



## MSc in Computer Science - Team Project

### Interim Report Template

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# 1. User Scenario: The Characters

## 1.1 Identifying Target Users – Market Analysis

According to Patwardhan and Yang (2013), online news readers in the U.S. appear to be younger (41% of them were between the ages of 18-34) as compared to conventional newspaper readers (only 23% in the same age category) in the year 2001. However, according to Gottfried and Shearer (2017), there was a rise in the consumption of online news across the demographic groups in the U.S. in the year 2016. There was an increase of 6% among those ages between 50-64 (35% in 2017 vs. 29% in early 2016). Although we are not in the U.S., we could deduce two user groups as personas for our applications based on these references as we emphasize on consumptions of news in Western nations which will be elaborated more in the subsequent subsection. Their details are in Figure 1 and Figure 2.



Figure 1 User persona – Ong

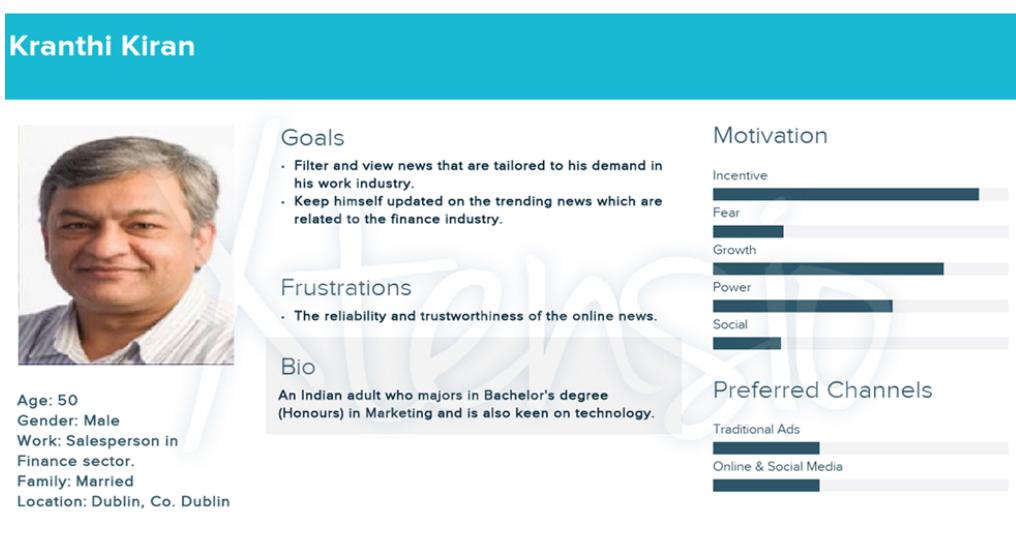


Figure 2 User persona - Kranthi

## **1.2 Importance of Target Users – Hofstede’s Six Dimensions of Culture**

It is indisputable that target users vary with respect to their technological skills, ages, and cultures. Based on the stated aspects of target users, we identify their significance through Hofstede’s Six Dimensions of Culture approach. Our application, IceyFauxNews is expected to adhere to these cultural dimensions to accommodate the needs of our target users. Moreover, these cultural dimensions also assist us to determine the suitable UI features for our application.

It is also well-noted that Hofstede identified differences between Eastern nations (e.g., China) and Western nations (e.g., Ireland, U.S.) on several dimensions as asserted by Hope and Li (2004) but we only focus on Western nations in this context. The details of the relevant cultural dimensions for the application are asserted as follows:

### **1.2.1 Power Distance Index (PDI):**

In this context, our application inclines to suit society with low PDI since we focus on Western nations which can tolerate greater diversity of opinion as stated by Hope and Li (2004). A low PDI score indicates that the powers or rights of the users are shared and widely dispersed. According to Baxi (2018), the process of obtaining the trust among society with low PDI score is a matter of casualness and bluntness to engagement, for example, users are not required to fill up lengthy form upon signing up for a new account on our application as only email addresses and passwords are required.

### **1.2.2 Individualism vs. Collectivism (IDV):**

Our application inclines to contextualize site engagement for society with a high IDV score. Users among the society with high IDV scores tend to have weaker interpersonal connections with others. In addition to that, Baxi (2018) also states that these users are only interested in how a product or service benefits them, for example, our application allows the users to filter the source of the news based on their desires. This was firmly supported by the assertion from Zhou (2008) which implied that this dimension is the most prominent one among all dimensions and individualism is frequently related to Western nations, even Hofstede also supported this claim and commented that there has been and still is a strong feeling that individualism is more prevailing than collectivism.

### **1.2.3 Uncertainty Avoidance Index (UAI):**

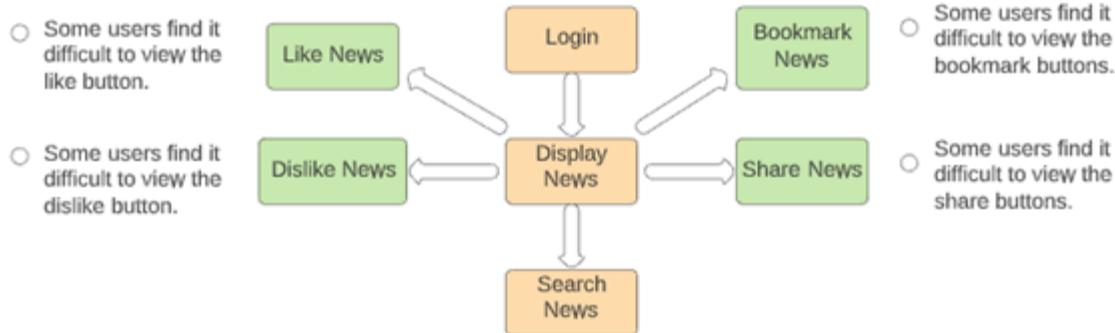
Our application inclines to accommodate society that has low UAI which corresponds to the nature of Western nations that have a low level of anxiety, lower emotionality, and high willingness to accept risk as asserted by Hope and Li (2004). With respect to this, our application populates news from various sources without any restrictions.

## **1.3 Problems Encountered By Target Users – User Journeys**

There are two aspects of the problem encountered by target users – the absence of awareness of fake news and the difficulty of accessing news websites. The

former will be elaborated in section 2. Technical Problem: The Setting. This section focuses on the latter.

Before outlining the problems that we are solving for target users in the existing application (News360), a typical user journey through the application is elected and examined as shown below:



The current problems that have been identified upon entering the user journey are as follows:

- The user interaction features' buttons are barely visible.
- Users can only search the news after logging into the system.
- Users can only filter the news based on the categories listed on the news themselves.

## 2. Technical Problem: The Setting

### 2.1 Why are we building IcyeFauxNews?

In today's epidemic, fake news keeps appearing on social media and has a very bad impact on human life. Fake news can have financial or health impacts on people's lives, for example: "Eating a balanced diet of bananas and apples for twelve days will reduce weight. 'Elon Musk's decision to close all overseas factories' hit the stock market.

Therefore, a website based on a true and false news detection system, suitable for any age group/any gender/any type of work and social attributes was created. The real and fake news identification systems on the market require to donate or membership fees. We are committed to creating a free and multi-functional news website for every user, including real-time news identification, news recommendation, and users manually input news for identification.

