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**Report Layout and Style**

T­he following guidelines **must** be adhered to:

* All **text will be black** in the report unless in very exceptional circumstance.
* Main body text must be at least **11pt font** using either **Arial or Calibri** font.
* Main body text will have **1.5 line spacing**.
* **Margins** will be a minimum of **2 cm on each side**.
* All **pages** will be **numbered consecutively**.
* **Figures** must have **captions** and be **numbered** (e.g., Figure 1).
* **Tables** must have **captions** and be **numbered** (e.g., Table 1).
* **Figures** may be **black and white**, or **colour**.

**Word Count**

There is a **10,000-word limit** for the project. Do not see this as a target, but rather a limit to the number of words we expect a project to have. All words in the main body, excluding words in figures and tables, will count to your word count. If you think you will go over 10,000 words, you should consider what can be removed from the main body and placed in an appendix.

**Copyright and Intellectual Property Rights (IPR)**

Your report should be written considering that it will be within the public domain. Normally, you retain copyright over your written work and Intellectual Property Rights (IPR) over any technical work. There are situations where this might not be as simple, for example when working with a company or on a larger university project. There are strategies you can utilise:

* You can inform your supervisory team that the project cannot be made available to other students undertaking an BSc Project.
* You can provide a shortened report for sharing that does not contain the protected information.
* You can assign IPR to the external collaborator, although you should take great care when doing so. It is best to speak to your supervisor.
* Non-disclosure agreements can be made between the external collaborator and the supervision team.

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Project Report Title

Subtitle if required

By

Your Name

Submitted to

**The University of Roehampton**

In partial fulfilment of the requirements

for the degree of

**BACHELOR OF SCIENCE IN COMPUTER SCIENCE**

Abstract

Abstract narrative

Signed (apply signature below)

**Declaration**

I hereby certify that this report constitutes my own work, that where the language of others is used, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of others.

I declare that this report describes the original work that has not been previously presented for the award of any other degree of any other institution.

**Date:** Enter the date here

**Enter your name here**

Acknowledgements

Acknowledgements narrative

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# **Introduction**

GUIDANCE (text in blue can be deleted from your final submission)

An initial paragraph introducing the project context and idea (all projects).

The focus of this project is to visualise data from three regions (LEC – Europe/Middle East/Africa; LCS – North America; and LCK – South Korea)) in the professional League of Legends eSports scene from 2015-2017 and see where teams and regions outperformed one another in aspects of the game. These aspects are the total gold difference in games, the individual gold differences between the roles of the game (top, jungle, mid, bot, and support), kills, and objectives (Baron Nashor, Dragons, Rift Herald). The initial data that was sourced from Kaggle [1] will be used to compare these various aspects and present them on an interactive web page that will allow users to explore the visualisations in different manners that may affect the visualisations.

## Research Question or Problem that will be Addressed

GUIDANCE (text in blue can be deleted from your final submission)

A hypothesis and/or research question(s) (research-based projects)

1. A focus of this project would be to determine which team performs the best within a region based on factors of the game and individual roles.
2. The next question would be which is the best team out of the 3 regions to be compared, which will be judged on the same factors.
3. With this information, the question now would be does it match with the results of the individual regions rankings and their ranking in the global world championship Worlds.

These research questions serve a purpose, as the answers found will show how relevant and impactful the factors of the game as visualised are within the game. It will show whether there is a correlation between these factors and the results of teams and regions or whether there is a need for more factors of the game to be taken into consideration.

## Aims

GUIDANCE (text in blue can be deleted from your final submission)

1. The first aim of this project would be to implement useful visualisations that users and the game’s community can use.
2. The next aim would be the ability to determine the strengths and weaknesses of teams and regions.
3. The last aim would be the ability for pro players/teams to identify areas they are weak compared to others to focus on what to improve upon.

The first aim would answer the first two research questions of this project to determine which is the best team in a region and the best region overall. This will allow users to make judgements about teams and regions using visualised data that is factual and will encourage them to talk and engage with others within the game’s community.

