DARK PATTERNS
BUSTER HACKATHON
2023

DarkDetect

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Proposed Solution: Utilizing A Chrome Extension For Capturing Instances Of Dark Patterns On Websites.

I. ABSTRACT

In the ever-evolving landscape of e-commerce within the digital age, the pervasive use of deceptive user interface practices, commonly referred to as dark patterns, poses a formidable challenge for online consumers. Recognizing this issue, we introduce an innovative solution manifested in the form of a Chrome extension meticulously designed to detect and counteract dark patterns on various shopping websites.

Our solution adopts a multifaceted approach, leveraging the synergy of web scraping and

Natural Language Processing (NLP) techniques to dissect and analyze text content. This intricate process allows for the identification of deceptive design tactics employed on e-commerce platforms, empowering users with the knowledge to navigate through online interfaces more judiciously.

A notable aspect of our extension is the inclusion of a pie chart feature, which dynamically visualizes the distribution of detected dark patterns across different categories.

It's crucial to clarify that while our current solution doesn't incorporate OCR directly, we recognize the evolving nature of technology and the potential for expanding our capabilities. As part of our commitment to continuous improvement, we invite collaboration and feedback from the community. By engaging in a collaborative dialogue, we aspire to drive further innovation, refine our solution, and contribute to the creation of a more trustworthy and user-friendly online shopping experience.

We understand that dark patterns can significantly impact the online consumer journey, and our extension strives to serve as a vigilant guardian against these deceptive practices. By combining advanced technological techniques, we seek to provide users with a tool that not only identifies dark patterns but also equips them with valuable insights, enabling more informed decision-making during their online interactions.

As we progress, we remain dedicated to refining and expanding the functionalities of our solution. We are committed to staying attuned to user needs and evolving technologies, ensuring that our extension remains a robust and effective ally in the ongoing battle against dark patterns in the dynamic landscape of e-commerce.

In conclusion, our Chrome extension stands as a testament to our commitment to user empowerment and transparency in the digital realm. We believe that by fostering collaboration, receiving constructive feedback, and staying responsive to the evolving needs of the online community, we can collectively contribute to the creation of a safer, more trustworthy, and user-friendly environment for online shoppers worldwide.

II. PROBLEM STATEMENT

Design and prototype innovative apps or software-based solutions that can detect the use, type, and scale of dark patterns on e-commerce platforms.