### 2.2 Why is it hard to detect fake news?

#### 2.2.1. Hard to define fake news

For users, it is difficult for them to tell whether the news is true or false. But the news is affecting their lives all the time. As Golbeck et al. (2018) mentioned, 'Fake news is information, presented as a news story that is factually incorrect and designed to deceive the consumer into believing it is true.'(pp. 17-21). For example, user Kranthi Kiran wants to make sure that timber can be shipped from South America on time based on political news from the past week. If he receives some fake news, it is likely to affect his judgment and cause economic losses.

## 2.2.2 Hard to find a benchmark dataset for fake news detection

Technically, it is difficult to find fake news data set with standards in the field. ‘However, statistical approaches to combating fake news has been dramatically limited by the lack of labeled benchmark datasets.’(Wang, 2017). After doing a lot of research, we found that the lack of effective and comprehensive data sets has always been a problem in the development of fake news detection models.

In solving the problem of fake news data set, we are facing two major problems.

### 2.2.2.1 Obtaining the dataset

Challenges are finding labeled news data sets to train the model for real-time news detection and reducing the difference between the distribution of the training text news data and the actual news text.

After long research, we found a series of data sets and merged them. In the integrated data set Figure 3, label0 is real news, label1 is fake news, and all news comes from laboratory papers that are sending requests to paper authors and Kaggle competitions. This is also one of the reasons that the prediction performance of the model is not as good as the test performance: it is impossible to 100% define fake news.

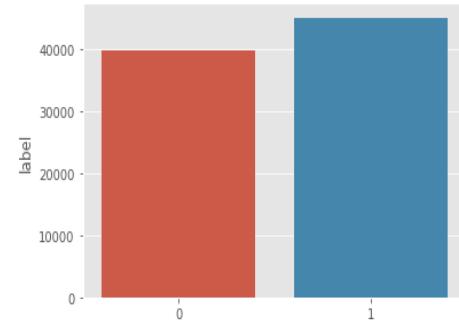


Figure 3 Labeled data

### 2.2.2.2 Cleaning the dataset

Another challenge is figuring out ways to clean up the data set, weaken the strong features that affect the prediction results, and reduce the dimensionality of the training model. This involves cleaning the title and text of the news articles as follows:

- Regularization
- Removing XML/HTML tags
- Convert to lower case characters
- Removing the URLs

It can decrease the dimensions of the model by merging “Works”, “working” and “work” into one word.

## 2.2.3 Tuning the model

The technical challenges comprise of finding the optimal parameters, tuning the Hyper-parameters, and getting better accuracy while avoiding overfitting the model.

### 2.2.3.1 Choosing the parameters

After finishing all pre-processing, how to choose parameter settings is a technical challenge. Firstly, the results always unknown before the end of the training. Secondly, because we have over 80,000 rows of news articles in our dataset, the training time is long. It will range from 160 to 200 minutes. These reasons caused most of the time we can only wait for the results of the training and change parameter again to see if there is no increase.

### 2.2.3.2 Tuning

After experiencing the training of manually tuning parameters, a new method was discovered through research that uses Tensorflow Keras neural network library to construct Long Short-Term Memory (LSTM).

After defining the hyperparameters of the model, LSTM\_units, neuron\_dense, dropout\_rate, embedding\_size, batch\_size, max\_len, epochs and loss function binary\_crossentropy, the metrics become accurate. The AX package is used to experiment with tuning hyper parameters. This results in the parameters values as Batch\_size=128, Epochs = 20, max\_len = 500, LSTM\_units = 120, dropout\_rate = 0.35, neuron\_dense = 120. The accuracy of the best model is shown in Figure 4.

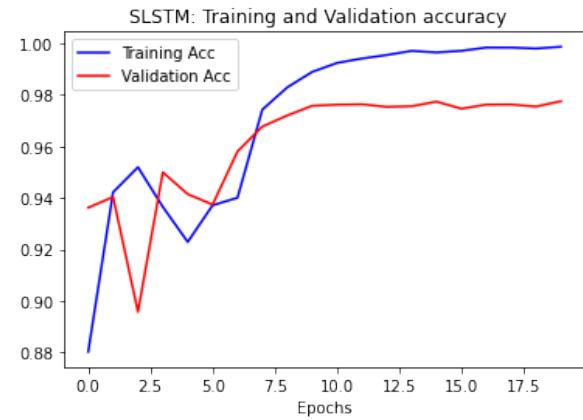


Figure 4 Accuracy of LSTM

## 2.3 Core technical challenges in Icey fox news Recommendation system

IceyFauxNews collects hundreds of news articles from multiple APIs every day. However, recommending too many irrelevant articles will affect the user experience. Therefore, IceyFauxNews needs a news recommendation system to help our target users quickly and accurately find the news they are interested in. Therefore, to build an effective news recommendation system, we have summarized four core technical problems in this area.

### 2.3.1 Cold-start

Most recommendation systems will recommend content to users based on their user profile(user's gender, age, click histories, etc). When we try to recommend news articles to new users of IceyFauxNews, we do not have a lot of information about users. This leads to the Cold-start problem. So the IceyFauxNews news recommendation system may not accurately recommend news articles to users. Cold start is an eternal topic in the field of recommendation systems (Karimi, Jannach & Jugovac, 2018).

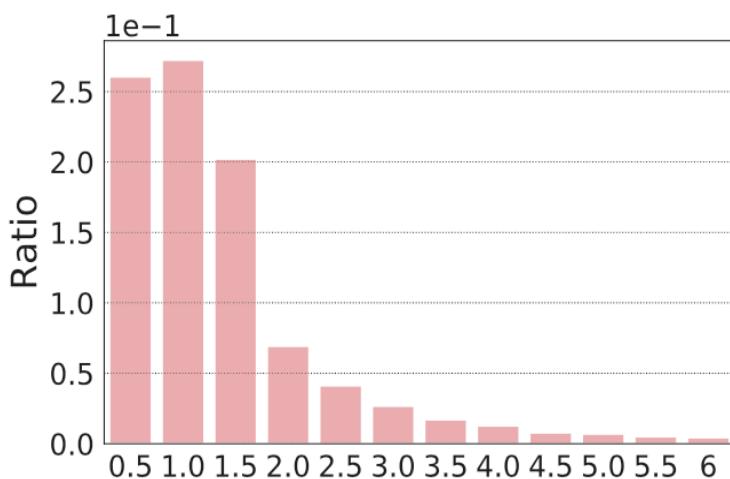
When facing a cold-start problem, a general approach is to try to combine additional information into the recommendation system (Karimi, Jannach & Jugovac, 2018). In order to solve or alleviate the negative effects of cold start on Icey fox news, we consider recommending news to new users based on the user's profile, such as the user's gender and geographic location.

### **2.3.2 Users' interest in news is constantly changing**

The interest of users will change over time(Ozgobek, Gulla & Erdur, 2014). In restaurant recommendation systems, e-commerce recommendation systems(like Amazon), and movie recommendation systems, although users' interests will change, they will not fluctuate significantly in the short term. For example, people's food preferences will not change in a short time. But in the field of news, people's interests are likely to change a lot in the short term(Ozgobek, Gulla & Erdur, 2014). For example, being attracted by breaking news. People's interest in the news may change due to changes in their geographic location and time of day.

### **2.3.3 Recency of news**

It is very important to consider the recency of news when recommending news to users. Due to the characteristics of news, most news has a short life cycle(Karimi, Jannach & Jugovac, 2018). Wu et. al(2020) analyzed 46,000 news articles and 3 million click records found that more than 84.5% of news articles survive less than two days (Figure 5). Therefore, recency should be considered as an important factor in the recommendation system of IcelyFauxNews.



