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Developing Text Mining Web Applications for Teaching and Learning Using Shiny Apps

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Abstract

Text mining has emerged as a vital technique for extracting insights from large volumes of textual data. This research paper presents the development of an interactive Shiny apps called TextCrunch to facilitate the teaching and learning of text mining principles. The application is an innovative educational tool that provides users, including educators and learners, with an intuitive platform to explore text data analysis techniques. Developed within the Shiny framework, the web application offers a comprehensive yet user-friendly interface. Users can upload text data and produce real time outputs through word clouds, frequency plots, and topic modeling results. The word cloud visualization highlights prominent terms, while frequency plots offer insights into term occurrences. The integration of topic modeling assists users in identifying latent topics within the text, adding depth to the analysis. This paper elaborates on the technical aspects of the application's development, including text preprocessing and the creation of interactive visualizations. By offering an environment for hands-on exploration of text mining concepts, educators can illustrate intricate data analysis procedures effectively, while learners can actively engage with the content, reinforcing their understanding of text mining techniques. This research contributes to the field by highlighting the potential of technology-driven tools in enhancing the teaching and learning of data analysis principles.

Keywords: Text Mining, Shiny Apps, Teaching Aid

Introduction

In the digital age, the exponential growth of data and information has revolutionized the landscape of education and learning. The accessibility to vast amounts of textual content, ranging from academic journals and research papers to news articles and online discussions, presents both opportunities and challenges for educators and learners alike (Nawaz et al., 2023; Audrin & Audrin, 2022). Harnessing this immense repository of information requires innovative approaches that not only facilitate efficient extraction and analysis of relevant knowledge but also engage learners in a dynamic and interactive manner. One such approach

is the utilization of text mining techniques within the context of apps designed for teaching and learning purposes.

Text mining, a subset of natural language processing (NLP), involves the extraction of meaningful patterns, insights, and knowledge from unstructured text data (Sarker, 2022). It enables the automated processing of large volumes of textual content, enabling the discovery of hidden relationships, trends, and concepts that can enrich educational experiences (Shu & Ye, 2023). Coupling text mining with web-based applications provides a compelling platform to deliver these insights to learners and educators in a user-friendly and interactive manner (Potter et al., 2016). Among the various tools available for creating such applications, Shiny by RStudio stands out for its ability to effortlessly transform data analyses into interactive apps without requiring extensive web development expertise (Potter et al., 2016).

This research paper explores the development of a text mining apps using Shiny, specifically tailored for enhancing teaching and learning experiences. By bridging the gap between textual content and educational engagement, this application aims to empower educators to efficiently curate and deliver relevant information while offering learners an immersive and exploratory approach to studying complex subjects. The paper delves into the underlying principles of text mining, highlighting its potential contributions to education. Additionally, it examines the features and capabilities of Shiny that make it a suitable platform for creating dynamic educational tools.

The objectives of this paper are:
1. to develop Shiny apps for text mining analysis.
2. to demonstrate the result of text mining analysis using the apps.

Shiny Applications in Teaching and Learning

In the 21st century, technological advances significantly impact the teaching and learning process. The explosive growth of online and offline education environments indicates a need for an effective teaching and learning process. In recent years, there has been a growing demand for interactive tools that facilitate efficient data exploration and visualization (Sabuncuoglu & Sezgin, 2023; Wang et al., 2021; Fawcett, 2018). Shiny, a web application framework developed for the R programming language, has emerged as a powerful solution to address this need (Chang et al., 2015).

The Shiny package (Chang et al., 2015) is a highly effective software development platform for building web-based application frameworks, making it very efficient to convert R scripts into user-friendly, interactive Shiny applications (Fawcett, 2018). Its intuitive design and user-centric approach democratize the analytical process, enabling both technical and non-technical users to engage with data seamlessly (Hart et al., 2020). By integrating a user interface (UI) and server logic, Shiny fosters rapid prototyping and iterative development, facilitating real-time changes and swift adaptations to evolving research questions (Gebauer et al., 2023). This agility, complemented by its customization options, ensures a tailored user experience that aligns with the intended purpose and aesthetics. Hence, Shiny apps have gained widespread popularity as effective tools for both teaching and learning due to their interactive and engaging nature.

The web-based applications by Shiny can provide online resources for teaching and learning text-mining applications. Online resources offer significant benefits compared to traditional teaching methods. These resources facilitate active learning by providing access to current datasets, interactive apps, explanatory materials referencing more extensive content,

assessment tools, and engaging activities. These features enhance the learning experience and make text mining more interactive and enjoyable for students (Wang et al., 2021). Students can use the Shiny app and comprehend intricate concepts such as introductory statistics courses through a user-friendly point-and-click interface, eliminating the need for users to write or compile any code (Potter et al., 2016).