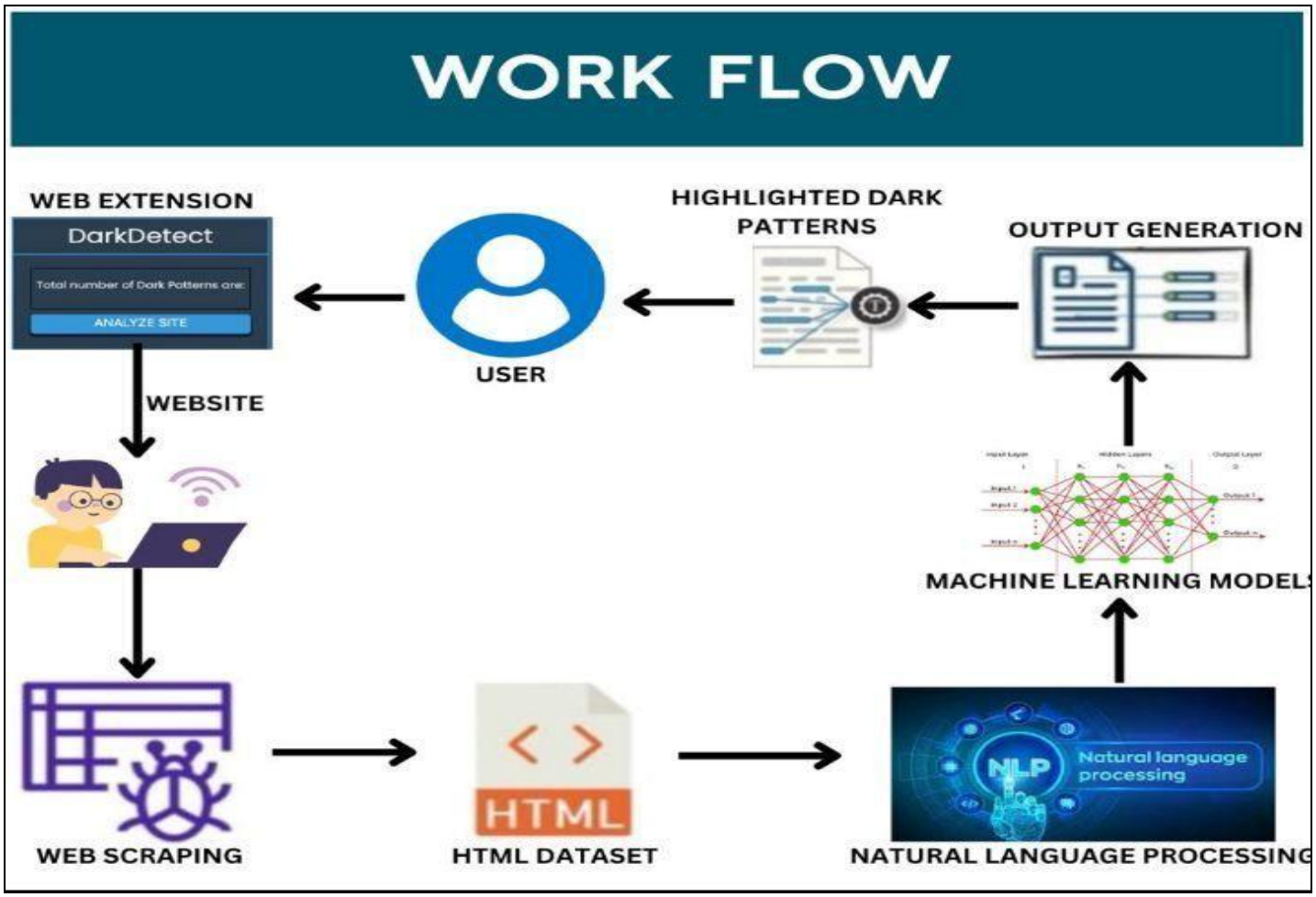
III. METHODOLOGY

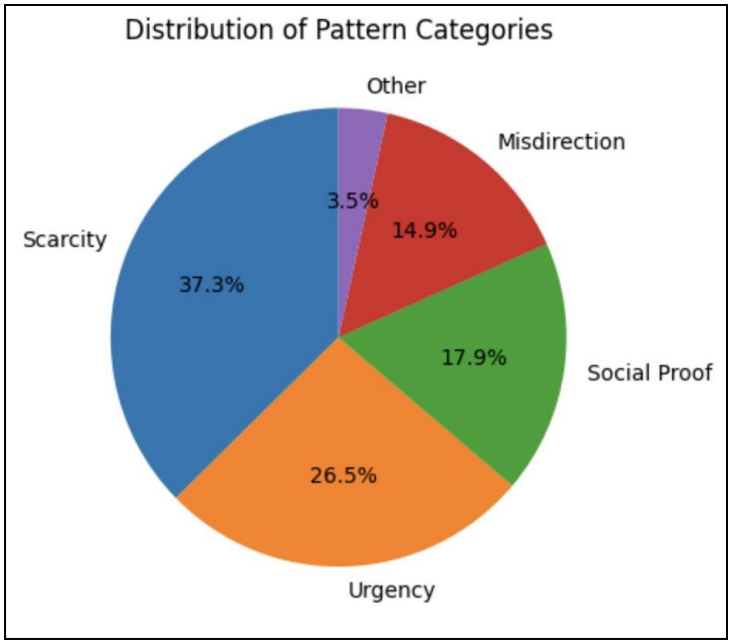
A. Data Collection:

