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*by* Farley Staines

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BSc Data and Information Systems  
A comparative analysis of driving  
performance and styles across  
simulators and real-world scenarios

Farley staines

Nik Whitehead

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### 3. Introduction

The project focuses on analysing and comparing driving performance and styles across different scenarios, including experienced vs. inexperienced drivers, qualifying vs. race conditions, and simulator-based vs. real-life environments. The growing use of driving simulators in research has proven effective for training and behaviour analysis, offering a controlled setting to study various driving behaviours without real-world risks. This project aims to bridge the gap between simulated and real driving by identifying key differences and similarities.

It will utilize telemetry data from both simulators and real-world driving to examine speed, throttle, braking, and steering inputs. By applying a structured data-driven approach, the project seeks to uncover patterns in driver improvement and how external factors like weather or track conditions influence performance.

## 4. Background to the Proposed Research

The use of driving simulators for research and practical applications has been growing over the years, with their legitimacy and accuracy often debated. Studies have shown that simulators provide a safe and controlled environment for testing and practising a variety of driving situations, from speed perception, error rates and driving styles, without the risk assigned to real world driving. However, there are question about how well simulator results translate to real-world situations.

Hussain et al [1] validated the use of driving simulators for speed perception, demonstrating that simulators could mimic real world conditions closely enough to be useful. They found that while participants generally drove faster in simulators, the trends between perceived and actual speeds were similar across both environments. Similarly, Shechtman et al [2] explored driving errors between on-road and simulator environments, and finding no significant differences in error types, indicating that behaviours measured in simulators could be generalised to real world driving under similar conditions.

In professional motorsport, the complexities of driving styles increase due to the subtle differences between the driver's skill level and changing dynamics of racing [3]. In works, such as those done by Ekanayake et al [4], focused on comparing expert driving behaviours in simulators and real-world scenarios, using a mix of performance measures and psychophysiological data to investigate the degree to which driving skills are transferrable. They found that physiological indicators such as vigilance levels varied, whereas basic driving performance metrics showed a level of consistency between the two environments. This can suggest that advanced simulators can be an effective tool for training and analysing for competitive settings.

In the realm of esports, specifically sim racing, driver recognition and competitive integrity have become a critical issue. Studies [5] on driver behaviour and performance tracking within the simulators have laid the groundwork for detecting unsportsmanlike conduct, cheating, and establishing a fair play environment[4]. This line of research benefits from information gained from traditional racing studies since both involve a high degree of skill and distinct driving styles however subtle. These can both be captured and analysed using telemetry data and machine learning techniques.[1]

Researchers have developed numerous ways to identify drivers based on their driving style alone. Worle et al [6] builds upon this by applying advanced machine learning techniques, specifically random forest classification, to identify drivers in professional racing. By only focussing on objective criteria gathered from control inputs (throttle, brake, and steering), this helps narrow the gap between general driver behaviour analysis and the specific needs of motorsports. Another research paper by Schlemitz et al [7] extends the previous work[6] [8] by focusing specifically on pedal interactions. They gathered and used a substantial dataset spanning multiple season and drivers for which they applied a supervised learning technique to analysis the dataset.

Combining these findings, it is apparent that while driving simulators cannot replicate everything about real world conditions, however they do offer a robust platform for controlled testing, training, and behaviour analysis. The studies mentioned demonstrates the importance of verifying the accuracy of simulators for a range of driving situations and highlights the importance in using advanced technologies in closing the gap between virtual and real-world driving experiences.

## 5. Aims & Objectives

### Aim:

The aim of this project is to analyse and compare driving performance and styles across different scenarios like between experienced and inexperienced drivers, qualifying and race conditions, simulator-based and real-life driving environments, and how external factors affect the outcome.

### Objectives:

Compare where and how fast or experienced drivers improve over slower or inexperienced drivers.

Compare the different driving styles between qualifying (where you need to drive fast over one lap) and the race (where you need to drive quickly and survive over multiple laps).

Compare the different driving styles between driving on a simulator compared to driving a car in real life for qualifying and the race.

Investigate the impact of external factors like, weather conditions, track conditions, and car setups have on driving performance.

## 6. Methodology

### 6.1. Research Methodology

#### 6.1.1. Philosophy

This project will adopt a positivist methodology to analyse quantifiable data from multiple laps, focusing on identifying patterns, trends, and relationships. By comparing objective measurements like speed, time, and distance. The project aims to pinpoint where and how drivers improve and explore different driving styles. The advantage of this approach lies in its ability to convert data into statistical insights, offering general strategies for improvement and behaviour analysis. However, a drawback is that it overlooks subjective factors, such as a driver's perception and fear of crashing, which may differ between simulator and real-life scenarios due to safety concerns.

#### 6.1.2. Approach

The project will use a mixed approach, starting with a deductive method to test specific hypotheses about driver improvement and driving styles, such as "Drivers improve faster in the simulator compared to real life." This structured approach allows clear, measurable comparisons, like evaluating whether faster drivers improve more efficiently over specific corners or braking zones. However, this method may limit findings to the scope of the hypotheses, potentially overlooking other patterns. To address this, the project will shift to an inductive approach after the deductive analysis. This second phase allows for the discovery of unexpected patterns and insights that were not part of the original hypothesis, providing a more open exploration of the data. For example, this can help identify new factors affecting performance, such as weather conditions. While the inductive approach may lead to conclusions that are harder to generalize, new theories can be developed and later evaluated deductively, balancing exploration with structured testing.

