

# RDV: An Easy to Use Data Visualisation Tool for Reddit

**Jorge Goncalves**

Center for Ubiquitous Computing, University of Oulu  
firstname.lastname@oulu.fi

## Abstract

With the rapid proliferation of social media sites, researchers have increasingly turned to data generated from these platforms to investigate human behaviour. In this paper we report the design and implementation of the RDV (Reddit Data Visualisation) platform, a visualisation tool aimed at facilitating the analysis of a publicly available Reddit dataset, which contains ~1.7 billion JSON objects collected from October 2007 to October 2015. RDV allows for researchers without advanced coding skills to easily analyse this dataset, while also providing a tailor-made platform to account for the intricacies of any dataset originating from Reddit. We showcase the features of the platform through two examples of data analysis using the Reddit dataset within the scope of Policy and Politics: 1) the 2015 nationwide ruling legalising same-sex marriage in the United States of America, and 2) the 2015 United Kingdom general elections. Finally, we conclude by discussing the need for better and simpler visualisation tools for researchers to analyse Big Online Behavioural Datasets, and report our ongoing work in this area.

## Introduction

Millions of people login daily to several different internet platforms (e.g., Facebook, Google, Twitter, Instagram and Reddit), which has fundamentally changed how humans communicate, seek information, discuss a plethora of topics, follow their interests, as well as a number of other activities. As a direct result of the widespread adoption of these platforms, the stream of user information being generated online has increased exponentially in the last few years. For this reason, researchers of different scientific domains have increasingly leveraged this data to investigate human behaviour. For instance, previous work has highlighted how the information contained within these social streams can provide rich insights on people's opinions and perceptions on a number of different topics (Park, Ciampaglia, & Ferrara, 2016; Zhuang, Jing & Zhu, 2006), what motivates certain online behaviours (Maity, Saraf, & Mukherjee, 2016; Schrammel, Köffel, & Tscheligi, 2009), and effects of social networking sites on users (Liu et al., 2014). However, an important challenge that scientists face with such large behavioural datasets is that of information overload due to the sheer quantity of available data (Kovach & Rosenstiel, 2011).

In this paper we describe the design and implementation of a web-based platform, called RDV (Reddit Data Visualisation), meant to provide an easy and approachable way to analyse Reddit's entire publicly available comment dataset. Reddit is an entertainment, social networking, and news website where registered community members can submit content, such as text posts or direct links, making it essentially an online bulletin board

system. The dataset consists of ~1.7 billion JSON objects complete with the comment body, score (including up and down votes), author, subreddit, position in comment tree, creation time and other fields that are available through Reddit's API. We created our platform by implementing a user-friendly web interface for making queries, and then presenting the information visually in the form of multiple charts such as bar charts, line charts, and word clouds. Through this platform we give interested Reddit users and researchers the possibility to easily analyse this rich dataset regarding a number of different topics such as Policy or Politics.

To showcase the usefulness of our platform and the potential for obtaining rich insights from this dataset, we present a couple of analysis examples focused on Policy and Politics. We present results on the reaction on Reddit regarding the June 26<sup>th</sup>, 2015 ruling on the legalisation of same-sex marriage in the United States of America. As a more longitudinal analysis, we showcase changes in discussion points throughout the 2015 United Kingdom general election race. Finally, we discuss the need for better and simpler visualisation tools for researchers to analyse Big Online Behavioural Datasets, and report ongoing work aimed at improving the platform.

## **Related Work**

### **Analysing Online Human Behaviour**

Emerging online communication technologies are fundamentally changing the way we behave, interact, and socialise (Reynolds et al., 2011). It has been estimated that in 2016 over 2.3 billion people use at least one social media platform (Chaffey, 2016). In recent years, researchers have increasingly turned to this unprecedented source of data to investigate and better understand a plethora of different human behaviours. For instance, previous work has investigated if a user's social network structure can provide insights regarding his or her personality characteristics. As an example, previous work (Venkatanathan et al., 2012) found a relationship between social network structure on Facebook and social capital, and how this relationship is moderated by personality traits. In another study, researchers demonstrate through a network science approach that empathy is closely linked with social capital (Venkatanathan et al., 2013). Social network analysis has also been used as proxy for studying empathy (Wölfer, Cortina, & Baumert, 2012), which showed that empathy is mirrored in the structure of social ties among adolescents in German schools.