Links to Our Datasets :

1)Dataset 1
2)Dataset 2

We implemented a dual-dataset methodology to enhance the depth of our analysis. The first dataset encompasses an array of pattern strings, each associated with a specific pattern category. This enables the classification of patterns into four predominant dark pattern types: Urgency, Social Proof, Misdirection and Scarcity. Simultaneously, the second dataset comprises strings that are binary classified into 0 or 1, where 0 indicates no dark pattern and 1 indicates a dark pattern. We combined both datasets into a single dataframe. By employing this dual-dataset approach, we establish a comprehensive framework for examining the entire dataset, ensuring a balanced representation of both dark patterns and non-dark patterns.





Pie chart demonstrating proportions of different categories in

This systematic process provides a nuanced

understanding of the prevalence and categorization of dark patterns on the specified website. The integration of two distinct datasets bolsters the reliability of our machine learning models, contributing to a more robust and accurate identification of dark patterns. This methodology is pivotal in furnishing a comprehensive view, presenting a holistic picture of the types and frequency of dark patterns present on the website under scrutiny.

B. Scraping Techniques:

This JavaScript script serves as a powerful tool for enhancing the efficiency of web scraping endeavors. The script facilitates the intelligent extraction of relevant information from HTML elements while disregarding extraneous or undesirable content.

a. *Relevance Filtering:*

The script addresses the challenge of filtering out irrelevant HTML elements during web scraping processes. By leveraging predefined conditions, it selectively identifies elements that contribute meaningfully to the data extraction objective. By excluding irrelevant elements, the script contributes to the overall improvement of data quality. It minimizes noise in the extracted data, ensuring that the output is more representative of the desired information.

C. Feature Extraction:

In our approach, both TF-IDF vectorization and Count Vectorization were employed to convert the pattern strings extracted from e-commerce websites into numerical feature vectors. TF-IDF vectorization was chosen for its ability to weigh the importance of words, while Count Vectorization provided a simple and effective representation of word frequencies in the documents. These feature vectors served as input to the machine learning models for training and classification, enabling them to learn patterns and make predictions based on the text data extracted from the websites.

D. Text Augmentation:

We employed libraries such as TextAttack and nlpaug to address the issue of spelling errors and synonym variations in order to synthetically increase the size and usability of our dataset. However, this strategy resulted in overfitting of the data due to the

generation of excessively specific variations. Consequently, we opted against advancing with this particular approach. CharSwapAugmenter didn't sound much relevant as most of the popular websites do not have spelling errors in text on their website.

E. Large Language Models

Large language models like BERT were avoided due to their computational intensity, prolonged prediction times, and challenges in integration with the backend systems. The decision was based on the resource-intensive nature of these models, making them less practical for efficient and swift predictions. Additionally, their intricate computational demands posed difficulties in seamless integration with backend infrastructure, leading to the preference for alternatives that better aligned with operational efficiency and system responsiveness.

F. Model Training:

After conducting extensive model evaluations, which included Random Forest Classifier, Multinomial NB, and Bernoulli NB, we arrived at the determination that Bernoulli Naive Bayes (NB) stands out as the most accurate choice for our specific use case. Bernoulli NB operates as a probabilistic classifier, leveraging Bayes' theorem and making strong independence assumptions between features. This model showcases exceptional performance in text classification tasks, particularly when features, such as word presence indicators, are discrete. This characteristic aligns seamlessly with our use of TF-IDF and Count Vectorization. The discerned accuracy and suitability of Bernoulli Naive Bayes make it the optimal choice for our model.