The next aim of identifying strengths and weakness can relate to all the research questions as by identifying these factors you can select the best team or region. Also, when looking at the third research question the strengths or weaknesses identified can be used to determine the disparities between it and the results.

The last aim relates to the second aim where identified weaknesses then become the aims of improvement for professional players or teams. It can also relate to the third research question as it will aim on lowering the disparity from regional and global achievements but, this is on the assumption that such weaknesses are improved upon.

## Objectives

GUIDANCE (text in blue can be deleted from your final submission)

Objectives are the tangible steps that will be taken to achieve the aims -- tasks that will be done.

To achieve the aims of this project the following objectives are to be achieved:

1. The first objective is to source the data, which was found on Kaggle [1] and consists of data from 2015-2018 for over 10 different regions in the eSports scene.
2. The second objective is to scrape more data into the dataset that focuses on other aspects of the game.
3. The third objective would be to understand and manipulate the data from the dataset to prepare it for use.
4. The fourth objective would be to research which method of visualisation is best.
5. The last objective would be to create an interactive webpage that will present the visualisations and data in a clear format that is easy to interpret.

## Legal, Social, Ethical and Professional Considerations

GUIDANCE (text in blue can be deleted from your final submission)

Your project must include a description of the legal, social, ethical, and professional issues relevant to the project. All projects will have either a legal, social, ethical, or professional issue element. You must discuss these here and highlight any issues that had to be addressed before undertaking the project.

If your project required ethical clearance, then this must be clearly stated in this section, including how the ethical considerations were managed.

The legal issue this project may face is the sourcing of the data from Kaggle [1], but as it is an open-source dataset, there shouldn’t be an issue. Also, based on objective 4, if there is a process of scraping further data, there is a process of making sure that it is processed legally.

The main ethical issue that links with legality is the fact that initially, the dataset can be considered to have personal data and would therefore have to abide by the GDPR. However, the only sort of data that can be considered as such are the players’ names, but these are, for the most part, pseudonyms, and publicly available data.

A social and ethical issue to consider is that these visualisations may lead users to make judgements about the game and use it to gamble, which is not the intention of the project. However, as the data covered spans from 2015-2017, there will be no such issues unless the project is expanded to use more recent data, where this factor will be taken into consideration.

A professional consideration is to ensure that the visualisations are correct and that there are no errors made during the manipulating stage to provide factual information. Another thing to consider is that there may be teams and players who have performed poorly and wish for their data not to be used. If that is the case, it will be implemented so that it follows their wishes, and we must be sympathetic as it may cause online harassment otherwise.

## Background

GUIDANCE (text in blue can be deleted from your final submission)

You need to convince your examination team that your project is a viable one by answering the question -- **Why is this a suitable project for an BSc Project?**

The aim of the background section is to provide the reader with the relevant contextual information necessary to understand your work. The background section is useful to describe:

* What the examiners need to know about in order to understand your project (for example, any external systems / games / technologies, who uses them, and why).
* Any assumptions that you have made.
* How this project pushes you beyond what has been covered in the degree.
* Why this project / topic was selected.

This section concludes with a summary of the findings from your background investigation and how that **justifies** the work undertaken in your project. This section must be suitably referenced based on the context and justifications that you provide.

League of legends is one of the most popular online MOBA (multiplayer online battle arena) where the main game mode consists of two teams of five players fighting each other of a map, Summoner’s Rift, to defeat each other by achieving the objectives of the game.

There are 3 lanes of the map (top, mid, and bot) and 5 roles (top , jungle, middle, bottom, and support) where each team is battling to ultimately destroy the nexus of each other’s team. Where the nexus is the lifeline of the team which is situated right at the back of a team’s base and is either destroyed by enemies or detonates in the case of surrender. It is protected by towers, inhibitors, minions, and the team.

To achieve the main objective of destroying the nexus there are many steps to be taken to reach it like destroying the structures (towers and inhibitors) to reach the nexus. Will write further about the game later.