A large body of work has explored user behaviour towards privacy when using online social media. This is an important element of social media platforms, even though there is often a "privacy paradox", i.e. a discrepancy between people's privacy attitudes towards sharing information and their actual sharing patterns. For instance, previous work has revealed a high discrepancy between stated concerns and actual behaviour towards sharing static profile information (Acquisti & Gross, 2006; Venkatanathan, et al., 2014). Several techniques have been proposed to assist users in dealing with these privacy concerns, such as selective sharing (Kairam, Brzozowski, Huffaker, & Chi, 2012) or narrowcasting (Goncalves, 2011; Goncalves, Kostakos, & Venkatanathan, 2013). Other work has investigated how social media data can be used to predict events, trends, and user reactions. For instance, researchers developed a framework that successfully predicted most of the new popular fashion models that appeared in 2015 based on images collected from Instagram (Park, Ciampaglia, & Ferrara, 2016). Others have investigated

how various socio-linguistic properties are responsible for hashtag compound formation on Twitter and propose a model to predict popular hashtag compounds (Maity, Saraf, & Mukherjee, 2016). There has also been work on modelling the competition dynamics that shape the fate of Facebook posts, and provided actionable insights to improve user engagement (Goncalves et al., 2014; Goncalves et al., 2015).

The data generated in these online platforms has also enabled large-scale studies linking lifestyle and health data at an individual and community level (Garimella, Alfayad, & Weber, 2016). On the individual level, researchers developed a research framework that utilises the LIWC (Linguistic Inquiry and Word Count) to detect the real-time mood of Twitter users (Park, Cha, & Cha, 2012). They found a correlation between the depressive state and the tweet sentiment of that user. Similarly, previous work has highlighted the potential to use social media to detect and diagnose major depressive disorder in individuals (De Choudhury et al., 2013). Specifically, they find that everyday social media use can be leveraged to predict the onset of depression in individuals, as measured through decrease in social activity or raised negative affect. Other medical conditions have been studied by leveraging social media data, such as sleep problems, substance abuse and eating disorders. On the community level, researchers used smile recognition on 9 million geotagged Twitter images and developed a Smile Index as a formalised measure of societal happiness (Abdullah et al., 2015). Further, Sadilek & Kautz show that the health of a population can be predicted based on their Twitter usage when coupled with other factors (Sadilek & Kautz, 2013). Next, we look at some of the visualisation tools for large datasets reported in literature.

### **Big Data Visualisation Tools**

The appropriate visualisation of information contained within large datasets is an important challenge for analysts and researchers. Without tools to adequately explore the large quantities of information being collected, and despite its potential usefulness, the data becomes useless (Keim, 2001). Tinati & Halford also consider the methodological challenges for those who engage with Big Data, and propose tools that address both the ephemeral, changing nature of platforms such as Twitter and the many temporary or permanent networks that form within one platform (Tinati & Halford 2012). Further, inadequate visualisation of the information can lead to the researcher or data analyst to miss potential biases within the dataset. For example, demographic bias (Halford, 2014) and geographic bias (Grinberg et al., 2013) can have a significant impact in the produced outputs of the analysis meaning that decision-makers can ultimately be ill-informed.

There are several visualisation tools aimed at large datasets reported in literature. For instance, DEVise is a data exploration system that allows users to easily develop, browse, and share visual presentations of large tabular datasets from several sources (Livny et al., 1997). Another example is ParaView, a tool that provides a graphical user interface for the creation and dynamic execution of visualisation tasks. It supports the visualisation and rendering of large datasets by executing these programs in parallel (Ahrens et al., 2005). Dendroscope is another tool aimed at visualising and navigating both small and large datasets, specifically phylogenetic trees (Huson et al., 2007). More recently, an open source visualisation tool called VisIt was developed for visualising and analysing particularly large datasets. VisIt is aimed at enabling data understanding, scalable support for growing data, and providing a robust and usable product for end users (Childs, 2013).