G. Flask:

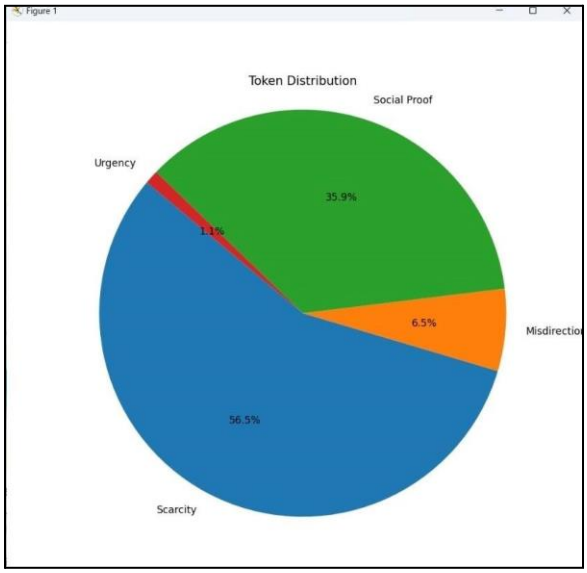
We have harnessed the capabilities of the Python Flask library to establish a robust linkage between our frontend files and sophisticated ML models. Flask, known for its lightweight and versatile nature as a web framework, empowers us to seamlessly gather inputs from a browser extension. This integration enables us to efficiently process the received inputs through our machine learning models and present the refined results back to the user in a streamlined and user-friendly manner. The adaptability and efficiency of Flask play a pivotal role in enhancing the overall connectivity and user experience of our web application.

IV. RESULT

The website strategically highlights dark patterns with a distinctive red color, effectively bringing them to the user's attention and elucidating their nature and specific types. Furthermore, users gain access to a detailed pie chart showcasing the percentage breakdown of different dark pattern categories. This not only serves to enhance user awareness but also provides a comprehensive visual representation, enabling users to grasp the prevalence and diversity of deceptive tactics employed on the website.

In our analysis, we employed pie charts as a visual tool to offer an in-depth depiction of the

percentage distribution of identified dark patterns on the specified website, leveraging the capabilities of our machine learning models. This visual representation ensures a comprehensive understanding of the prevalence of various dark patterns, showcasing both the maximum and minimum occurrences. By presenting this information through pie charts, we aim to provide a detailed and easily interpretable insight into the dark pattern landscape on the website, facilitating a nuanced examination of its user experience and potential ethical considerations.



An example of pie chart demonstrating proportion of categories of Dark Patterns

V. DELIVERABLES

A. Web Extension:

We've designed a functional web extension tailored for revealing dark patterns on e-commerce sites. This specialized browser add-on serves to identify and expose deceptive design tactics, promoting transparency and empowering users to make informed choices when navigating online shopping experiences. By integrating our extension, users gain a valuable tool to enhance their awareness and protect themselves from potentially manipulative practices implemented by certain e-commerce platforms.

B. Dark Pattern Detection:

The web extension excels in identifying and spotlighting dark patterns, showcasing its proficiency in analyzing various elements on web pages. Its effectiveness lies in the ability to unveil manipulative design practices, thereby empowering users to navigate online spaces with increased awareness. By scrutinizing web page components, the extension serves as a valuable tool in promoting transparency and countering deceptive design strategies, contributing to a more informed and user-centric online experience.

C. User Interface:

Our extension features an intuitively designed interface, ensuring user-friendliness. Users can effortlessly configure settings, explore identified dark patterns, and make informed decisions while navigating online shopping. The interface provides a seamless experience, empowering users with tools to customize their preferences and stay informed about potential manipulative practices. Whether

adjusting settings or gaining insights into detected dark patterns, our user-friendly design enhances the overall browsing experience, fostering transparency and enabling users to navigate e-commerce environments with confidence.

D. Documentation:

We've compiled comprehensive documentation detailing our web extension's functionalities. This includes a thorough user guide and insights into the dark pattern detection algorithms, eliminating the need for installation instructions. Users can delve into the intricacies of the extension without the hassle of installation guidance, gaining a deeper understanding of its capabilities in identifying and combating dark patterns during their online interactions.