*Figure 5 The survival time of news article(Wu et.al,2020)*

### **2.3.4 The influence of hot news**

Since hot news in the news will absorb a large number of users, it will cause serious head effects. In this case, the recommendation system will mistakenly believe that users like this kind of news and recommend a lot of relevant news to users.

For example, when a large-scale outbreak of an epidemic occurs, because a large number of users will click on articles related to the epidemic, the recommendation system may classify these users as similar users, and recommend articles to users based on their browsing content. This will cause the recommendation system to recommend a large number of articles related to the epidemic, which will cause other news content to be ignored. In other words, a large amount of flow and attention is occupied by a small part of hot news, and most of the remaining news only occupies a small part of the flow and public attention.

## **2.4 Review of similar websites**

### **2.4.1 NewsGuard**

The following are the Pros and Cons of NewsGuard:

<https://www.newsguardtech.com/>.

#### **2.4.1.1 Pros**

The evaluation results are very intuitive and detailed, divided into 4 categories: red, green, satisfaction, platform, and show nine evaluation criteria from credibility and transparency. The total score of 100 points is based on the five criteria of credibility and the four criteria of transparency. If it exceeds 60 points, it is green. Let users feel very easy to use and have professional results.

It is easy to use and obtain. The software has been listed in the web store and can be downloaded directly as a plug-in in the web store of the browser. Pull out the selected text when in use, and the webpage will automatically pop up various indicators of evaluation grade/score, credibility, and transparency.

#### **2.4.1.2 Cons**

Charges. After registering the mail, the bank card must be bound for normal use. After binding, the account has a free 2-week trial.

Manual analysis/evaluation. All results are based on the journalist's prior analysis of news source websites, not a real-time evaluation of the news itself.

### **2.4.2 FakerFact**

The following is the Pros and Cons of FakerFact: <https://www.fakerfact.org/>

#### **2.4.2.1 Pros**

Analyze real-time news. In the first method, the user enters the URL on the FakerFact website, and Walt (FakerFact AI) gives the judgment result. After the algorithm scores, the news in the URL is classified into the label. According to the current experiments, the labels include Satire, Agenda, Driven, opinion, Journalism, Wiki, Sensational, etc. The analysis result will give the most influential sentence on the label in the news. The second method is for the user to directly enter a piece of text.

Free and convenient to use. All functions of FakerFact are free, even if you have not created an account on this website. Also, FakerFact's extension is available in the chrome and Firefox stores, and users can pop up the function bar for instant analysis when browsing the news.

#### **2.4.2.2. Cons**

Although the name of the webpage is FakerFact, Walt cannot tell whether the news is true or false, and can only perform text analysis to give a label score and classify it.

User login can only use Google account and cannot create an independent account.

### 2.4.3 Analysis of comparisons

On NewsGuard, based on the scores of its professional news work team and analysis team, it has solved the needs of users Krathi Kiran, but NewsGuard does not draw conclusions from the text analysis of the news itself but based on the history of the news site, the news author's History and some surrounding factors to evaluate. I think there may be survivorship bias here. At the same time, the user Ong Yee Von, as a student group, cannot be 100% guaranteed that she will spend money to subscribe to products that are used to browse true and false news in her leisure time.

On FakerFact, the website can meet the needs of Ong Yee Von. As a student who meets hobbies, the news is labeled and given specific sentences to meet user desires. But for user Krathi, Walt's results did not match his satisfaction.

## 3. Technical Solution: The Plot

IceyFauxNews is a fake news detector website that aggregates news from various sources, predicts the trust rate of each news article, and recommends customized news to users.

### 3.1 System Overview

#### 3.1.1 Fake news detector

All the news presented in the feed has an associated trust rating that tells how much an article can be trusted. Users can also enter a piece of text or a URL to check the truthfulness of any content using the IceyFauxNews detection system.

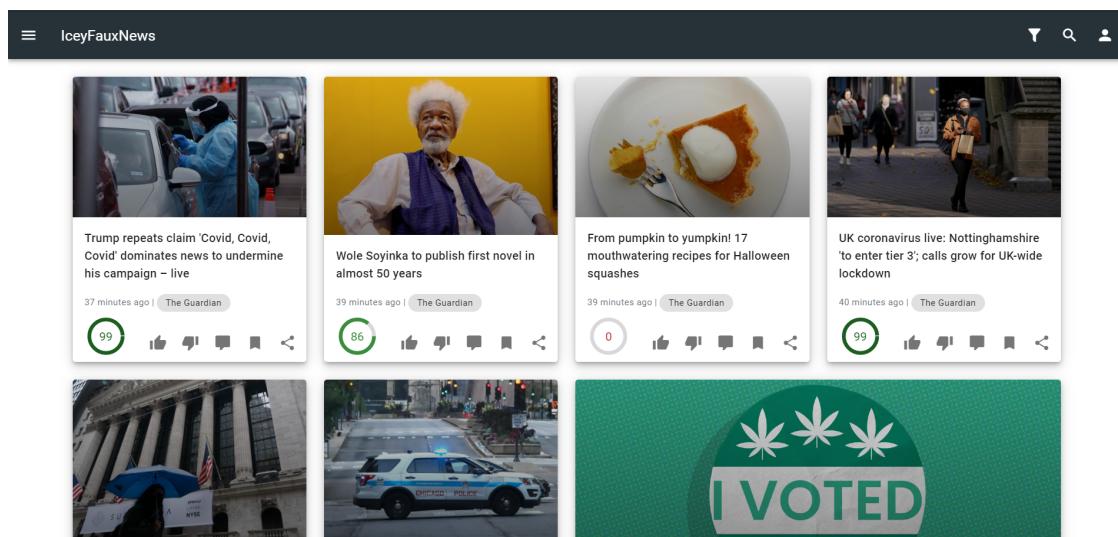


Figure 6 Home page with trust ratings

### 3.1.2 User profile and news recommendations

Users can build a profile by entering simple details such as name, age, gender, location, and interesting topics that will help improve their news recommendations.

The screenshot shows a user profile page for 'lulu@gmail.com' from 'Split, Croatia'. At the top, there's a blue circular profile picture with 'LN' in it. Below the profile picture, the email address 'lulu@gmail.com' and location 'Split, Croatia' are displayed. To the right, there are statistics: 0 Reads, 0 Likes, 0 Dislikes, 0 Comments, and 0 Saves. The main content area is divided into sections: 'PERSONAL INFO' (Email address: lulu@gmail.com, First Name: lulu, Last Name: niuniu, Gender: Other, Date of Birth: 2017-02-04, City: Split, Country: Croatia), 'MY NEWS SOURCES' (Buzzfeed, BBC Sport, Fox News), and 'INTERESTS' (Activities). There's also an 'EDIT' button at the bottom of the profile section.

Figure 7 User profile page

### 3.1.3 News configuration

Users can configure the news sources and topics they want their news feed from, or mute the sources and topics that they are not interested in.

The screenshot shows a news feed with three news cards. The first card is titled 'Roglic wins to gain time on Carapaz' and features a photo of a cyclist. The second card is titled '28 Of The Funniest "Bachelorette" Tweets From Last Night's Bonkers Episode' and features a photo of a woman smiling. The third card is titled 'The Cast Of "Zoey 101" Reunited To Create A Music Video For The Theme Song, And 9-Year-Old Me Is Shaking' and features a photo of a person. Each card has a timestamp (e.g., '8 minutes ago'), a source ('BBC Sport', 'Buzzfeed'), and interaction buttons (like, dislike, comment, share, save).