What makes this project suitable, and challenging is the need to research further into modules previously studied (data science, software development 3, data visualisation, and software engineering) and into new areas within them. The first area of research was Python and its libraries in particularly pandas and NumPy where the aim was to manipulate and prepare the data for use. The main challenge being the ability to work arithmetically with different sized arrays that is discussed further in section 3 and 4. The main area of research for this project was d3js which is a JavaScript library and focuses of making interactive visualisations. This was a very new and different experience as it was unlike any of the languages I’ve worked with and proved very challenging but, its ability to make interactive visualisations proved its worth.

* What was new and difficult
* Refer to tech and lit section
* The interest in the subject and area of focus (LoL)
* Maybe talk about the growth in visualisation (use google trends)

## Report overview

Describe the upcoming sections in order -- this provides your reader with a roadmap of the report.

The following section, section 2, will focus on the research gone into this project along with the technologies that were selected to use.

Section 3 will cover the design and methodology of the project where it will talk about the design of the project along with the steps taken to achieve it. It will also talk about what alternative approaches could have been taken/used in various aspects of the design. Followed by it will be how the project was managed and this will discuss the Kanban method implemented and the tools used and their usefulness and effectiveness.

Section 4 will discuss the implementation and results where it will go into further details in aspects of the methodology giving a more in-depth analysis. Followed by it will be the final results of the project that will show and present the final product and discuss and evaluate it.

Section 5 is the conclusion where it will conclude the project as a whole and have a section to reflect upon the project and any future work that may or can be done.

Section 6 displays all the references and sources that were used throughout the project.

# **Literature or Technology Review**

GUIDANCE (text in blue can be deleted from your final submission)

**Literature Review** (for research or investigation-oriented projects)

All projects should reference some academic literature, although it is primarily research-orientated projects that will conduct a significant literature review in the background section. As with the technology review, the goal here is to make it clear why the choices were made in the project. It is expected that at least the research methodology and/or evaluation approach is defined from existing sources.

* There was a look at papers relating to League of legends but for the most part there was no relevance into what this project aims for.
* There were some papers that very trying to calculate odds of winning and the different win conditions in various regions, where their results of findings would be very helpful when analyzing the visualisations [2].
* A lot of other papers looking at teamwork and other more probability-based research was unavailable to view due to paywall.

**Technology Review** (for build or investigation-oriented projects)

The technology review focuses on technology that will be and could be used for the project. Typically, it is expected that you have reviewed different technology options for your project and summarised these options here. It should be clear why the technology choices taken were made.

GitHub is used for version control, so it allows for the storage and tracking of the project and was chosen as it is a widely used and industrially recognised platform for code hosting. Due to this, integrating a project is very straightforward, with a lot of tools and resources that can be easily accessed by anyone. Also, having previous knowledge and experience working with GitHub in previous modules makes it the best choice compared to others. Whilst there are other alternatives that could be used, like GitLab and Bitbucket, there is no advantage to considering them, so it makes GitHub the best choice.

ClickUp was used to manage the project in a Kanban style, where it kept track of all the tasks needed to complete the project. It also has an option that can display all the ongoing tasks in a Gantt chart, which is very useful, and it provides a clear overview of the project and its timeline. There were other project management tools that could have been used, such as Trello, but they were simply chosen over because of the layout preference. Trello uses a card layout, whereas ClickUp uses a simple list layout, which I simply prefer and hence why it was chosen.

Python was chosen for testing, manipulating, and preparing the data for use due to its numerous libraries, which allow it to be very flexible. Due to having previous experience working with Python in several previous modules, there isn’t a steep learning curve. Apart from manipulating data, it can also be used to visualise data using other libraries, which makes it perfect for starting the project. Jupyter Notebook was used as the environment to code Python in, and this was because it made executing bits of code easy to observe and debug. It is also heavily used for data exploration, as it is simple to perform iterations while observing the outcome, which is ideal for this project. Also, having used it with Python in previous modules makes it easy to work with as there is familiarity with it and no steep learning curve. There were a few alternative languages that could’ve been considered alternatives, like JavaScript or C/C++, but Python has a much lower learning curve because it’s much easier to learn. SQL would’ve been the best alternative to use as its main focus is working with datasets, but while there is some experience with it in previous models, it was the bare fundamentals. However, this project could’ve used SQL as an alternative approach, where the results would’ve been the same, but the time taken would be more drastic.