E. Demo Video:

F. Presentation:

We aim to present a comprehensive overview during the hackathon, encompassing various aspects such as elucidating the problem statement, delving into the intricacies of our solution, highlighting key features embedded in the web extension, and elucidating the potential impact it holds in effectively countering dark patterns prevalent in the e-commerce landscape. Our presentation will provide a detailed exploration of these elements, offering a holistic understanding of the challenges addressed, the innovative solutions proposed, and the tangible benefits our web extension brings to the realm of e-commerce.

G. Scalability and Efficiency:

1.Lightweight Architecture: The extension is designed with a lightweight architecture, ensuring minimal impact on browser performance and resource consumption. This lightweight design facilitates smooth operation across various devices and browser configurations.

2. Efficient Data Processing: The extension employs efficient algorithms for data processing, enabling quick analysis of webpage content to detect and classify dark patterns. This efficient processing ensures that users experience minimal delays or lags when using the extension.

3.Scalability Across Websites: The extension is scalable across a wide range of websites and web pages. Its robust design allows it to adapt to different website structures and layouts, ensuring consistent performance regardless of the website being analyzed.

4. Real-Time Analysis: The extension performs real-time analysis of webpage content, providing users with instant feedback on the presence of dark patterns. This real-time analysis enhances user experience by enabling immediate detection and response to manipulative design tactics.

5.Comprehensive Reporting: The extension generates comprehensive reports detailing the presence and types of dark patterns detected on each webpage. These reports provide users with valuable insights into the deceptive design tactics employed by websites, empowering them to make informed decisions about their online interactions.

6. The DarkDetect extension has been developed using standard web technologies such as HTML, CSS, and JavaScript. By avoiding the utilization of browser-specific features or APIs, the extension ensures broad compatibility across various versions of the Chrome browser.

Overall, the DarkDetect extension offers scalability and efficiency by combining lightweight architecture, efficient data processing, adaptability to different websites, real-time analysis, minimal user input requirements, comprehensive reporting, and compatibility with Chrome browser environments..

H. Ethical Considerations:

The DarkDetect extension ensures user privacy by employing a crawler programmed to extract solely visible content relevant to analyzing dark patterns. It refrains from accessing or collecting sensitive or personally identifiable information from webpages or user browsing activity. Throughout the development and presentation of this project, our focus is on ensuring ethical practices, privacy compliance, and a user-friendly experience for online shoppers.

VI. CONCLUSION AND FUTURE WORK

In summary, our project successfully tackles the crucial issue of identifying and countering deceptive user interface tactics on e-commerce platforms. Through the integration of web scraping, Natural Language Processing (NLP), and machine learning, we've created a robust Chrome extension capable of identifying and highlighting dark patterns. This empowers users to make more informed decisions during their online shopping experience.

Our comprehensive solution showcases the efficacy of incorporating technologies like OCR to overcome data extraction challenges and leveraging NLP for text analysis and classification. Beyond improving user experience by offering real-time insights into deceptive practices, our extension actively promotes transparency and ethical conduct in the digital marketplace.

Looking forward, we envision further enhancements to our project, including the incorporation of advertisement analysis capabilities and scalability improvements. By continuously refining and expanding our solution, our goal is to create a lasting impact

by fostering trust, transparency, and fairness in online transactions.

[Dark Patterns at Scale: Findings from a Crawl of 11K Shopping Websites (arxiv.org)]

In the future, there are plans to incorporate **Optical Character Recognition (OCR)** technology into the project. This integration would broaden the project's scope, transitioning it from exclusively handling text to encompassing both textual content and images. This expansion aims to enhance the project's capabilities, enabling it to effectively process and interpret information not only from written text but also from visual data in the form of images.

OPTICAL CHARACTER RECOGNITION (OCR):

In scenarios where websites impose restrictions on scraping, users have the option to submit screenshots via an HTML form. This enables them to accomplish the same text extraction task, leveraging the capabilities of OCR technology to enhance flexibility and overcome scraping limitations.

We appreciate your attention and support.

The research paper we followed: