Team Competitiveness in Formula One

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Project Goal and Motivation:

Our project aimed to understand the impact of intra-team competitiveness on the overall performance of Formula One racing teams. Motivated by the observation that closely matched teammates may push each other to excel, we sought to determine if smaller gaps in qualifying times between teammates correlate with better team performance, as measured by win and point percentages.

Research Questions and Hypotheses:

Hypothesis 1: Is a 0.5 second difference in qualifying times a valid benchmark for defining competitiveness between teammates?

Hypothesis 2: Do teams with more competitive pairings (as defined by the 0.5-second benchmark) enjoy higher win percentages?

Hypothesis 3: Do more competitive pairings achieve higher point percentages, indicating overall better team performance?

Methodology and Statistical Analysis:

We utilized one-sample and two-sample t-tests to evaluate our hypotheses. These tests helped us compare the established benchmarks against the data collected from racing events. We also explored machine learning models, including elastic net regression and k-means clustering, to uncover any underlying patterns or correlations between competitiveness and team success.

Findings:

Hypothesis 1: We found that the 0.5-second benchmark is a statistically valid measure for distinguishing between more and less competitive team pairings, as we failed to reject the null hypothesis indicating that this benchmark aligns well with standard competitive definitions. Hypothesis 2 & 3: Our analysis showed statistically significant differences in both win percentages and point percentages between more competitive and less competitive team pairings. Teams with smaller qualifying time differences between drivers tended to perform better in races, supporting the idea that closer competition within a team leads to better outcomes.

Machine Learning Insights:

Elastic Net Regression: Contrary to our expectations, we found no strong correlation between competitiveness (as measured by qualifying time differences) and overall team success in terms of win and point percentages. This suggests that the relationship might be influenced by other, unmodeled factors.

K-Means Clustering: This model revealed distinct groupings based on competitiveness and performance metrics, highlighting complex patterns that suggest both highly competitive and less competitive teams can exhibit varying levels of success.

Conclusions and Further Research:

The results largely confirmed the utility of the 0.5-second standard in assessing team dynamics and its correlation with performance outcomes. However, the inconclusive results from the elastic net model suggest the need for further investigation, possibly with more sophisticated analytical tools or more comprehensive data sets. Future studies might explore additional variables that could affect team performance, such as strategic decisions, technical advancements, or individual driver skills.

This research underscores the nuanced nature of team dynamics in high-stakes environments like Formula One racing and points towards a complex interplay between individual competencies and team success. Further exploration into these dynamics can provide deeper insights into effective team management and performance optimization in various competitive fields.

Capstone Component:

For the capstone component, our group decided to implement an interactive web app showcasing some interesting visualizations from our project. The main visualization was the graph plotting data points on average qualifying time and team points scored in a season, these were the benchmarks of driver competitiveness and team competitiveness respectively. Our interactive graph allows users to hover over any datapoint to see the team it represents and relevant information. The user can also select a specific season to look at and analyze or look at the distribution of all data points over all seasons.

Link to our project video showcasing this component: https://drive.google.com/file/d/1iHArTvIRv_G6_HIGakFz-WrTBHh4J0o-/view?usp=sharing