ParseHub would be used to scrape more data for the dataset regarding other aspects of the game. The reason it was considered was due to it being one of the best free data scrapping tools available that required little to no programming knowledge. As data scrapping is a very prominent part of the industry, there are only a few free alternatives like Octoparse and ScrapingBot which can be used.

D3.js which is a JavaScript library, was chosen as the method of visualisation because of its ability to create dynamic and interactive visualisations. Due to it being very flexible, it allows for one to create very interesting visualisations, but the learning curve is very steep and that is what makes this project challenging. But because it is integrated with JavaScript, it makes web page implementation much easier in the long run. An alternative approach could’ve been to use Tableau, but it wouldn’t make the project worthwhile as it’s easy to learn and use tool. The reason it was chosen over it was due to d3js being much more flexible and integrates with websites better making the styling much easier.

HTML and CSS will be used for the front end of the webpage, and this is simply because it is the most standard and core languages when creating webpages. HTML is used to create the structure of the webpage whilst CSS creates the styling where the only alternative approach would be to use Pug which is HTML is a more readable style. Whilst it makes the code look cleaner it would be better to work with HTML and CSS as there is a lot more documentation around it which makes bug fixing easier.

**Summary Table**You might include a table that summarises the benefits and limitations of what you have reviewed, highlighting opportunities for project novelty where identified.

# **Design or Methodology**

GUIDANCE (text in blue can be deleted from your final submission)  
The aim of this section is to explain to your reader the work you are going to undertake. You should refer to the outcomes of your Literature and/or Technology review and state how they have influenced your Design/Methodology. Depending on whether the project is more build or research-focused, this section can take one of the following forms.

**Design** (for build or investigation-oriented projects)If your project is a build focused project, you should provide a design for what your project will build. The nature of this design will depend on your project, but it should provide a complete idea of what you are going to build, including the technologies to be used.

**Methodology** (for research or investigation-oriented projects)If your project is research-focused, then you need to define the particular research methodology you are using to gather and assess data. Typically, this will involve some sort of data gathering process and statistical analysis of results. However, you should also describe the tools (e.g., technologies) that you will use as well.

**Alternative Approaches**Another important point in this section is to document any alternative approaches you could have taken to complete the project. For example, were there different technology choices, design choices, or methodological choices you could have taken? You should explain why you have taken the approach you have taken rather than these alternatives.

The first step of the design of this project is to source the data from Kaggle dataset [1] which is then cleaned in excel by getting rid of unnecessary columns of data (towers, champions, bans, and address) where then the data is narrowed down to focus on 3 of the main regions (LEC, LCS, and LCK). Now that we have a dataset cleansed and downsized to focus of the project’s aim the next step would be to scrape more data from sites that host data for professional games that focus on other aspects of the game such as cs (otherwise known as creep score/farm, is the count of monsters killed that give gold and experience). To do this a scraping tool, like ParseHub, will be used on sites like [3] [4] [5] where the method would be to simply scrape the data displayed on the site. Another way would be to find the source of the data using inspect element tool to directly connect to the API to source the data.

Once the data has been cleansed, we can then move onto manipulating and preparing the data to use when making the visualisations. To do this Python and its libraries pandas, NumPy, and itertools will be used to perform the manipulations using their respective functions. The pandas library will be used for creating a data frame of the data whilst, the NumPy library will focus on the arithmetical and transformation operations with itertools being used to merge different sized arrays.

The sort of manipulation would be getting average scores of all games played by a team and this data will then be used to explore basic visualisations using the matplotlib library. This will be done to see the shape of the data and see if can clearly visualise the data and to potentially see if there is anything that can be spotted that relates to the aims of the project. Followed by this will be a more advanced visualisation using the bar\_chart\_race library to create an advance visualisation to test its effectiveness in portraying the data. This project could’ve alternatively been done solely within python and its libraries for visualisation however, d3js allows for visualisations that are more interactive, flexible, and better overall.

Once this has be done the next step will be to export the manipulated data into a new csv file that will then be transformed into a json file, so the data is stored in array and object format. Once the json file is ready then next step will be to make the first d3js visualisation and start developing the webpage.

