AN EFFICIENT GOOGLE EXTENSION FOR SUMMARIZING COMPLEX ONLINE ARTICLES: DEVELOPMENT, IMPLEMENTATION, AND EVALUATION

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ABSTRACT

This program aims to solve the problem for those people who find it hard to comprehend and get the necessary information they need when reading difficult and long articles online [1]. The program is a Google extension available to everyone and can summarize the articles users find on all the websites into bullet points, providing a specific explanation when needed [2]. The program contains three important systems, including prompt engineering, flask server, and Google extension. When the user clicks the summarize button, the text on the website will be sent to Chat GPT, and it will summarize the article based on a specific prompt we set [3]. The server allows the program to respond to users' requests, and Google extensions provide access to end users. We conducted an experiment that tested the accuracy of the summary on 20 different websites and got an average accuracy of 8.35 out of 10. We found out that the program works well for long articles that usually are harder to read, accomplishing our goal to help people read long and difficult articles and get information efficiently.

KEYWORDS

Article Summarization, Google Extension, Prompt Engineering, User Comprehension

1. INTRODUCTION

Many people have problems reading longer and harder articles nowadays, and they might not have enough time for reading too [4]. People either read texts by simply scanning, or they just give up on reading after viewing the first few lines. The extension helps them read more efficiently and completely. A website analyzed the reading pattern of their users, and they found out that when viewing a webpage, the average time for people to concentrate and read an article is 55 seconds, and only 25% of readers finish reading all the text in one 1600-pixel page. A 2022 data shows that for people between the ages of 15 to 64, their average time spent on reading is around 12 minutes. This problem affects the availability of information to people because since they do not have time to read, they cannot gain anything from the articles. This means it is hard to get information, which shapes their thoughts and ideas, from reliable and authorized sources. Knowledge of general people will decrease, and it will cause people to be misled easily.

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To help with this problem, my application is an extension, and it helps users to summarize articles on websites. Since many users read articles online without downloading them, we believe that making the program into an extension is the most suitable way for online reading. By simply clicking a button, users can get the summary at the right top of the page within a few seconds. The extension solves the problem by providing a simple way to assist people with their reading process without complicated steps. The summary helps people to get information efficiently, and it also helps them to understand the text more accurately if they want to read the whole article by themselves. Compared to Google AI Overview, which gives answers based on information it finds all over the internet, this extension focuses on summarizing information from only one web page, ensuring the credibility and accuracy of information generated [5]. Users can choose the sources they trust.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. The use of prompt engineering

Users might have some questions about how we use Chat Gpt to work properly. When we send the texts on a web page to Chat Gpt, we have a specific prompt used to make sure that it returns a valuable and neat response. Unlike simply asking it to summarize the text, we set up a scene and assigned a specific character for the AI, making sure the summary is accurate. The use of prompt engineering is important in assigning the scene and character to help summarize. We set the character of Chat GPT as a college professor analyzing an article for their student [6]. By assigning a system role, the result is easier to understand and more reliable.

2.2. The extension

For the question of whether the extension can summarize text on any web page, our extension works properly for most of the websites people use, but there are some websites that block external plugins or extensions from visiting their page [7]. For those websites, the extension will report an error or tell you that it does not support the website. Additionally, users may be concerned about what kinds of texts the extension can summarize. Although it is designed to summarize articles, the extension also works for a variety of texts, like Reddit threads, literature, and poems. We tested it in the experiment process and believe it can work well.

2.3. Going to anther page

There may be questions about whether the users can go to another page when waiting for the response. Since the extension will be shut down if you change a web page, users cannot switch pages during the process. However, the waiting time is not long, the summary will appear soon after you press the button. For those who are concerned about privacy and information safety, our extension only has access to the text on web pages. The principle is when you use the extension, it will send the website to our program and then it will send only the texts to Chat GPT. We do not use any personal information or analyze any data.

3. SOLUTION

Figure 1. Flowchart of program

On any webpage that includes articles or texts, users can easily use this Chrome extension to improve their browsing and reading experience by simply clicking the icon located on the upper right side of the Chrome browser [8]. Once clicked, the extension begins the process of sending the web information directly to ChatGPT, within a few seconds, users receive a concise and clear summary of the text information on that webpage. This summary is displayed at the top of the page, allowing users to quickly view the main points and essential details without having to read through the entire article or text. The extension will stop the summarizing process if the user leaves the webpage or switches to another screen.