While there are numerous other examples of such visualisation tools, many of them either require advanced coding skills or do not adapt well to certain datasets as they were developed with broad use in mind. The platform reported here is specifically tailored to the intricacies of the Reddit dataset. This enables interested researchers to easily pick up the platform as there is a reduced learning and configuration barrier. We describe the dataset and the platform in more detail in the following sections.

## Reddit Dataset

As of July 2016, Reddit is the 26th most visited website in the world with over 500 million monthly visitors (Similarweb, 2016). The dataset consists of ~1.7 billion JSON objects starting from October 2007 up until October 2015. It contains several fields obtained through the Reddit's API including but not limited to:

- **id:** A unique identification number.
- **body:** Comment written by a Reddit user.
- **score:** Number of upvotes minus the number of downvotes.
- **upvotes:** Number of upvotes given to a particular comment.
- **downvotes:** Number of downvotes given to a particular comment.
- **author name:** Reddit user that wrote the comment.
- **subreddit:** Area of interest in which the comment was posted (e.g., games, movies, politics, news).
- **position in comment tree:** Parent comment or a response to another comment.
- **creation time:** Date and time the comment was posted.
- **gilded:** States if the comment was made by a user with Reddit gold (premium service).

The platform has grown exponentially over the years. Figure 1 shows the increase in number of comments (left) and unique authors (right) during the timeframe contained in the dataset.

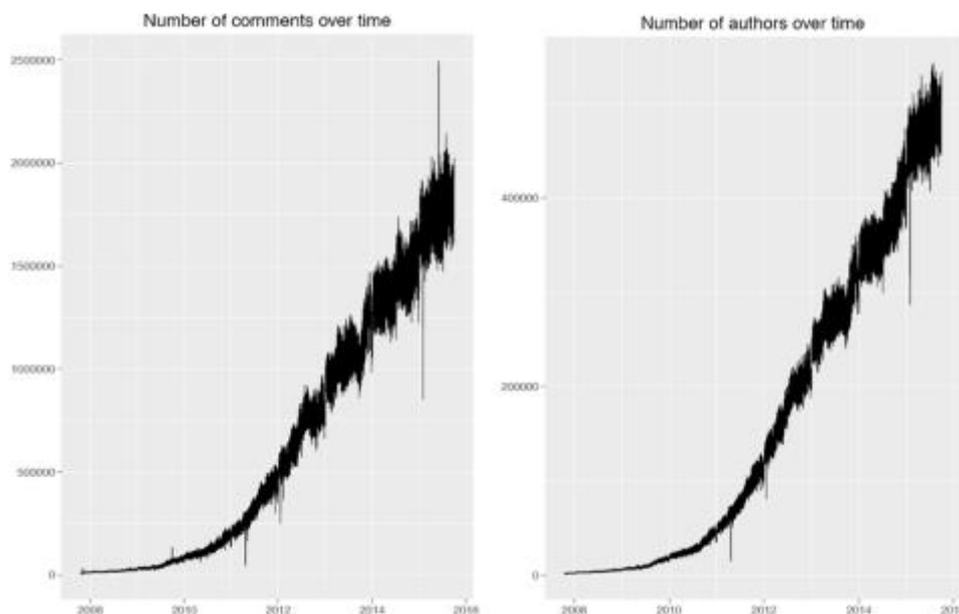


Figure 1. Number of comments (left) and unique authors (right) on Reddit over the years.

## The RDV Platform

RDV was implemented using the Shiny web framework with additional libraries for both the front end and the back end of the web application. Shiny Dashboard is a package for R that provides a set of functions designed to create analyses into interactive web applications. It is easy to use and configure making it ideal for analysing complex datasets, such as the one described here. Shiny Dashboard also allows dynamic and responsive design meaning a high-level of compatibility across multiple devices. The web-based platform is connected to a MySQL database where the Reddit dataset is stored. The database is stored on a large commercial server and the functional web page on a smaller local server.

In its current iteration, the platform has three different analysis patterns, which will generate varying data visualisations based on selection parameters defined by the user:

- **amount of comments (Figure 2):** provides visualisation of the frequency of comments through bar or line charts.
- **subreddit relations (Figure 3):** provides visualisation of relationships between subreddits based on certain threshold of shared commenters through a network graph.
- **frequency of words (Figure 4):** provides visualisation of word frequency through word clouds. Word clouds give greater prominence to words that appear more frequently within the selected data and ignores stopwords (e.g., the, a, be, as, for).