Figure 8 News sources filters

### 3.1.4 User interactions

The newsfeed is presented in a grid layout containing several news cards whereby users can click on a card to read the full article. Every news card has components for interaction with users such as like, dislike, comment, share, and save. All the interactions of a user with the website help improve the recommended feed of the user. A link to the source website is also given along

with the article which opens the news article from the source website on a new browser tab.

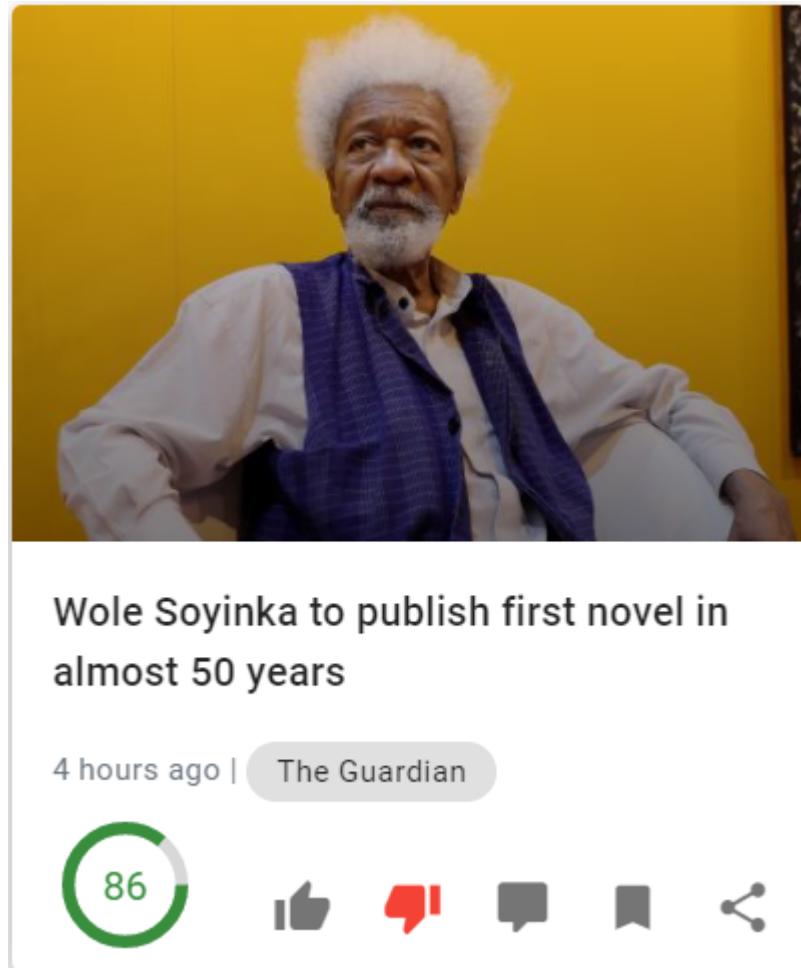


Figure 9 Single news card

### 3.1.5 User stats and activity

All user interactions are presented in a timeline visualization on the activity page and the cumulative statistics are displayed on the stats section on the profile page.

## 3.2 Technical components

### 3.2.1 Frontend (Vue.js)

This is the user interface presented to the user, i.e. IceyFauxNews website accessible through a web browser on a computer or mobile phone. The frontend is developed using a web framework Vue.js which provides a Model-View-Controller architecture for the frontend app, enabling easy to build and manage frontend applications. The framework is gaining popularity and community support evident in a 229 percent increase in adoption of Vue.js in the last year, as compared to a 34 percent increase for React.js which still tops the list in most used web frameworks. ("The Good and the Bad of Vue.Js Framework

Programming," n.d.) A few features which convinced us to choose this technology for the project are briefed.

### 3.2.1.1 Lightweight and performant

The Vue.js framework weighs featherweight with 18KB and has better performance in the rendering of the web page with the virtual DOM architecture. ("Interactive Results," n.d.)

### 3.2.1.2 Reactive two-way data binding

This is a connection between model data updates and view (UI). This helps easy track data updates and maintaining the state of UI along with the data (see Figure 10). This also facilitates much cleaner code and avoids the possibility of the formation of mesh-like flow in the code.

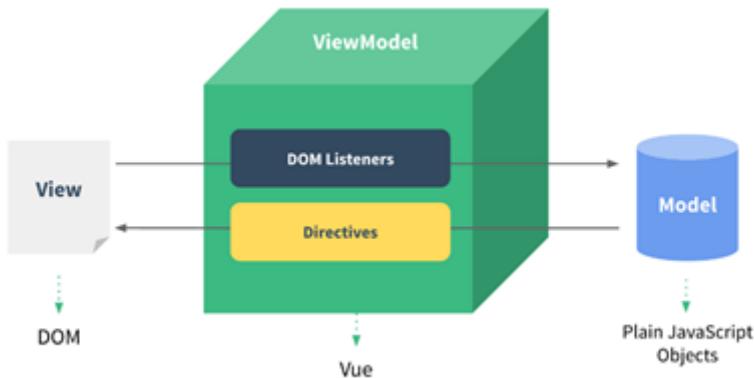


Figure 10 Two-way data binding ("Getting Started - Vue.Js," n.d.)

### 3.2.1.3 Components

Reusability is a primary software design principle. Vue.js facilitates to build single-file components that can be plugged into different sections of a website. Several community-built components can also be easily sourced from GitHub allowing faster development.

### 3.2.1.4 Ease of learning

As with other frameworks, Vue.js does not require in-depth knowledge of other libraries, JSX, TypeScript, etc. Just basic knowledge of HTML, CSS, and JavaScript is enough to get started on the development.

## 3.2.2 Backend

### 3.2.2.1 Website server (Node.js + Express.js)

This is the server responsible for handling requests from the frontend to get data regarding news, user, etc. This is also responsible for aggregating news from various APIs, reading and writing from the database, requesting the machine learning server for trust rating prediction of news and news recommendations for the user, and implementing the business logic for the IceyFauxNews system. The choice of Node.js is driven by the following reasons:

- Full-stack JavaScript – JavaScript on both frontend and server means increased development productivity due to knowledge, code, and tool sharing across the stack.
- Asynchronous event-based architecture – Asynchronous request handling architecture by Node.js gives a better response time enabling better responsiveness of real-time applications such as a Newsfeed website. PayPal, for example, noticed a 35 percent decrease in response time since migrating from Java. (Engineering, 2018)
- Community support – Increase adoption makes Node.js the obvious choice for all full-stack JavaScript solutions out there. This follows with a wide range of node modules available on the npm registry making backend development more robust and efficient. (“This Year in JavaScript,” n.d.)
- Express.js webserver – This allows for quick and easy setup of a rest API server for node.js. This provides a controller for the MVC architecture at the backend. Handling of different request and response formats such as JSON, form parameters, etc. is made extremely simple using Express.js. (“Companies Using Express,” n.d.)

### **3.2.2.2 ML-Server (Python)**

This is the server responsible for handling all machine learning prediction and recommendation requests. This also handles the request to get full text for a news article using news scraping library newspaper3k. Since this server only deals with running the machine learning code and communicates with the backend server, it is implemented using a simple threaded python webserver. Threading is required to ensure that it can handle concurrent requests without a decrease in performance. (“Http. Server — Http Servers — Python 3. 9. 0 Documentation,” n.d.)