* Talk about making a line chart visualisation with a simple hover function that displayed the team’s name. Then developing it to improves its functionality like displays the values, game count, and ability to select a line. (Not sure how to write design for d3js section as it has only been started. Can mainly talk about it in section 4 implementation at the moment).

**Your Project Management Approach**Under this heading, state your project management strategy and justify your choices compared to other alternatives. Describe the benefits and limitations of your strategy and refer to your supporting project management documentation in the appropriate area of the appendix.

* ClickUp and why it was used, benefits, and its alternatives (Trello).
* GitHub and its purpose
* Not sure how to write this section and make it differ from the technology section. I will be adding screenshots of the ClickUp and GitHub but it seems like I will just be repeating what I said in section 2. Should I take it out of section 2 and put it here?

# **Implementation or Results**

GUIDANCE (text in blue can be deleted from your final submission)

Once the examination team know what you planned to do, you must tell them what happened -- **What was the outcome of the work you undertook in the project?**

A build or investigative project will discuss the implementation. **Do not just paste in lines of code to your report and call that an implementation! Your report should feature minimum code to only discuss points.** The idea for implementation is to describe how the design has actually turned out.

A research or investigative project will present the results from performing the methodology. These results must be correctly presented, using appropriate tables, charts, and statistical tests that suit the nature of the project. Results should be summarised, and any findings clearly presented.

When cleansing the original dataset within excel this was done by selecting the unnecessary columns: towers; champions; bans; and address (broken link for match’s history). Next by filtering the region column by its value 3 of the main regions (LEC, LCS, LCK) were selected within all data regarding the other regions being deleted. The final thing to do was to filter the data once again for its year and delete any data from 2018, and this was done due to the data for 2018 only being partial data from the whole year.

From here the data is ready to be manipulated in Python and is therefore first read and arranged into a data-frame using the pandas library. From here a variable is creating that selects a subset of the dataset and focuses on a single team’s data, where the first focus is the ‘golddiff’ column which shows the gold difference in a game. The main step is now to implement an element wise average of the ‘golddiff’ column to show the average gold difference within all the games a team plays in one season. But while it might be easy to get an element wise average of arrays normally, due to the fact the arrays within the ‘golddiff’ column being of different lengths as some games are longer than other. The solution to this was found to be using the NumPy and itertools libraries where the first step is to select the column and make a NumPy array. But this led to an issue where the arrays were being read as strings (see Figure 1).

A picture containing text

Description automatically generated

Figure - Issue with NumPy array

This meant after some type testing that the data being read through the csv file were of string type and so to fix this after checking the documentation for the ‘read\_csv’ function [6] using the converters property was the solution. The converters argument allows you to parse a column and apply a function/value when reading the csv file and so the ‘golddiff’ column is given the value ‘pd.eval’. And what the ‘pd.eval’ value does it that evaluates the string expression returning it as a ndarray, scalar, pandas object, or None [7] and together with the converters argument the column is read as an ndarray now rather than a string.

Text

Description automatically generated

Figure - NumPy array after fixing data type error.

Now after fixing the data type error when creating the NumPy arrays they are created in the desired format (see Figure 2). After this the list function is used with the ‘zip\_longest’ function from the itertools library [8] and what this did was that it creates lists based on the indexes of the array. The function also has an argument called ‘fillvalue’ which by default is set as None but in this circumstance where the arrays are of different lengths and arithmetic operations will be performed it is given the value ‘np.nan’ [9]. This fills the empty indexes with a value of NaN instead of 0 as a 0 will affect the results when calculating the average. Now it is converted back into a NumPy array where all the arrays are of the same lengths and are ready to be averaged. To work out the average the ’nanmean’ from the NumPy library is used which calculates the mean of the arrays while taking into considerations of any NaN values [10]. The argument axis is set to 1 so that the mean calculation works out the average of each array where each array will represent each minute in a game from 0 (see Figure 3 for the result).

Text, letter

Description automatically generated

Figure - Array of element wise average

* Basic matplotlib line chart
* Bar chart race
* First d3 visualisation
* Add values (coordinates) to the hover function.
* Adding the game counts to the hover function.