The first component is Prompt Engineering, which uses ChatGPT API in order to summarize the web articles [9]. Since it is too difficult to do with just standard Python, we have to use OpenAI's API system to use ChatGPT outside of the website. The extension relies on generative large language models to create sufficiently accurate and concise summaries, and the large language models are AI-trained on large sets of natural language data and can approximate intelligent responses to specific questions.

```
def summarize_by_url(url):
    response = requests.get(url)
    soup = BeautifulSoup(response.content, 'html.parser')
    text = soup.body.get_text('', strip=True)
    connection = client.chat.completions.create(
        messages=[
            {
                'role': 'system',
                'content': 'You are a college professor, and you are analyzing an article for students. Please summarize the text in a reasonable length, and make
            },
            {
                'role': 'user',
                'content': text
            }
        ],
        model='gpt-3.5-turbo',
    )
    return connection.choices[0].message.content
```

Figure 2. Code Sample

As shown in figure 2, we use the ChatGPT 3.5 model and prompt engineering to instruct ChatGPT on how to act. We assign the following system role:

"You are a college professor, and you are analyzing an article for students. Please summarize the text in a reasonable length, and make the summary easy to understand. If you notice that the article is talking about multiple different topics, summarize the topics separately."

This system role informs ChatGPT about its purpose using the persona pattern and allows it to act in a manner than one would usually get when visiting the standard ChatGPT web application.

The Beautiful Soup Python library is also used in the server. Beautiful Soup is a library designed to allow Python programmers to access and search through the HTML content of web pages. We use Beautiful Soup to grab the main content of the web article, and send it as a user role, then it returns a JSON of the summarized article [10].

The Second component is the Flask server, which is a Python library and microframework hosted online and can be accessed anywhere. API calls allow the server to respond to requests, so applications like the Chrome Extension can send requests with a payload for the server to manipulate. We also need to have an API that uses ChatGPT to generate summaries of web pages on request.

```python
@app.route('/summarize', methods=['POST'])
def summarize():
    data = request.get_json()
    url = data.get('url')
    if not url:
        return jsonify({'error': 'URL is required'}), 400
    summary = summarize_by_url(url)
    return jsonify({'summary': summary})

if __name__ == '__main__':
    app.run(host='0.0.0.0')
```

Figure 3. Code Sample

This Python code is called whenever the Chrome Extension makes a request to the server to summarize information from a certain web page. It is specifically an API available from the server, accessible via a POST request, which requires a JSON payload containing a specific URL, with the key “url”. When the chrome extension icon is clicked on a web page, this portion of the server will be called and requested to generate a payload of the summarized article, based on the provided URL. If there is no valid URL, we send it back with a 400 error. If there is a valid URL, we use ChatGPT to summarize the web article as explained previously. Then, the server generates a JSON package to store the summarized web article and sends it back to the Chrome Extension to render onto the HTML popup.

The third component is the Chrome Extension as figure 4 shows the page the end-users see. Chrome Extensions are easy to run for the end-user on the webpage and fit the need of summarizing articles online well, which helps with the accessibility of this application. When the icon is clicked, a popup window will display the ChatGPT summary of the web page. The extension uses HTML, CSS, and Javascript, which is used to send a request to the Python Flask server [14].

Figure 4. Screenshot of program on page

```
document.addEventListener('DOMContentLoaded', function() {
    chrome.tabs.query({active: true, currentWindow: true}, function(tabs) {
        var activeTab = tabs[0];
        var activeTabUrl = activeTab.url;

        const url = 'https://lora-server.onrender.com/summarize';
        const data = {
            url: activeTabUrl
        }

        fetch(url,
            {
                method: 'POST',
                headers: {
                    'Content-Type': 'application/json', // Adjust headers as needed
                },
                body: JSON.stringify(data), // Convert data to JSON string
            }
        )
        .then(response => response.json()) // Convert response to JSON
        .then(data => {
            var converter = new showdown.Converter()
            document.getElementById("summary-container").innerHTML = converter.makeHtml(data["summary"]);
        })
        .catch((error) => {
            document.getElementById("summary-container").innerHTML = error;
        });

        });
});
```

Figure 5. Code Sample

The Javascript function in figure 5 runs whenever the DOM is loaded, which within the context of a Chrome Extension, means whenever the user clicks on the Chrome Extension icon in their browser. This Javascript function will grab the active tab, which is the current web page that the user is on, which should be the web article that they want summarized. Afterwards, we send the URL of the active tab to the server in a POST web request. Once the summary is generated and sent back as a JSON, we unpack the JSON to retrieve the summary. The summary is a string written in Markdown format, which allows for the text to display styled elements such as bold letters and header texts, so we have to use an HTML Markdown renderer to display the Markdown properly. Lastly, we modify a div in the HTML code of the Chrome extension popup to show the summary to the user.

4. EXPERIMENT

Since the Chrome Extension relies extensively on the ChatGPT API to generate its summaries, it must be thoroughly evaluated to see if the ChatGPT API is capable of consistently providing quality results. Poor summaries can lead to misinformation being spread to the end user. ChatGPT must also inversely not make summaries that are too long or too complex, as that would defeat the purpose of using the Chrome Extension in the first place.

We will be performing an accuracy experiment on the ChatGPT API to determine if it is viable to use the LLM for the Chrome Extension. To do so, we will be evaluating 20 websites to see if the Chrome Extension can consistently generate valuable and usable summaries. These 20 websites were chosen for various reasons. They vary in the content, the length, and the political bias of the author. We will evaluate each generated summary on a score from 1 to 10, with considerations being placed on length, relevance, accuracy, and utility for the end user. At the end of this experiment, we will look at the average score to determine how to improve the ChatGPT model's capabilities and where the extension's weak points may lie. We can see the results of the experiment in table 1.

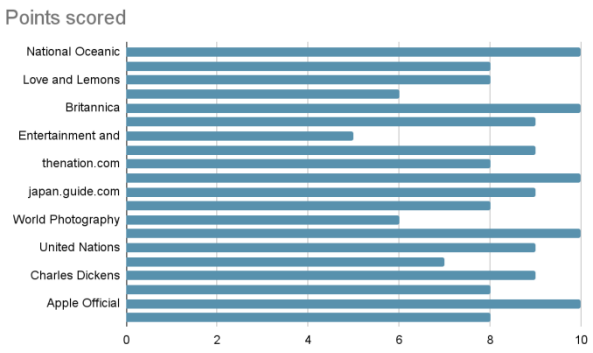
Table 1. Rating

	Source	Article Link	Article Title	Score (1-10)
1	National Oceanic and Atmospheric Administration	https://www.noaa.gov/education/resource-collections/climate/climate-change-impacts	Climate change impacts	10
2	National Geographic	https://www.nationalgeographic.com/animals/mammals/facts/domestic-dog	Domestic dog	8
3	Love and Lemons	https://www.loveandlemons.com/homemade-pizza/	Homemade Pizza	8
4	British Broadcasting Company	https://www.bbc.com/news/live/cerv8e19vevt	Trump's VP pick Vance to give primetime speech at convention	6
5	Britannica	https://www.britannica.com/topic/Don-Quixote-novel	Don Quixote	10
6	Columbia Broadcasting System	https://www.cbsnews.com/news/what-the-last-nuremberg-prosecutor-alive-wants-the-world-to-know/	What the last Nuremberg prosecutor alive wants the world to know	9
7	Entertainment and Sports Programming Network	https://www.espn.com/espn/otl/story/_/id/7920276/otl-university-alaska-anchorage-runner-marko-cheseto-most-tragic-run-espn-magazine	Into the wild	5
8	Esquire.com	https://www.esquire.com/uk/culture/a28395824/instagram-fish/	The Life And Death Of An Instafish	9
9	thenation.com	https://www.thenation.com/article/archive/secret-archive-mexican-suitcase/	A Secret Archive: On the Mexican Suitcase	8
10	The National Broadcasting Company News	https://www.nbcnews.com/sports/olympics/olympics-2024-opening-ceremony-watch-start-time-rcna163453	Olympics opening ceremony 2024: Everything you need to know	10
11	japan.guide.com	https://www.japan-guide.com/e/e2164.html	Tokyo City Guide	9

12	forums.unrealengine.com	https://forums.unrealengine.com/t/solved-i-cant-use-my-uv-texture-map-in-ue5/791243/4	[SOLVED] I can't use my UV texture map in UE5 (It's a threaded discussion)	8
13	World Photography Organisation	https://www.worldphoto.org/about-us	About World Photography Organisation	6
14	State.com	https://www.slate.com/articles/health_and_science/science/2013/07/big_sandy_machine_gun_shoot_arizona_s_gun_lovers_and_gun_control.single.html	Fire on the Hole	10
15	United Nations	https://sdgs.un.org/goals	The 17 Goals	9
16	armandhammer.com	https://www.armandhammer.com/articles/fun-ways-to-play-with-your-cat	Top 11 Ways to Have Fun with Your Cat	7
17	Charles Dickens Online	https://www.dickens-online.info/a-christmas-carol.html	A Christmas Carol	9
18	culture.org	https://culture.org/art-and-culture/caravaggio-paintings/	The Dramatic Realism of Caravaggio Paintings and His Artistic Legacy	8
19	Apple Official Website	https://www.apple.com/apple-vision-pro/	Vision Pro	10
20	Louvre Museum Official Website	https://www.louvre.fr/en/exhibitions-and-events/exhibitions/masterpieces-from-the-torlonia-collection#presentation-1916	MASTERPIECES FROM THE TORLONIA COLLECTION	8

The summaries created on average scored 8.35 points. As seen in Table 2, the lowest score achieved was 5 points. 1 website got this rating. The highest score achieved was 10 points. 5 websites got this rating. The most common score was 8.

Table 2. Scores



We believe that the average score of 8.35 indicates that the extension does its job well for most of the time. Based on the summaries, it seems that the API consistently fails when given websites about short and already summarized articles, because the outcomes are sometimes longer than the original text and not to the point. The API performs best when the website is Biography and Popular Science. Overall, we believe that the program performed well because it can summarize the main points for a formal or academic article. To improve the program's performance during these tests, we intend to in the future improve the prompt.

5. RELATED WORK

In the paper "Awareness Development for Online Reading" by Victoria Zenots, the researcher focuses on metacognitive strategies and how to bridge the gap between online reading and paper reading [11]. The paper introduced some specific teaching styles that may help students who have English as a foreign language. On the other hand, instead of teaching technology, our research focuses on helping people to read directly with AI technology. This can provide more efficient and immediate help for all people.

In "Facilitating Online Reading Comprehension in Enhanced Learning Environment Using Digital Annotation Tools" by Azmuddin, Ruhil Amal Azmuddin; Nor, Nor Fariza Mohd; Hamat, and Afendi, the researchers facilitate reading comprehension using digital annotation tools, helping students to have a better understanding of English for science and technology field [12]. The research focuses on assisting students to paraphrase and summarize the article by themselves, and our research focuses on providing them with a summarized paragraph to help them understand the whole article. This is more useful for people who struggle with reading because it provides direct help and at the same time cultivates their interest in reading.

Julie Coiro, in "Online Reading Comprehension: Challenges and Opportunities", pointed out a few difficulties of online reading, stating that it is a new literacy perspective, and the advantages of online reading [13]. The research provided theoretical solutions and advice. Compared to Coiro's research, our research focuses on helping people to overcome challenges and utilize the strength of online reading, such as compressing long information to improve the efficiency of learning, with existing technologies instead of simply predicting the possible situations and listing the challenges readers face.

6. CONCLUSIONS

The project focuses on providing immediate help to improve reading experiences by summarizing the article for the readers, but it lacks a way to help them improve their reading skills and have better comprehension in the long term. With more time, we can develop a system that helps readers get involved in the process and guides them through the article with simple games and questions. To expand the program, we will do more research on how people read online and what might help them to improve their reading skills. We will include more features to help a variety of people who face different problems while reading, such as people with dyslexia, attention deficit, and hyperactive disorder. Moreover, we can collect data and give reading suggestions based on the users' reading habits, reading levels, and interests to guide them, encouraging them to develop a reading habit using the advantage of online reading. Reviewing the process of this project, we should do more research on the features of online reading, specify the difference between different reading perspectives, and make more prompt suggestions to fit different situations and types of articles.

We used the extension for different types of articles on different sites and asked it to summarize them. From 1 to 10, the experiment tested the accuracy rate of the summarization. We set it up by preparing 20 websites with articles on a variety of topics and forms for the extension. The most significant finding was that it works best when it comes to long articles such as popular science or biographies. The reason behind that is that these kinds of articles have clear structures and can be broken out into bullet points. For shorter articles like life tips, since many of them are already in bullet points, the extension sometimes omits important information to shorten the sentence. The experiment was successful because we could find out that the program summarized well with an average accuracy rate of 8.35/10 on the websites we told it to summarize.

The first research “Awareness Development for Online Reading” aims to use metacognitive strategies to connect the reading experience of online and paper reading, the second research “Facilitating Online Reading Comprehension in Enhanced Learning Environment Using Digital Annotation Tools” explores the use of of online annotation to help students read digitally, and the third research “Online Reading Comprehension: Challenges and Opportunities” discusses how online reading changes reading habits and how people can adapt [15]. All the methodologies focus on connecting the idea of online reading back to paper reading and helping people comprehend the text using the strategies used in paper reading. The shortcoming is that they do not fully take advantage of network and online technologies and develop a system to fit the features of online reading. Most people are looking for fast and efficient information, especially on the webpages, when they are reading online. Our project addresses this by giving them a way to get information directly, thus increasing the amount and accuracy of information, and improving the reading experience for users.

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