- News recommendation system: the news recommendation system was built based on word embedding by using a pre-trained google news word2vec model. In the news recommendation system, all the information from IceyFauxNews was treated as sequences. For example, the articles can be treated as sequences, the users can be seen as a series of user behavior, including click history, like articles or dislike articles. Then we use the word2vec model to calculate the vector of each article and each user in IceyFauxNews. By calculating the cosine similarity of vectors, we can recommend similar users, similar articles to our users.
- Fake news detection: the fake news detection model is a style-based automatic fake news detection model. This model tries to detect the manipulators in the writing style of news articles. Tensorflow was used to build the LSTM model here. Tensorflow models can be easily deployed on the web. LSTM model is a variant of the RNN model and has high performance on learning long-short term dependencies. So we choose LSTM as our fake news detection part’s baseline model.

### **3.2.3 Database (MySQL)**

The news website involves lots of relational data such as likes, comments, saves, which are all tied to news articles and users. Envisioning of strongly relational data in the system was primarily responsible for the choice of our database. We

have calibrated the traditional MEAN stack (MongoDB, Express.js, Angular.js, Node.js) to our needs by using Vue.js in place of Angular.js (as discussed in section XX), and MongoDB with MySQL. A normalized relational schema saves a lot of redundancy from our system along with providing the stability and robustness of MySQL. (Schwartz, Zaitsev, & Tkachenko, 2012)

Sequelize (Object Relationship Mapper) is used to access the database. This node.js framework maps the database into objects providing model classes that can seamlessly integrate with the system. This also takes away the task of handwritten queries in the code and makes the code much cleaner and more readable. (Chima, 2019)

### 3.3 How it works?

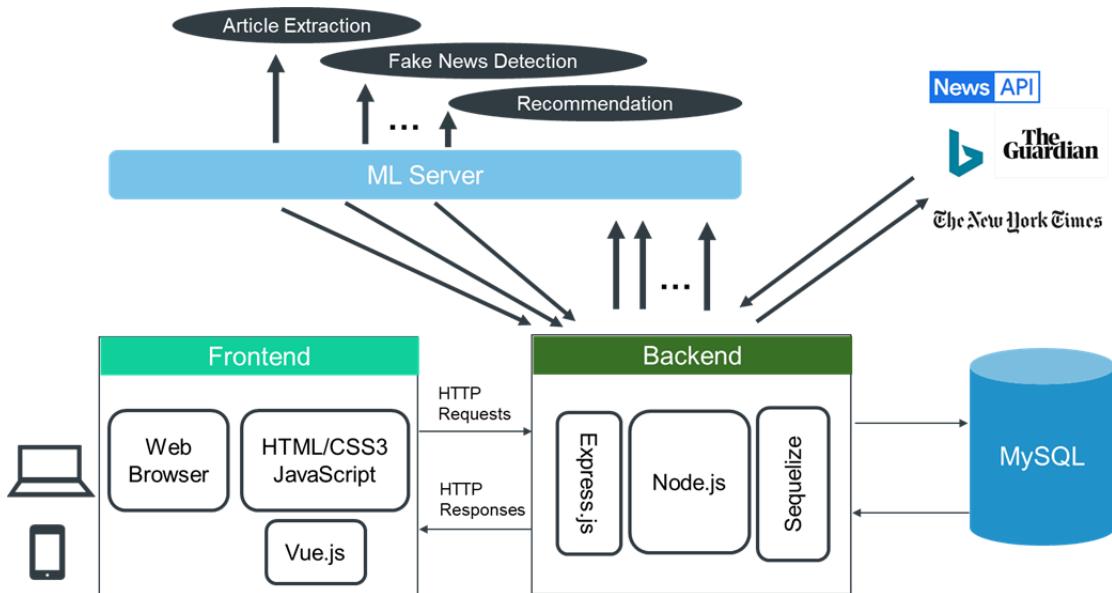


Figure 11 System architecture diagram

A user such as Ong interacts with the IceyFauxNews website, i.e. frontend (see Figure 11). Request for news feed goes to the Node.js backend server that initiates requests to multiple news APIs (Bing, NewsAPI, Contextual, Guardian, and NYTimes for now) in parallel and aggregates the results in a desirable format. After receiving the results, the backend server requests for the predictions of the news articles from the machine learning server. This news feed is returned to the frontend and presented on the website. Since the predictions for fake news tend to take in excess of 10 seconds, the prediction labels on the news cards are updated later after the page is already loaded to give a better responsive experience to the user.

The data science perspective of the recommendation engine is presented in Figure 12.

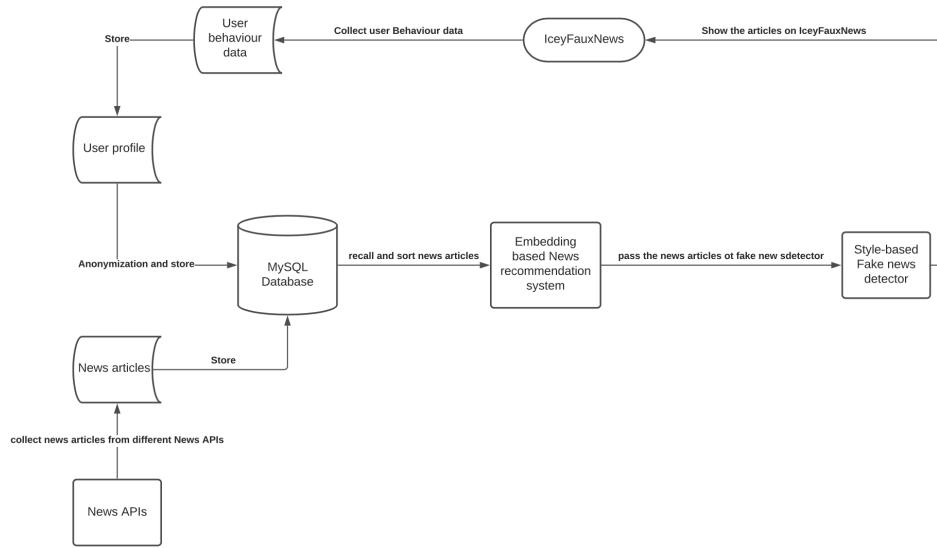


Figure 12 Data flow for recommendation engine

### 3.4 Data source

In IcyeFauxNews, we have three parts of data to collect and maintain. Firstly, we need to get real-time news articles from other news websites, such as Bing, NewsAPI, contextual web search, Guardian, and the New York Times. Secondly, we collect several fake news datasets from the Kaggle and some journals. Finally, we found a benchmark dataset called Microsoft News Dataset(MIND), which is a large-scale dataset for news recommendation systems.

We get the basic information of the news article through APIs available. Also, we make use of the Python library newspaper3k to scrape the full text of the article from the URL.

The data source for training fake news detector:

Data source's description	The URL of the dataset
<b>Fake news dataset run by UTK Machine Learning Club</b>	<a href="https://www.kaggle.com/c/fake-news/data">https://www.kaggle.com/c/fake-news/data</a>
<b>Fake news from webhose.io API</b>	<a href="https://www.kaggle.com/mrisdal/fake-news">https://www.kaggle.com/mrisdal/fake-news</a>
<b>Paper data set from UCSB</b>	<a href="https://www.cs.ucsb.edu/~william/data/liar_dataset.zip">https://www.cs.ucsb.edu/~william/data/liar_dataset.zip</a>
<b>fake real news from PolitiFact and GossipCop</b>	<a href="https://github.com/KaiDMML/FakeNewsNet">https://github.com/KaiDMML/FakeNewsNet</a>

The data source for building a news recommendation system:

The name of the data source	The URL of the dataset
<b>Microsoft News Dataset</b>	<a href="https://msnews.github.io/">https://msnews.github.io/</a>

### 3.5 Data collection

In this part, we mainly introduce the methods when we collect real-time news articles. For the other two datasets(fake news detector and news recommendation system), we only did two things, find datasets and downloaded

them. Besides, we also combined and cleaned the datasets by using python scripts.