There are several features that are common across the three patterns, including: 1) selecting the time period for which to perform the analysis, 2) limiting the analysis to certain subreddits (e.g., look at comments made only in the Politics subreddit), 3) defining the comments' score range (i.e., selecting only comments with a certain score range) and 4) selecting comments' gilded status (i.e., select all comments, only gilded comment or only non-gilded comments).

In addition, each pattern has specific features to allow for more control from the user. In the amount of comments pattern the user can also define a list of keywords (i.e. only comments with certain words will be taken into account and a list of authors (i.e. only comments from certain authors will be taken into account). In the subreddit relations pattern the user can also define the percentage of shared commenters (i.e. threshold of shared commenters between two subreddits to imply a relationship) and the minimum size of the subreddits included in the analysis (i.e. minimum number of posts within a subreddit for it to be considered). Finally, the frequency of words pattern allows the user to set the minimum frequency for a word to be considered and the maximum number of words that appear in the word cloud.

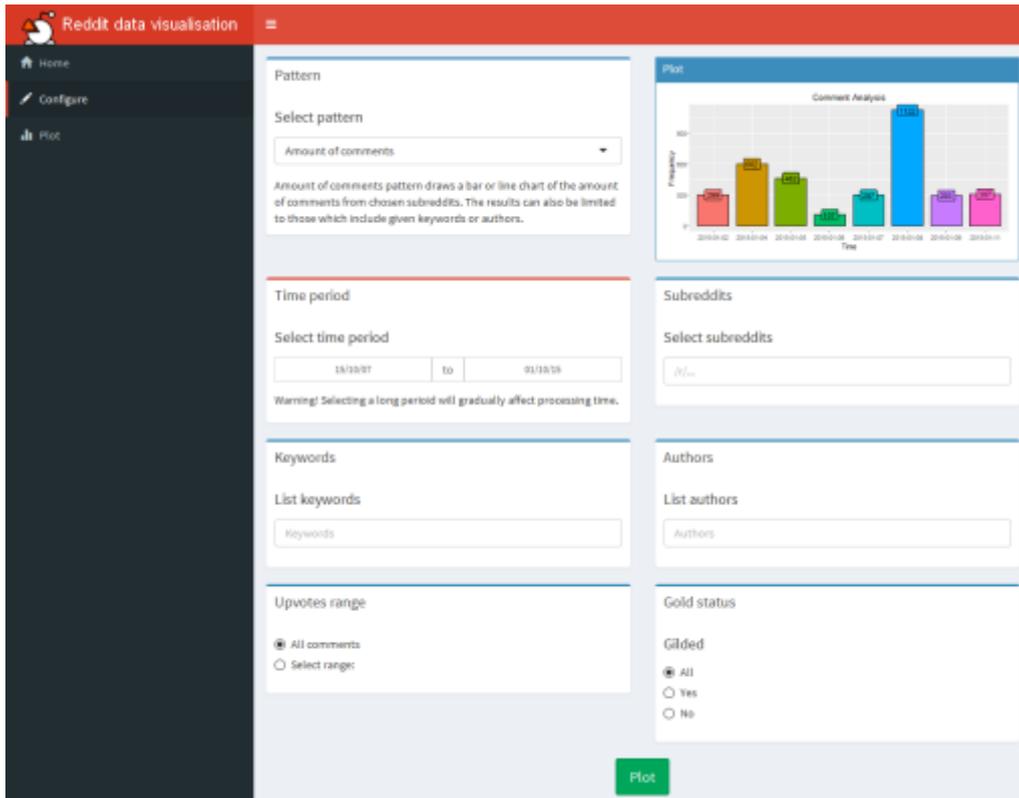


Figure 2. Amount of comments analysis pattern.

