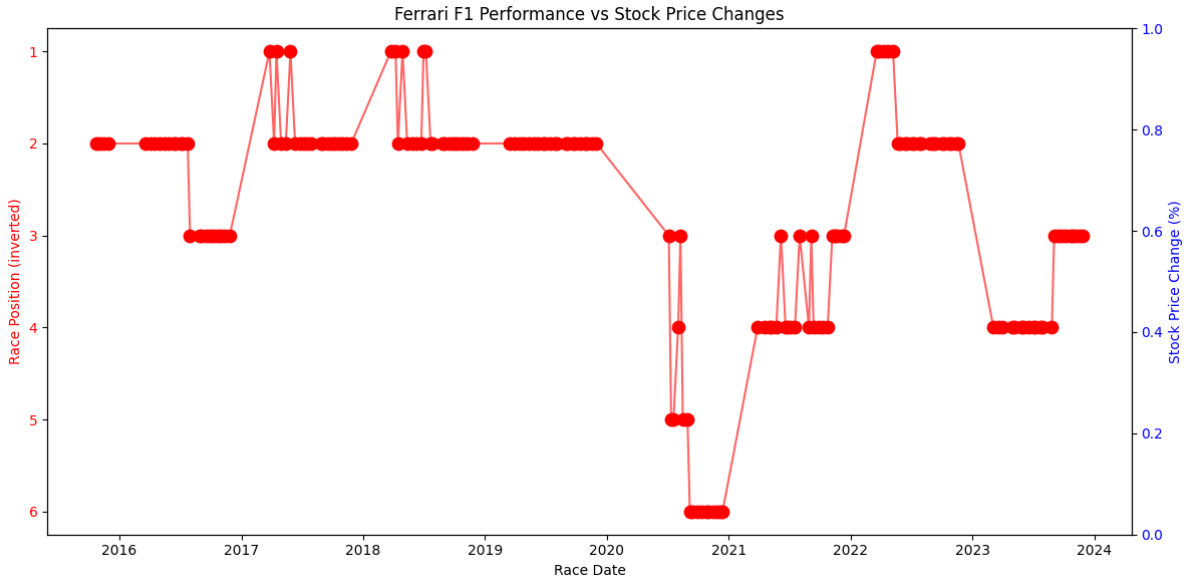

# Understanding from the Graph:

From the above graph we can detect that from **2015 to 2021**, Mercedes consistently maintained top race positions, often finishing **1st or on the podium**, which aligns with their **dominant championship streak** during this era. The red dots clustered at the top reflect this dominance. During this period, the stock frequently responded positively to strong race performances, as seen by the green bars above the x-axis.

However, starting from **2022**, there's a noticeable shift:

- Mercedes' race positions are more scattered and less dominant.
- **No championships won post-2021**.
- When Mercedes does win an occasional race, there's a **small but visible positive stock movement**, indicating that **investor confidence is reactive to individual wins rather than overall dominance**.

Overall, this graph suggests a **stronger correlation between sustained dominance and stock performance prior to 2022**, while **occasional wins post-2021 produce more muted stock reactions**.




Same Pattern Can be Observed with the Ferrari team.

## Data Modelling:

**Target Variable:** Binary classification of stock movement (price_up)
**Data Split:** 70% training / 30% testing (with balancing of classes)

**Models Trained:**

| Model | Accuracy | F1 Score | ROC AUC |
|---|---|---|---|
| Logistic Regression | 0.5490 | 0.7089 | 0.5124 |
| Random Forest | 0.4902 | 0.5938 | 0.3618 |
| Voting Classifier | 0.5938 | 0.5000 | 0.6872 |

## Conclusion:

- Ferrari's F1 race performance shows some predictive signal for short-term stock movement.
- While linear correlation is weak, classification models, particularly ensemble models, demonstrate improved ability to detect stock direction (AUC = 0.6872).
- Additional features and financial context (earnings dates, news) could enhance the model further.

### Project Timeline

1. **Milestone 1** (Data Collection & EDA) - February 5- February 21, 2025
2. **Milestone 2** (Advanced feature engineering, Model development for performance prediction & Initial dashboard structure) - February 21- March 15, 2025
3. **Milestone 3** (Dashboard development, Performance optimization & Final documentation and presentation) - March 15-April 15, 2025

**Next Steps:**

- Initial dashboard prototype development
- Add sentiment analysis from race news
- Try other models: XGBoost, Neural Networks (Milestone 3)