There are two parts for collecting news articles, one is collect URLs and basic information of news articles, the other is collect the text of news articles. In the first part, the javascript was used to collect real-time news information including images, descriptions, news titles, and URLs except for the text of news articles. Because the APIs of news websites do not provide this function. After that, a python script using the Newspaper3k library was used to collect real-time news articles.

### **3.6 Data storage**

This part will be divided into three parts respectively the storage of news articles, storage of fake news datasets, the storage of news recommendation system datasets.

#### **3.6.1 Storage of news articles**

We store the news article data in a MySQL database. The news article data includes news titles, news descriptions, news text, date of news, images, publishers, etc.

#### **3.6.2 Storage of fake news dataset**

We store the fake news dataset in Google drive rather than in the MySQL database. Because IceyFauxNews will directly use the fake news detector(trained deep learning model based on Tensorflow) to classify the authenticity of news articles. The fake news dataset was stored in Google drive is convenient for team members to access.

#### **3.6.3 Storage of news recommendation system datasets**

For building an effective news recommendation system for IceyFauxNews, a user profile is necessary. The user behavior and user basic information will be collected and stored in the MySQL database to build a user profile. The user behavior should include user's click histories, like or dislike news articles, the login time, etc. The basic information should be collected when the user creates a profile on the IceyFauxNews website. All the user individual data will be anonymized before being stored in the MySQL database.

## **4. Evaluation: The Reviews**

### **4.1 CRISP-DM**

Following the Cross-Industry Standard Process for Data Mining(CRISP-DM) to develop models, we planned the evaluation methods as follows.

#### **4.1.1 Business understanding**

The objectives of IceyFauxNews is to provide users with the news they are interested in and help them identify true and false news.

#### **4.1.2. Data understanding**

As GDPR mentioned, there are six principles of data protection guiding how information should be collected and maintained, which is shown in appendix 1.

#### **4.1.3. Data preparation**

After collecting data legally and correctly, we need to prepare the data as input, so what we will do to evaluate the data quality :

As the global data management community(DAMA) come up with 8 dimensions (appendix 2) to evaluate the data quality, we will take actions in these ways:

Inspect the extreme values in the dataset to test the data if it corresponds to reality.

1. Inspect the missing values in the dataset to test data integrity
2. Compare with the same type dataset from other sources in a timeline to check if data is recent.
3. Inspect the repeat values in the dataset to test uniqueness.
4. List the features in the dataset and compare it with the list of features we need, to test reasonability.
5. Compare different parts in the dataset to test the data consistency

#### **4.1.4 Fake news model evaluation**

We evaluate the model performance with the help of the confusion matrix(appendix 3), including four terms accuracy, recall, f1 score, and precision.

To evaluate the models, we will train three different models including CNN, RNN, and LSTM model, and compare three models from the above parameters. To get the best performance model to identify true and false news, we choose accuracy as the primary evaluate parameter on the premise that the dataset is balanced. And other parameters will be used to fix and improve the model.

For the success criteria of a fake news model in the training step, we set the accuracy of the test is over 90%.

#### **4.1.5 News recommendation model evaluation:**

To evaluate the news recommendation model, we use Area Under the ROC Curve (AUC) as an evaluation criterion. ROC is a receiver operating characteristic curve, which shows the performance of a classification model at all classification thresholds with two parameters TPR and FPR.

AUC is generally used in the evaluation of the classification problems, we use AUC to evaluate the model's ability in identifying users like and unlike.

$$TPR = \frac{TP}{TP + FN} \qquad FPR = \frac{FP}{FP + TN}$$

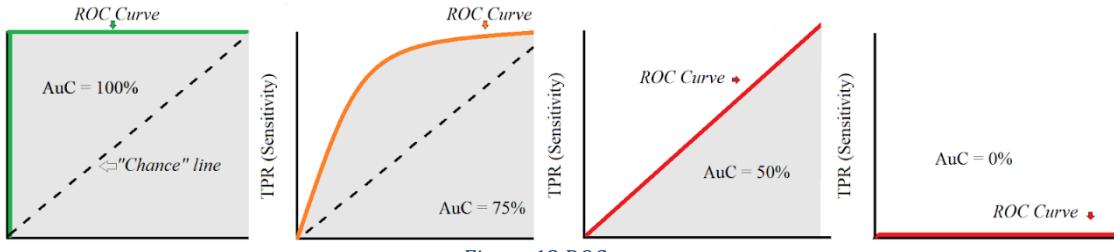


Figure 13 ROC curve

For the success criteria of the news recommendation model in the training step, we set the accuracy of the test is over 60% by referring to Wu's paper in 2020.

#### 4.1.6 Evaluation with real-world data

##### 4.1.6.1 Fake news evaluation

Wang et al(2018) proposed a deep learning-based fake news detection model called EANN (Event Adversarial Neural Networks). The final accuracy of this model on the English news dataset is 71.5%(Wang et al, 2018). Thus, an accuracy that is above 70% on real-time news is considered a success in our fake news detection model as the factors in the real world will be much more complex and besides that, there is no good benchmark dataset available in the fake news detection area at the moment.

##### 4.1.6.2 Recommendation system evaluation

For the goal that recommends news that users are interested in, we evaluate from two angles, which are including scene transformation and content satisfaction.

For scene transformation, we take Unique Visitors Click Rate (UV Click Rate), which measures the attraction of news for different users. For example, the news website recommended news to 100 users and 78 users clicked the recommended news, so the UV Click Rate is 78%.

$$\text{UV Click Rate} = \frac{\text{Clicked User Number}}{\text{Total Recommended User Number}}$$

For content satisfaction, we will count the read time and like number to measure. For example, one user clicks an article which may read in 5mins, while the user only stays at that page in 10 seconds which is much shorter than the average, we can say the user is not interested in this article. What's more, to reduce some errors in user behavior like opening news pages without reading, we will calculate the thumb up rate to support measures.

$$\text{Thumb Up Rate} = \frac{\text{Thumb up Number}}{\text{Total Read Article Number}}$$

For these two angles, the scene transformation measures the ability that the website attracts new users, and the content satisfaction measures the ability that the website retains the users.

The success criteria for news recommendations in real use is that the unique click rate can be achieved to 1.5% by referring to data from the rainy factory website.

## 4.2 Testability

Testability evaluates how easy it is for developers to test the software when a modification is made (Hassan et al.). IceyFauxNew is implementing test-driven development using a JavaScript testing framework Jest.

We have defined a minimum line coverage of testing to be 80%. Up to now, out of 20 existing files, 16 files have over 90% coverage (figure.1). Although the rest 4 files fail to meet our minimum coverage, 3 of them is out of the scope of software development testing (e.g. files to extract news articles). The detailed success measurement of Testability can be found in Appendix 5.

File	% Stats	% Branch	% Funcs	% Lines	Uncovered Line #s
All files	74.33	67.48	75.96	79.46	
server	85.87	54.55	75	86.81	
app.js	95.35	100	100	95.35	19-20
db.config.js	100	100	100	100	
news.config.js	77.08	54.55	73.91	78.72	37,53-66,129
server/config	100	100	100	100	
auth.config.js	100	100	100	100	
server/controllers	70.31	75.93	81.48	70.68	
News.js	41.18	100	62.5	41.18	10-16,28-29,40-60
User.js	76.58	75.93	89.47	77.07	...1-222,234-238,270,285-289,311,347,362-366,390,405-409,426,442-446,462,488,502
server/middleware	100	100	100	100	
authJWT.js	100	100	100	100	
index.js	100	100	100	100	
server/models	100	100	100	100	
Article.js	100	100	100	100	
Comment.js	100	100	100	100	
Like.js	100	100	100	100	
NewsSource.js	100	100	100	100	
User.js	100	100	100	100	
index.js	100	100	100	100	
server/service	58.33	47.62	61.9	60.2	
ArticleExtractor.js	90.91	100	100	90	25-26
FakeNewsDetector.js	90.91	87.5	100	90	8
News.js	44	30	46.67	47.06	18-20,37,41-46,54,94-102,108-141

```

Test Suites: 4 passed, 4 total
Tests:    71 passed, 71 total
Snapshots: 0 total
Time:    20.582 s
Ran all test suites.

```

Figure 14 Code coverage

## 4.3 Changeability

Changeability measures how easy it is for developers to fix an issue and change or add new functionality.

The frontend framework Vue.js separates small blocks of UI into components that enable us to change, add, and reuse a function almost independently (Omer, Jha, & Kumar Khatri, 2019). Our backend structure separates business logic and data model from the request handler. See Appendix 5 for details of success measurement.

## 4.4 Usability

### 4.4.1 News Visualization Evaluation

News visualization refers to the home page of IceyFauxNews. A key to evaluation here is to make sure the news article trust rate is clearly presented and the user understands its meaning. A survey using the A/B testing method (Gallo, 2017) is conducted for this (see Appendix 4). Users get either the test version or the control version of the survey.

The first finding from the survey is that a ring with a rating is better than a bar with a different length because more users believe the ring indicates trustfulness. The second finding is that showing the fake level in a range of 0 to 1 is a bad idea as the user gets confused about what “100” means (Figure 15 & Figure 16).

More criteria measured can be found in Appendix 5.

What do you think the red ring tells about the news article?

11 responses

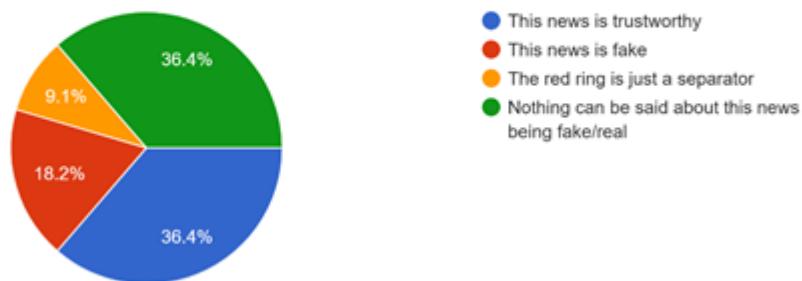


Figure 15 Ring test version

What do you think the red bar tells about the news article?

10 responses

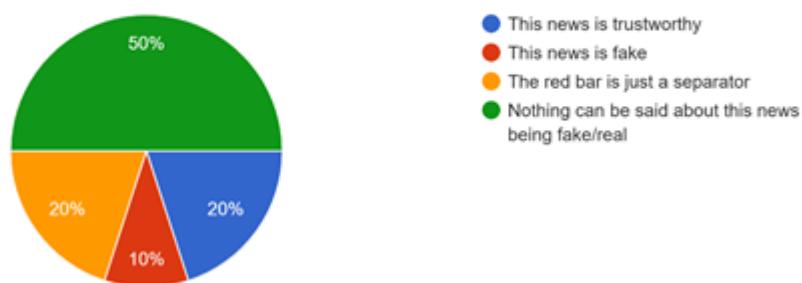


Figure 16 Bar control version

### 4.4.2 News Configuration Evaluation

News configuration refers to the filter of news articles by news sources and topics. We have planned a list of tasks for user observation which will conduct on

5 users (Nielsen Norman Group, 2020; "Performing Usability Studies," n.d.). See Appendix 5 for the task list.

#### 4.4.3 User Interaction Evaluation

User interaction refers to the like, dislike, comment, share, and save of news articles. We plan to build several prototypes of the interaction function. In each prototype, we take users' feedback and integrate users' requirements into the next prototype for further feedback. Some criteria have been identified (see Appendix 5) and more criteria will be added with the building of new prototypes.

### 5. Conclusion: The Plan

#### 5.1 Project Management Strategy

We are using SCRUM methodology for project management (Rising & Janoff, 2000). ZenHub helps us to better implement this method. We have initially created Epics and added some Issues under the corresponding Epic. Estimated points are added to Epics and Issues. The number of issues under Epics gradually increase as the development process moves forward. Our weekly workflow is described as follow:

- 1) Thursday: Sprint Planning
  - a. Create a Milestone for the next week.
  - b. Identify and add new Epics or issues. Each Issue must belong to an Epic, have a Milestone, be assigned to one or several team members, and have estimated points.
  - c. Move some tasks from Backlog to Sprint Backlog.
  - d. Ensure everyone has enough work for the week, measuring by points owned by everyone.
- 2) Friday, Monday, and Tuesday: Daily 1 hour Stand-up
  - e. Everyone talks about what they did yesterday and any problem that he is stuck on.
  - f. The scrum master helps to keep everyone up-to-date.
  - g. Ask each other questions to keep themselves on track.
  - h. Discuss solutions to the problem the team is currently facing (if any).
- 3) Wednesday: Team meeting and Sprint Retrospective
  - i. Sit together (might be remote depending on the level of restrictions) and share what made them Glad, Mad and Sad during the past week.
  - j. Compile Sprint Retrospective and push to GitHub repository.
  - k. Everyone shares a screen and shows any big progress on his part.
  - l. Solve big challenges that need collaboration (if any).
  - m. Make sure all the issues in progress are finished and no issue is in Sprint Backlog.

Figure 17 shows the Cumulative flow on GitHub.