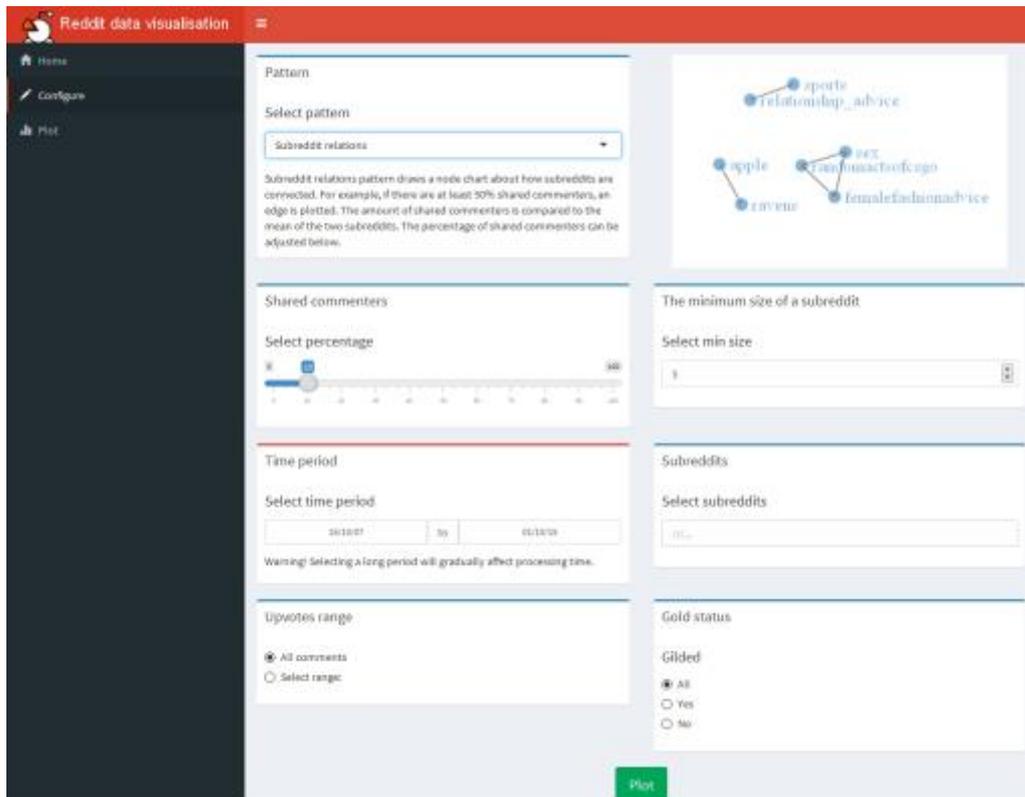


Figure 3. Subreddit relations analysis pattern.





Figure 5. Plot overview.

## Examples of Analysis based on RDV

We now showcase a couple of examples of analysis that can be easily achieved by using the RDV platform within the scope of Policy and Politics. Specifically, we presented analysis of the Reddit dataset regarding the 2015 nationwide ruling legalising same-sex marriage in the United States of America, and the 2015 United Kingdom general election.

### Same-Sex Marriage Ruling in the United States

In the United States of America, same-sex marriage became legal nationwide on the 26th June 2015. The Supreme Court ruled with a 5 to 4 vote that the Constitution guarantees a right to same-sex marriage, meaning that state-level bans on same-sex marriage were deemed unconstitutional. At the time of this ruling, public opinion on the subject had reached nearly 60% approval ratings from the general public (Hook, 2015) and had been on the rise even since 2010 when the nation was split 50-50.

We started by analysing the frequency of comments that included the word 'marriage' in the 3 days preceding the ruling, the day of the ruling and the 3 day after the ruling within 3 relevant subreddits: News, Politics and LGBT. Figure 6 shows a substantial increase in comments containing the word "marriage" within these 3 subreddits, particularly News and Politics. However, this increase was short lived as 3 days later it went back to more typical numbers.

