# Architectural Analysis

This section outlines some basic requirements of developers and players which have to be satisfied. Since multiple players should be able to play at the same time, a suitable platform has to be identified. Developers should be able to integrate tools to measure the learning effect in different situations. The generated player data should be stored in a structured, reliable and everywhere accessible way. Finally, there are some requirements for data analysis. The requirement analysis ensures the quality by checking (Paetsch2003):

* Necessity: Ensures requirement is needed.
* Consistency: Dissolves contradictory requirements.
* Completeness: Ensures all requirements are modelled.
* Feasibility: Practicable in context of budget and time.

The requirements engineering community classifies requirements as either functional or non-functional (Chung). In the next section we discuss the functional and non-functional requirements of the Virtual Rivals Framework to ensure quality and usability.

# Functional Requirements

Functional requirements describe what the system should do (Robertson). In this section we discuss the functional requirements of the *Virtual Rivals Framework*. The functional requirements are listed in descending order of priority. High priority features should be implemented first.

1. The game should include ghost cars with different behaviour patterns and skill levels.
2. Data evaluation should measure Enjoyment, Performance and Motivation.
3. Players should be able to access the game through the itch.io website.
4. The game should support multiple platforms:
   1. Browser: Edge, Chrome and Firefox
   2. PC: Windows
5. The controls provided for the players should be simple and self-explanatory.
6. The game has to support multiple players at the same time.
7. The framerate should be above 60 frames per second at all times.
8. Driving data should be recorded in the background at all time.
9. All data should be stored in the cloud.
10. Implementation of Genova Wheel of Emotions (see Section \ref).
11. Implementation of personality measures Big Five and Sensation Seeking (see Section \ref).
12. Questionnaires should contain clear and simple questions.
13. Developers should be able to add new functionality:
    1. Additional questionnaires
    2. New driving behaviour
    3. Additional opponents
    4. Record additional driving metrics
14. Every player and game data should be identifiable by a unique id.
15. Framework has to provide functions to identify software bugs.
16. Data evaluation should be able to statistically analyse personality measures.
17. Data evaluation should be able to identify driving patterns.
18. The race car should include an automatic gearbox.
19. Study participant recruitment should be performed using Amazon Mechanical Turk.
20. Display size should be adjustable.
21. The sound volume should be adjustable.
22. The race car should produce realistic engine sounds.
23. When driving through nature environment animal and wind sounds should be play.
24. The race tracks should be build out of basic building blocks straights, turns, plants, rocks, water, finish lines and trees.

# Non-functional requirements

The previous section introduced the functional requirements of the *Virtual Rivals Framework*. This section introduces non-functional requirements. Non-functional requirements describe how the system works (Robertson). They are not related to the functionality of the software e.g. performance, usability. The non-functional requirements are listed in descending order of priority. Requirements with high priority should be warranted at all time.

1. The player data is protected.
2. The racing simulation should optimise Enjoyment, Performance and Motivation.
3. Players without gaming experience or driving experience should be able to play without difficulties.
4. The players should always be able to abort when feeling uncomfortable.
5. The data should be accessible at all time.
6. Questionnaires should not influence the game flow.
7. Data integrity is ensured at all times.
8. Data evaluation should be fast and flexible for big data sets.
9. Data evaluation should be expandable for new metrics and graphs.
10. The graphics and objects used should evoke associations with a real race track.
11. Loading times should be fast.
12. System response time unnoticeable for the player.
13. The data evaluation should be reasonably fast, even for large data sets.
14. Data upload should be fault resistant.

This section introduces the main functional requirements and instruments to improve \textit{Enjoyment}, \textit{Performance} and \textit{Motivation} in racing simulations and measure the effectiveness. The main tasks are to create a virtual racing environment with integrated questionnaires and a statistical evaluation tool. The virtual racing environment is the race game where players are challenged by traditional ghosts and VRs. The structure and realism of the race environment influences the players’ *Motivation* and *Enjoyment and Education*. It is essential that the created race game is designed in a way that invites players. The objects should evoke associations with a real race track. The questionnaires are the main tool to gather information about the players. It is important to have clear and simple questions. Statistical evaluation is used to uncover trends and patterns within the data. The main goal is to analyse and compare players’ *Performance*, *Enjoyment* and *Motivation*. The next section gives a short overview of the projects structure and how the elements discussed in this section are integrated.

Requirements Engineering and Agile Software Development – Paetsch2003

On Non-Functional Requirements in Software Engineering – Chung

Robertson, S., & Robertson, J. (1999) Mastering the Requirements Process.

Requirements regarding the Virtual Racing Environment

The virtual racing environment is the race game where players are challenged by traditional ghosts and VRs. The virtual racing environment is very important for the learning experience. The structure and realism of the race environment influences the players’ Motivation and Enjoyment. Control: To fit all player types the controls should be as simple as possible. This means players without gaming experience or driving experience should be able to play without difficulties.56

3 Design and Requirements Graphics: It is essential that the created race game is designed in a way that invites players. The objects should evoke associations with a real race track. Multiplayer: The environment has to support multiple players because imple-menting such a feature is in the scope of this work. It should be possible for multiple users to complete the tracks at the same time. Maintainability: Oncecreated, developers must be able to identify software bugs and fix them. Itshould also be possible for programmers to extend the implemented functionalityanytime.Requirements regarding the Player Evaluation QuestionnairesThe questionnaires are the main tool to gather information about the players.To questionnaires should be based on the tools discussed in Section 2.2.3. Theyare essential to identifyEnjoymentandMotivationduring the race.Integrated:The questionnaires should not influence the game flow.Clear:It is important to have clear and simple questions. The controls duringthe questions should be self-explanatory and fault resistant.Fast:The loading times between questions should be fast. Time should be spentplaying, not answering questions.Requirements regarding the Player StatisticsPlayer statistics are used to identify player types and skills. The data is recordedon each lap for every player. The data is vital to measurePerformance.Hidden:The data recording should be in the background. The process mustneed only little resources.Extensibility:After the development is finished, the developers should be ableto add additional statistics.Requirements regarding the Data StorageThe data storage handles all data created by the players. The data is neededfor the method and player analysis.Fast:The loading and saving times should be as fast as possible to reducelatency.Reliable:The data should be accessible at all time.57

3 Design and RequirementsRequirements regarding the Statistical EvaluationEvaluation involves collecting and scrutinizing every data sample in a datastructure where the analysis can be performed. Statistical evaluation is used touncover trends and patterns within the data. The main goal is to analyse andcompare players’Performance,EnjoymentandMotivation.Fast:The data evaluation should be reasonably fast, even for large data sets.Extensibility and Flexibility:It should be possible to change metrics and addadditional metrics.

This section introduces the main functional requirements and instruments to improve Enjoyment, Performance and Motivation in racing simulations and measure the effectiveness.

The next section gives a short overview of the projects structure. An how the elements discussed in this section are integrated.