#### 6.1.3. Risks & Limitations

The risks of the project include a lack of data availability or quality, such as inconsistent or incomplete simulator data or insufficient real-world data, which could affect comparisons. To mitigate this issue, ensure that data collection process is robust, standardized, and error-free. Another risk is limited real-world data due to delays or disruptions. This can be managed by arranging agreements with drivers or engineers in advance, or by using historical data if new data is unavailable. If these measures fail, the project may reduce its scope to focus solely on simulator data analysis.

#### 6.1.4. Ethical Issues

One of the ethical issues with this project is data privacy and confidentiality, since its will be collecting and analysing driving data from simulator and real-life drivers, there will be managing of sensitive information that could be linked to their identity or performance. A few ways to mitigate any issues is to follow data protection regulations (e.g. GDPR) by ensuring that data is stored securely and anonymized. To help stored the data securely, strong encryption methods can be implemented as well as restricting access to who has access to the data.

#### 6.1.5. Validity, Reliability & Generalisability

##### 6.1.5.1. Validity

The project will be using a positivist methodology and because there will be measurable data which is ideal for creating concrete quantifiable conclusions which reduces the subjectivity.

#### 6.1.5.2. Reliability

If someone else were to follow the same methodology, then they should produce comparable results. However there are some factors that may affect the results. Data collection is a significant factor, even if it followed step by step they will not obtain the same results as there are inconsistencies in drivers and how they drive, but if they were to use the same dataset then they should obtain equivalent results. There will also be variations in the results based on what data has been gathered, for example, track, weather conditions and driver.

#### 6.1.6. Data Collection

The main data collected will include speed, throttle and brake inputs, steering, lap times, and sector times, from the game. Telemetry packets will get sent over UDP during gameplay and will be converted into data and saved in JSON format. The goal is to gather data from several laps, and if insufficient, more laps will be driven to fill gaps. If this still does not provide enough data, the track will be switched to a longer one, and the same number of laps will be repeated there.

### 6.2. Development Methodology

This project will be using the knowledge discovery in databases (KDD) methodology. The process looks at extracting valuable, actionable information from the data, which aligns with looking at driving styles and performance. This project will select useful data from the sources, then clean the data by managing missing data and normalising values. The data will then be transformed to highlight relevant features, this could be by converting the data into variables making it easier to analysis. It will then use various data mining techniques like clustering, classification, or regression to analyse the data. The last step will involve interpreting the results to ensure they align with the aims.

## 7. Resources and Planning

### 7.1. Hardware Resources

For this project, two devices will be required. One of the devices will run the program to collect and store the data received, so there should be an adequate amount of storage available as well as enough RAM since the program holds all the data and saves it all at once. The second device will run the game where the data will be sent from. This device will have a full racing rig with wheel and pedals and triple screens.

### 7.2. Software Resources

On the first device, python will be installed along with a custom-built program that will be collecting incoming UDP data and convert it into usable data and then store it as a JSON file. The second device will be running project cars 2 which will be using the 'project cars 2' UDP protocol.

### 7.3. Information Resources

The only external data that should be needed is telemetry data from races of real-life drivers. This data will come from the engineering and motorsports department.

### 7.4. Human Resources

For this project it should require no more than three other people to collect driving data from. These people will be acquired by them volunteering to complete a fixed program to which the data will come from.

### 7.5. Project Plan

The project plan has been defined in figure 1. It has five main sections: project proposal, final report, interim viva, final viva, and exhibition. The Gantt chart was created using TeamGantt.

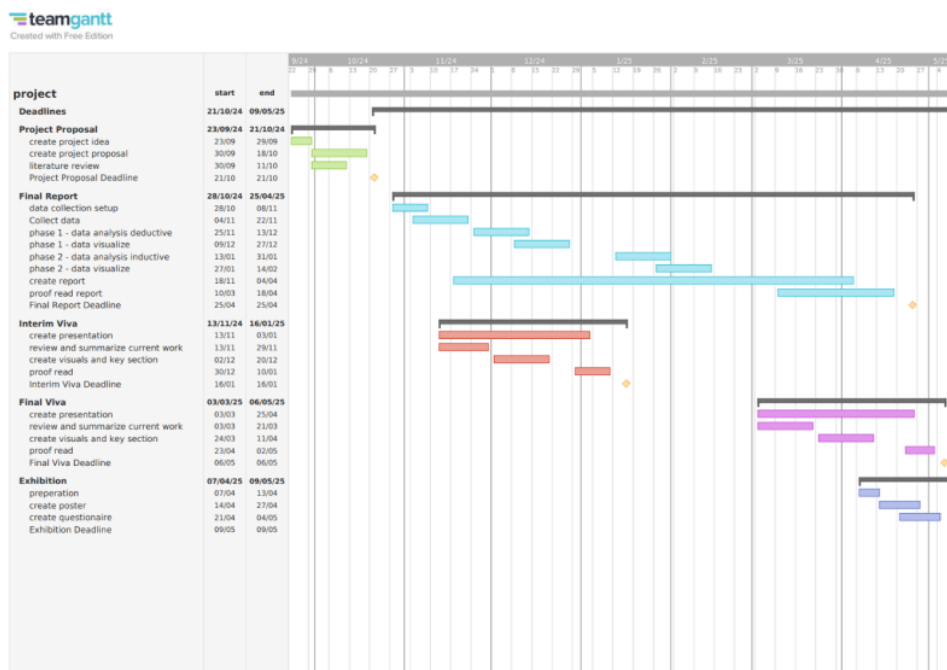


Figure 1 - Gantt chart created using TeamGantt.

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FINAL GRADE

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GENERAL COMMENTS

Have sent email with feedback as Nik provided handwritten pdf.

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