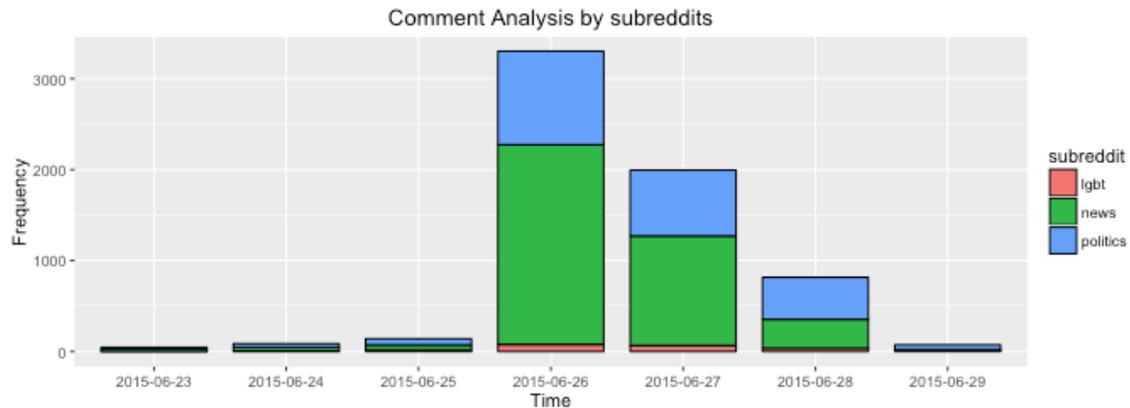


Figure 6. Frequency of comments that contain the word ‘marriage’.

Further, unlike other social media platforms (e.g., Twitter), Reddit’s stream of content is curated by the community. Comments made by the users can be either upvoted or downvoted by other members of the community. This goes beyond bragging rights for the original poster, as the visibility of a given post is determined in part by its score (i.e. upvotes - downvotes), which can be the difference between getting a few hundred or hundreds of thousands of views. While not perfect, in many cases the more interesting or useful discussion tend to be featured more prominently within the platform, while hateful and spam comments tend to be filtered away. For this reason, the community can self-regulate in ways that other social media platforms cannot. Hence, we followed-up by analysing the frequency of comments that led to a strong reaction from the community. We selected only comments that contained the word ‘marriage’ from the news and politics subreddits on 3 most active days (the day of the ruling and the two following days). Figure 7 top shows the frequency of comments with a score lower than -10, while Figure 7 bottom shows those with a score higher than 10. The plots show that there were substantially more highly upvoted comments than highly downvoted comments in both subreddits. This disparity in numbers was expected as it is well-known that the Reddit user base is young and leans liberal (Barthel, 2016).

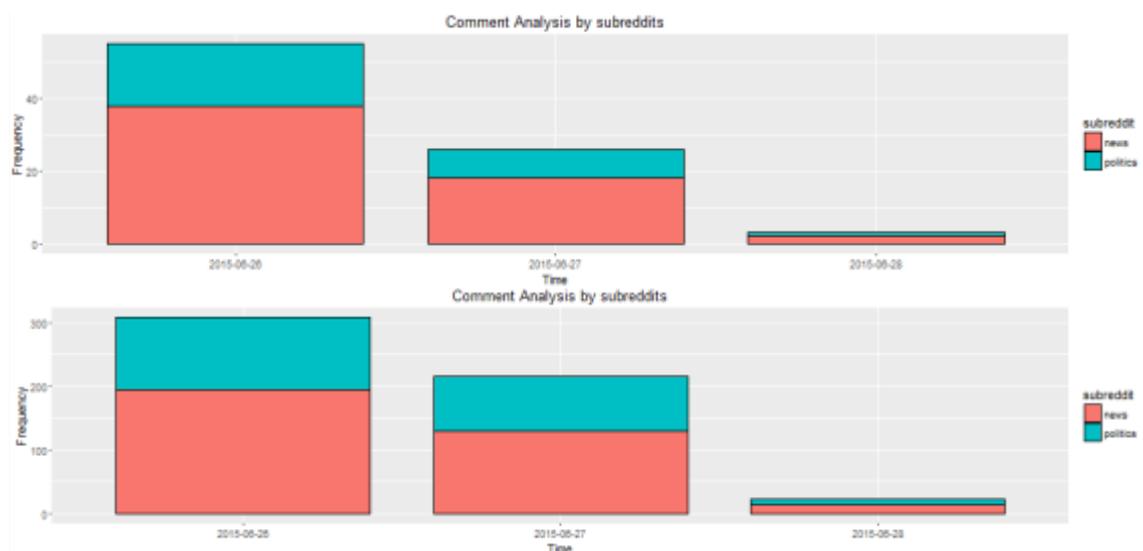


Figure 7. Top: Highly downvoted comments. Bottom: Highly upvoted comments.