Text mining, also known as text analytics, is an artificial intelligence technique that uses natural language processing (NLP) to convert unstructured data into structured data. The method is popular in computer science, information science, mathematics, and management (Humphreys and Wang, 2018). In text mining analysis, the data were processed in a form that can be structured and summarised (Miner et al., 2012). Once the text is summarised, further analysis can be conducted, such as data visualisation and advanced analysis. Since the process is meticulous and time consuming, therefore, the role of technology using simulations and dynamic visualizations is vital in supporting student comprehension (Potter et al., 2016).

Recent analysis using text mining applications for teaching and learning revealed the benefits of using the Shiny app such as students that use the app appeared to have done better in the lab quizzes. It offered reliable resources for students to practice and refresh prominent concepts anytime and anywhere during their free time (Wang et al., 2021). Prior analysis using the interactive Shiny app to facilitate research-informed learning and teaching revealed that the application had encouraged student interaction, particularly fostering a sense of collaborative learning and collective inquiry and increased student grades in the project work (Fawcett, 2018). Implementation of Shiny apps in or outside of class has the potential to increase a student's ability to understand and use advanced techniques and data from applied research and to enhance their satisfaction with the course (Fawcett, 2018)

A qualitative study of assessing Shiny apps through student feedback indicates that the students view online resources positively. However, they demand more support, just enough to facilitate getting started and using the tools effectively. Shiny apps are more satisfying and accessible to statistics educators for their work implementing educational activities (González et al., 2018). According to Potter et al. (2016), they highlighted Shiny's usefulness, ease of use, and flexibility through the examination of 17 existing apps across different subjects and skill levels. The authors further noted that Shiny simplifies applet creation for educators knowledgeable in R but not necessarily expert R developers. With the Shiny package, educators can craft interactive, dynamic, user-friendly, and visually captivating educational apps.

In conclusion, Shiny apps have emerged as a pivotal tool in modern education, addressing the growing demand for interactive and engaging learning experiences. Their intuitive design, versatility, and capacity to simplify complex concepts have reshaped the landscape of teaching and learning, catering to both students and educators. By bridging the gap between technology and education, Shiny apps offer a promising pathway towards enhanced comprehension, collaborative learning, and dynamic exploration of diverse subjects and skills.

Materials and Method

This section discusses on the source of data used and the process in Shiny applications.

Source of Data

The data used for the demonstration was obtained from a property management operator in Malaysia. The company manages properties and tenants regarding rental, maintenance, and

complaints. For this study, text data on tenant complaints extracted from the operator's system was analysed to produce text mining outputs.

Shiny Apps Process

The development of the text mining application known as *TextCrunch* in Shiny consists of two main components: the user interface (UI) and the server logic. The UI defines the visual layout of the application, encompassing elements such as input controls, plots, tables, and text. The server logic, on the other hand, handles the data processing, calculations, and reactive behaviour in response to user interactions. This separation of UI and server logic promotes modularity and enhances the development. Meanwhile the process in Shiny application involved several key stages, including data preprocessing, user interface design, backend logic, and interactivity. The flow of the process is shown in Figure 1.

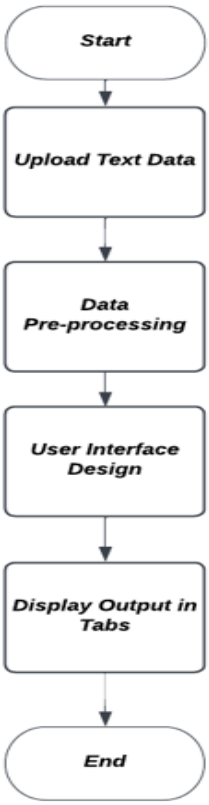

Figure 1: Flow of Web Application Process

The foundational stage of utilizing Shiny apps involves data provision. The application accepts user-uploaded text data in either .txt or .csv format. Next, the data is subjected to several preprocessing steps, including converting the text to lowercase to ensure uniformity in processing. Then, removing punctuation, numbers, and common stop words to clean the text and remove noise. Stripping whitespace for consistency and improved analysis. The user interface (UI) design of the Shiny application was carefully crafted to provide an intuitive and user-friendly experience. The UI comprises side panel for uploading data and panel consisting of four main tabs namely: "Overview," "Word Cloud," "Word Frequency," and "Topic Modeling."

The backend logic of the application was developed using the R programming language and the Shiny framework. Reactive programming principles were employed to ensure

responsive behaviour to user interactions. Upon uploading data or processing topics, reactive expressions were utilized to trigger the necessary data transformations, calculations, and visualizations. The Shiny framework inherently facilitates interactivity, allowing users to dynamically explore text data and glean insights. Users can upload data, observe the changing visualizations as topics are processed, and adjust parameters using sliders. This interactivity enhances user engagement and encourages iterative exploration of the textual content.