## Evaluation

GUIDANCE (text in blue can be deleted from your final submission)

The examination team now need to know how well the project went -- **How good was the outcome from the project?**

Evaluation is an important element of any project. You must tell your reader how good the final deliverable is. **Your project does not have to be perfect -- indeed the outcomes might have been bad.** The point is you must evaluate the outcome and discuss its strengths and weaknesses.

A key element of this section is a reflection on the aims and objectives set out at the start of the project, and how well these have been met. **Again, it is possible not to achieve an aim or objective.** The point is you evaluate how well you did meet your goals.

## Related Work

GUIDANCE (text in blue can be deleted from your final submission)

Answer the question -- **Who else has done something similar and how does my work compare?**

Another key element of this section is evaluating your work against that of others. How good is your work when compared to other people who have undertaken similar work? It is important to be able to understand how well you have achieved your goals in relation to others, while also considering the time limitations of the project.

# **Conclusion**

GUIDANCE (text in blue can be deleted from your final submission)

The conclusion summarises the project. You need to highlight your key outputs and/or discoveries. There are some particular subsections that must appear in your conclusion.

## Reflection

GUIDANCE (text in blue can be deleted from your final submission)

You must critically reflect on the entire project process and how well you have worked on the project. What particular things have you learned during the project? Why were you able and unable to meet project goals? What would have you done differently in hindsight?

A common approach many students take in this section is to claim poor time management. **Poor time management is rarely a problem unless you had too much to do in the project.** Normally, what is called poor time management is poor organisation, planning, and motivation. Being honest in your reflection will help you understand how you can improve these issues rather than focusing on time management issues.

## Future Work

GUIDANCE (text in blue can be deleted from your final submission)

Answer the question -- **What next?**

You've completed a significant piece of work -- perhaps the largest piece of work you have ever done. But no project is ever 100% complete, and you will have found new ideas along the way. If someone were to pick up your project, what avenues should be explored next?

# **References**

GUIDANCE (text in blue can be deleted from your final submission)

In this section, you **must** reference any sources used in your work. Typically, these sources will have come up during the investigation and related work sections. Your referencing must use the IEEE referencing style [IEEE Citation Guidelines2.doc (ieee-dataport.org)](https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf) .

It is **highly** recommended that you use reference management software such as Mendeley or Zotero.

Many students ask how many references are required. That is like asking how long a piece of string is. Your project should have as many references as is required for it. However, having few references indicates that no thorough investigation has occurred.

1. <https://www.kaggle.com/datasets/chuckephron/leagueoflegends>
2. Paper on Logic Mining in League of Legends <http://pertanika2.upm.edu.my/resources/files/Pertanika%20PAPERS/JST%20Vol.%2028%20(1)%20Jan.%202020/12%20JST-1649-2019.pdf>
3. <https://gol.gg/esports/home/>
4. <https://www.factor.gg>
5. <https://oracleselixir.com>

1. <https://pandas.pydata.org/docs/reference/api/pandas.read_csv.html>
2. <https://pandas.pydata.org/docs/reference/api/pandas.eval.html>
3. <https://docs.python.org/3/library/itertools.html#itertools.zip_longest>
4. <https://numpy.org/doc/stable/reference/constants.html#numpy.nan>
5. <https://numpy.org/doc/stable/reference/generated/numpy.nanmean.html>

# **Appendices**

GUIDANCE (text in blue can be deleted from your final submission)

Appendices appear after references. Your appendices depend on the nature of your project. **Do not assume people will read your appendices.** Even if you direct them to do so in your main text, appendices are considered additional information and should not be relied upon to understand your main body of work. Refer readers to an appendix using a phrase such as *see Appendix A for further details*.

The following documents **must** be included as references:

* Your Project Proposal.
* Your Progress Review Form.
* Your original plan and revised plans as your project evolved.
* A description of how to access any technical output. **It is strongly recommended you use GitHub or something similar to do this.**

Any important communications between you and external stakeholders -- **please ensure private data is removed and communications anonymised.**