The majority of heavily downvoted comments were firmly against the ruling and the community felt they did not offer a strong argumentation against it. Some examples of these comments include:

- *“finally, it's legal to have gay marriage shoved down my throat!”*,
- *“The logic used in this decision leaves the door wide open for further expansion of the marriage universe. Polygamists rejoice. I also predict the rise of casual marriage between people with absolutely no romantic interest in each other in order to take advantage of tax benefits, and even things like family insurance coverage”*,
- *“But why make gay marriage legal? How does that improve our species by catering to a group of people who if left alone would go extinct in less than 100 years?”* and
- *Ahh, let the hypocrisy over-floweth. "Yay! Gay marriage! Freedom is great!" "Booh! BAN THE CONFEDERATE FLAG!" Our society is so inconsistent. We're doomed.*

The majority of heavily upvoted comments were in favour of the ruling or the community felt provided good points to the ongoing discussion. Some examples of these comments include:

- *“And, as it turns out, kind of similarly to same-sex marriage being legal now, it doesn't matter what the unwashed masses think if the constitution specifically says something about it. In the same-sex marriage case, the 14th amendment guaranteed equal rights, whereas an outright ban on a flag couldn't happen due to the 1st amendment. It doesn't matter if people want an outright ban, the only thing that the government can do is not allow it on government property. Plus, I would argue that both things are in the name of progress - moving away from a symbol of racism and inequality and granting equality to others.”* (direct response to the downvoted comment regarding the confederate flag).
- *“There is no longer "gay" marriage, it is now just marriage. It isn't a subset or inferior product, it is all uniform and equal. Marriage is no longer an exclusive club, and that's a good thing for all of us.”*
- *“We're finally catching up with the rest of the industrialized world. Clarity edit: not specifically referring to marriage equality, just on how we treat our own citizens. It's a big step in the right direction.”*

While not possible solely with RDV, sentiment analysis of these selected comments could provide further insights regarding the emotive response and opinion of the members of the Reddit community on this topic.

## **2015 United Kingdom General Election**

The United Kingdom general election of 2015 took place on the 7th of May 2015, which elected the 56th Parliament of the United Kingdom. The election aimed at appointing one Member of Parliament to the House of Commons from each of the 650 parliamentary constituencies. The Conservatives won a 12-seat majority in parliament with David Cameron being re-elected Prime Minister of the United Kingdom.

We analysed the frequency of comments in the UKPolitics subreddit, which is the most subscribed subreddit regarding British Politics. Figure 8 shows the difference in number of comments posted on the day of the vote as well as the days of the preceding and subsequent week. There was higher activity within the subreddit on the day after the election, as at that point all the votes had been counted and users began to react to the outcome.

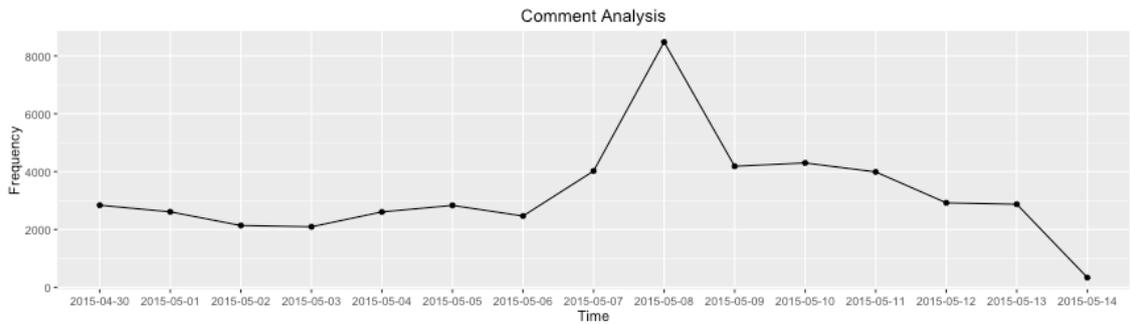


Figure 8. Frequency of comments made in the UKPolitics subreddit.