Results and Discussion

This section portrays the user interface and outputs developed in Shiny. As shown in Figure 2, the main user interface displays the title of the apps on top and a side panel with simple steps to upload data. Users are prompted to upload their text data in .txt or .csv format, which initiates the data preprocessing phase. Once the data is processed, users can navigate to the analysis tabs. Initially, the "Overview" tab will be displayed as main tab introduces the application and its capabilities.

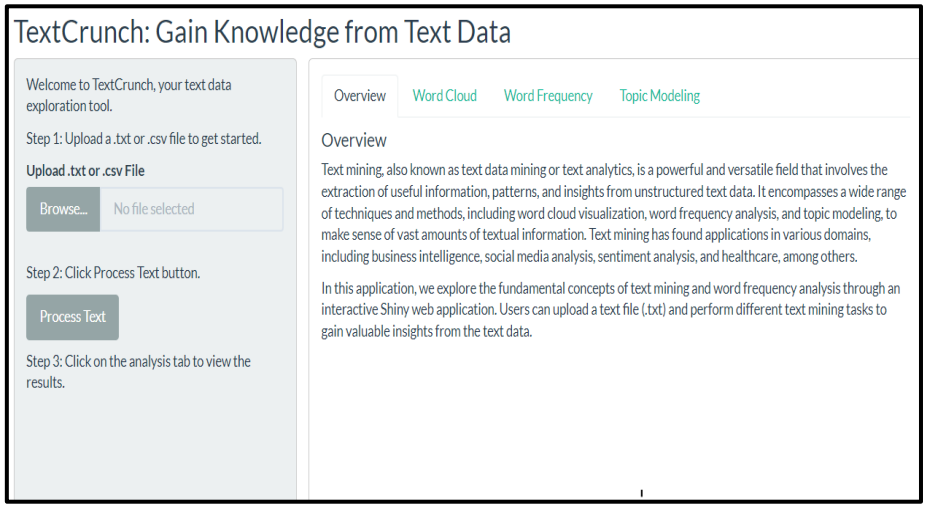

Figure 2: Main User Interface of TextCrunch Apps

In Figure 3, a word cloud depicting the top 100 most frequent words in the dataset is generated. Words are sized according to their frequency, providing an immediate visual summary of the data.

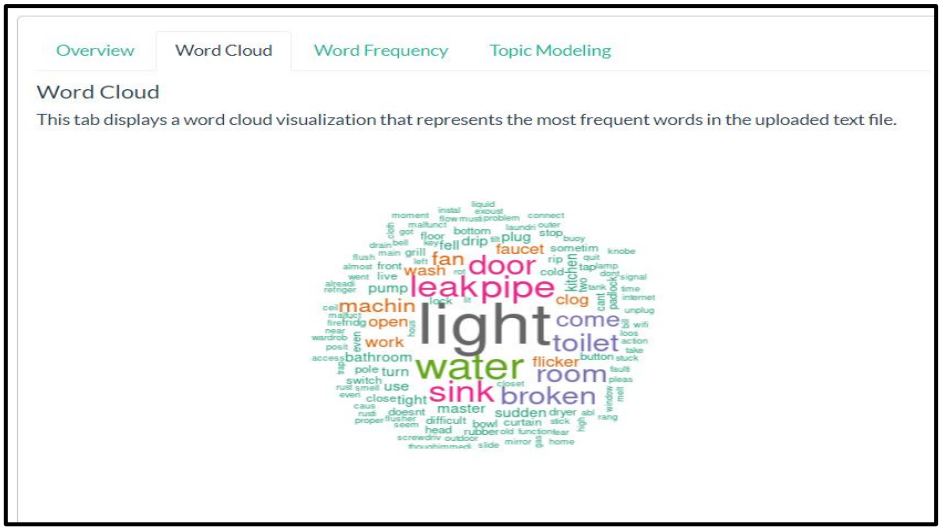

Figure 3: Word Cloud Tab

From the "Word Frequency" tab in Figure 4, users are presented with a table displaying the top 10 most frequent words along with their corresponding frequencies. A bar plot is also generated, offering a graphical representation of the word frequencies.