We then created two different word clouds using comments from the UKPolitics subreddit, one during a period leading up to the election (1st January 2015 - 7th May 2015, Figure 9 left) and the other during a period after the election (8th May 2015 - 30th September 2015, Figure 9 right). The word clouds were constructed using only words that appeared at least 50 times. Unsurprisingly, there are far more mentions of the Labour Party when compared to the Conservative Party (Tories), even though the latter won the election. The main Labour Party subreddit has over 4500 subscribers, while the main Conservative Party has around 600, which again highlights how the Reddit user base tends to lean liberal. During the period leading up to the election there were several issues being discussed by members of the community, namely immigration and taxes/money, which were the top two issues that decided the general election vote (Ipsos Mori, 2015). Post-election there was increase discussion regarding Jeremy Corbyn who took over the Labour party on the 12th September.

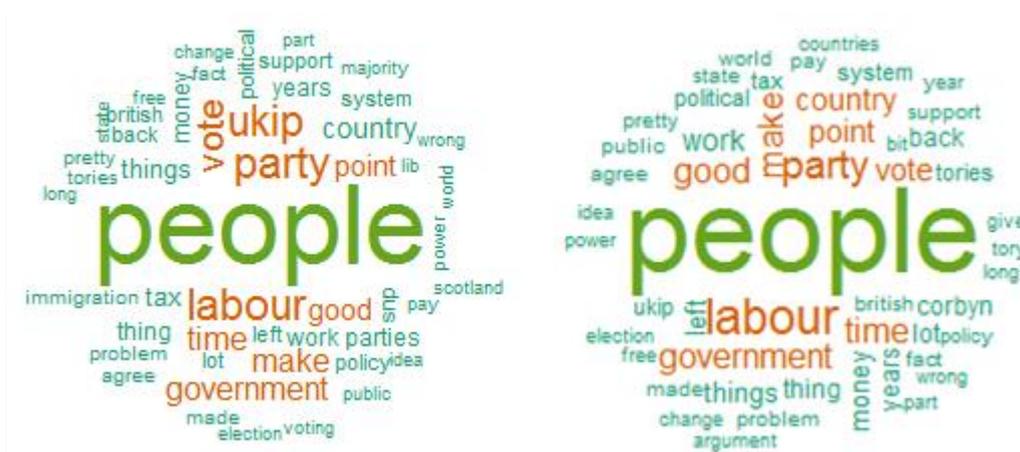


Figure 9. Left: Word cloud between 1st January 2015 and 7th May 2015. Right: Word cloud between 8th May 2015 and 30th September 2015.

As with the analysis pertaining to the same-sex marriage ruling in the United States of America, content analysis of selected comments, which we intend to make possible directly on RDV in the future, can provide further insights on the community's opinion on different aspects of this event.

## Conclusion and Ongoing Work

We present the design and implementation of the RDV platform, a visualisation tool aimed at facilitating the analysis of a ~1.7 million JSON object dataset from the Reddit social media platform. Previous work has emphasised the increased need of actionable insights when analysing social media for political and policy reasons (Goncalves et al., 2015). By providing simpler visualisation tools that do not require advanced coding skills, a larger number of policy and politics researchers can analyse publicly available social media datasets to extract useful insights. Further, more specific and tailor-made tools to a certain social media generated dataset, such as the one presented here, enables a more in-depth analysis that in turn can lead to richer insights. Here, we showcase a couple of examples of analysis that can easily be achieved through the use of RDV within the scope of Policy and Politics.

We intend to continue developing our platform to provide additional features to enable a more in-depth and varied analysis of Reddit datasets. For instance, allowing the analyst or researcher to select only comments with a certain minimum number of votes. This would facilitate the identification of controversial comments made within a predefined subreddit. Another planned feature is to allow for content analysis of comments directly on the platform. An example of a potential use case of this feature would be conducting sentiment analysis of comments within certain subreddits or of certain members of the community. This would help identify and measure the opinions of users to events, policy changes, among others. Finally, we are interested in moving beyond Reddit and create tailor-made visualisation tools for other popular social media platform, such as Twitter.

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