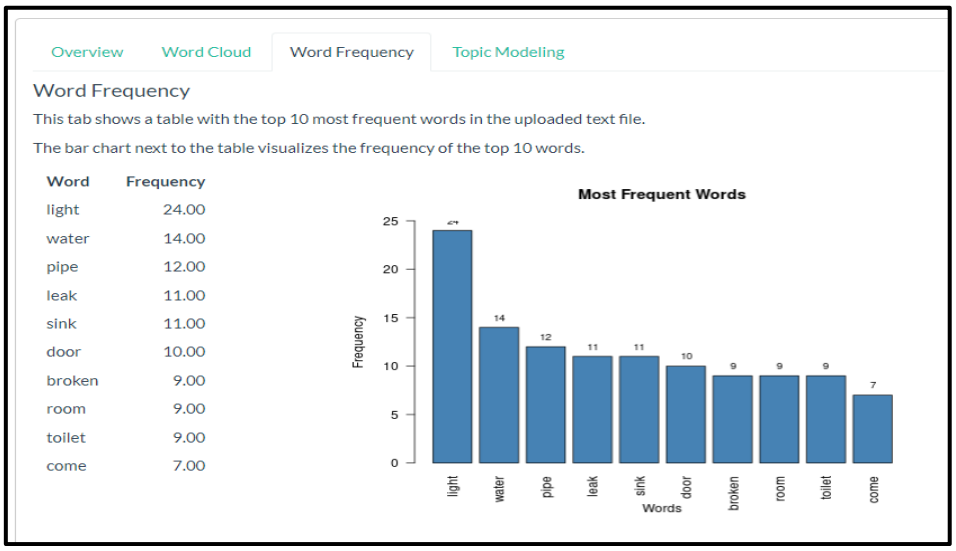

Figure 4: Word Frequency Tab

Finally, the "Topic Modeling" tab enables users to perform advanced text analysis using Latent Dirichlet Allocation (LDA). A slider allows users to specify the number of topics they wish to generate. After processing, the topics are displayed along with the top 5 terms within each topic, facilitating a deeper understanding of the textual content.

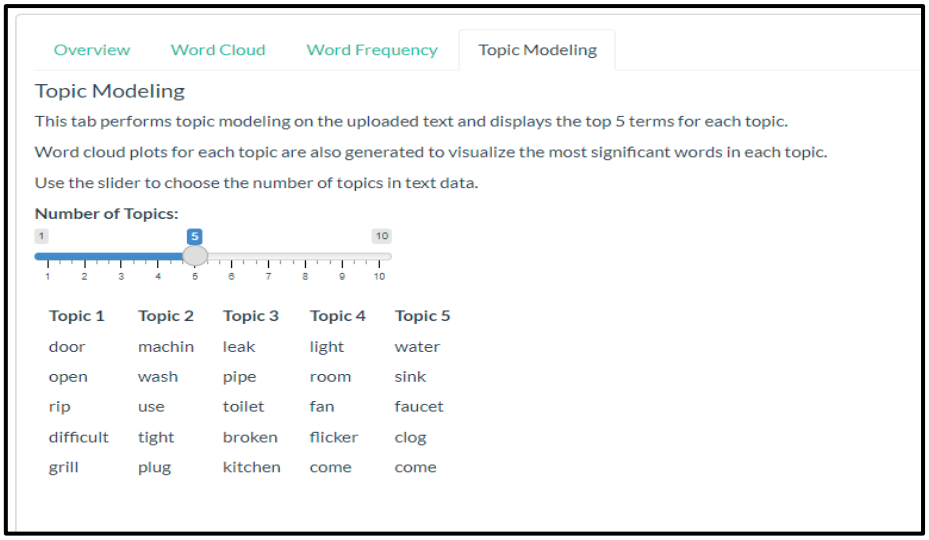

Figure 5: Topic Modeling Tab

Conclusion

This research paper presents the development of TextCrunch, an interactive Shiny application designed to enhance the teaching and learning of text mining principles. TextCrunch offers a real time output of text analysis techniques, including word cloud visualization, word frequency analysis, and topic modeling. By merging user-friendly interfaces, interactive visualization, and real-time feedback, Shiny empowers educators to create immersive learning experiences that bridge theoretical understanding with practical application (Fawcett, 2018).

In the context of teaching and learning, the development of the TextCrunch contributes significantly to the field by highlighting the potential of technology-driven tools to improve data analysis principles, especially in in the context of text mining. The use of Shiny apps in education offers benefits, including increased in class engagement, collaborative learning, and improved comprehension of complex subjects. As stated by Fawcett (2018), the use of interactive platform for data exploration, not only enhances students' analytical skills but also empowers educators to foster a holistic understanding of data analysis, critical thinking, and the collaborative nature of research.

Future enhancement of similar development should incorporate advanced NLP techniques like sentiment analysis. To elevate the educational impact, interactive tutorials, gamification elements, and customised modules could be added, catering to diverse user backgrounds. Finally implementing cloud-based storage and collaboration features would enable knowledge sharing among users.

In conclusion, while TextCrunch is a useful tool for text mining education, ongoing development, and refinement such as updates and maintenance are essential to maximize its potential impact in teaching and learning process.

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