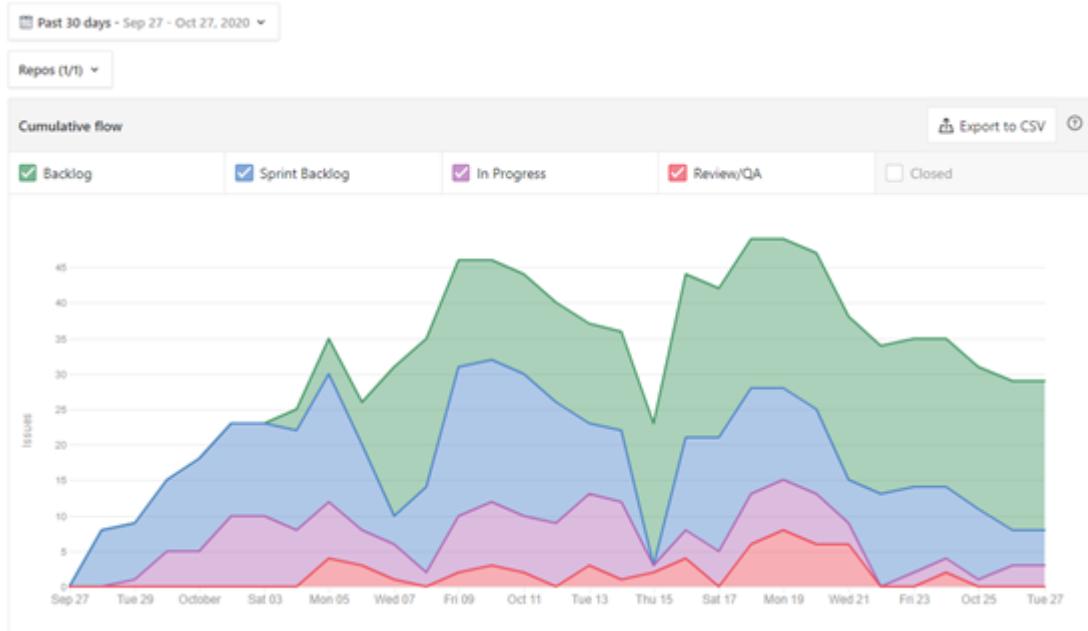


Figure 17 Cumulative flow

## 5.2 Challenges

### 5.2.1 Fake News Detector's Application to Real-world Data

One of the biggest challenges we are facing is the application of the Fake News Detection Model. Our model using LSTM (Long Short-Term Memory) achieved 0.9397 accuracy on the new test data set that has not seen the model. However, when it comes to applying the model to real-world news articles, the prediction is not desirable. For example, we have obtained real-time news from the BBC and some regular websites, and the default is all real news. However, the accuracy of the result predicted by the LSTM model is maintained at about 50%.

To solve this problem, we have tried to use other common deep learning models to train a fake news detector, such as using simple RNN(recurrent neural network) and one-dimensional mode CNN(convolution neural network). We also tried to use titles of news articles rather than the text of news articles to train our models. But none of these changes have brought a significant improvement to our model. In the remaining time, we will try to rebuild the dataset and retrain our fake news detection model. We are also planning to use the hybrid model, which combines RNN and CNN.

### 5.2.2 Website Performance

Another biggest challenge we are facing is the long time spent on getting many news article trust rates. Currently, we extract several news articles through news APIs using a Python script and then give the extracted news articles to the Fake News Detector running on a Python web server. Given 50 articles, the extraction takes around 10 seconds and the predication takes 2 seconds. Therefore, users will see news articles first and the ring with the trust rate comes with a 12-second delay. Any refresh or filter on news articles will cause the whole time-consuming process to run again.

We have figured out a possible solution by storing the trust rates in the database. In this case, any recent refresh and filter will show the trust rate ring in time.

### 5.3 Timeline

We have identified epics for the next 7-8 weeks to ensure we can effectively use the remaining time to achieve a successful outcome. As shown in Figure 18, on average, we finish 50 story points per week per Milestone. 293 story points are remaining (Figure 19). We should be able to finish them in the next 7 weeks and we have given ourselves some buffer for risk management.



Figure 18 Velocity chart

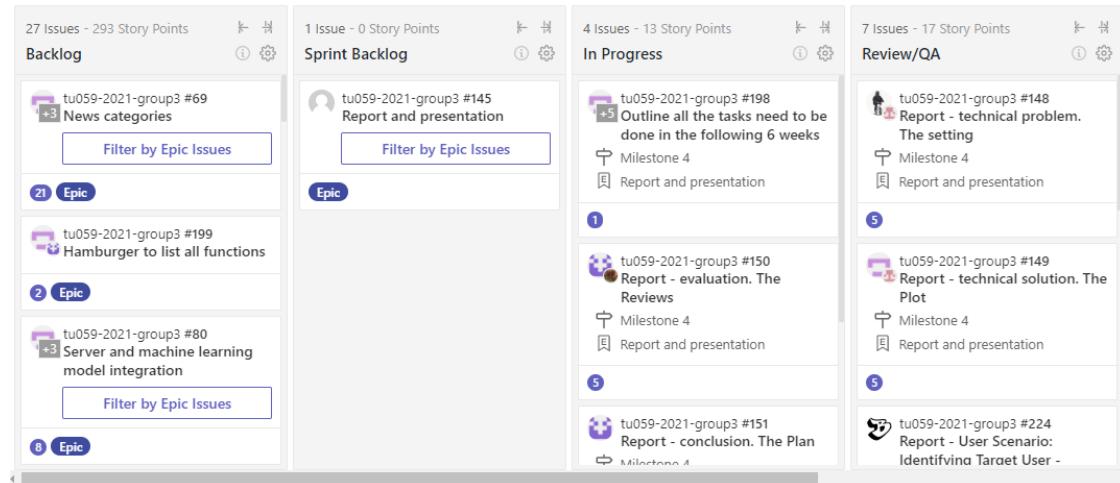


Figure 19 Zenhub board

The following Gant chart (Figure 20) shows the timeline for the remaining weeks. In the first four remaining weeks, we focus on the enhancement of Fake News Detector and the implementation of User Interaction, News Configuration functions, and the building of a Deep Learning-based Recommendation System. This enables us to deliver the User Evaluation on time.

In the last three weeks, our focus is on the integration of Recommend Engine with the website, the Enhancement of UI, Deployment, and evaluations. Some small development tasks will also be implemented in the early stage of these three weeks. This enables us to focus on the Final Report and Demo in the last week.

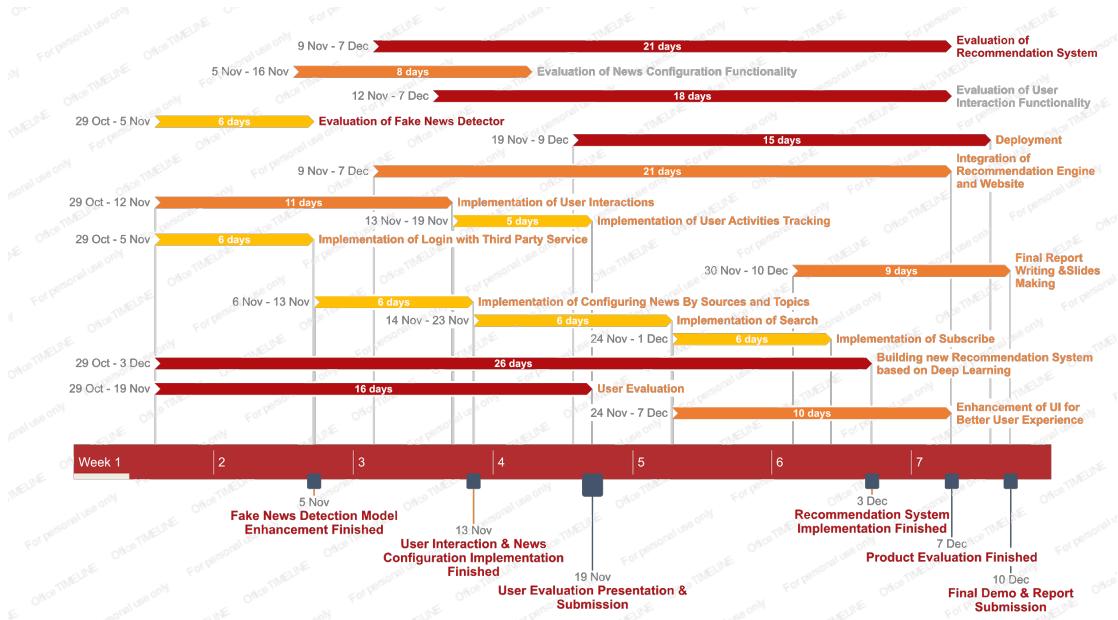


Figure 20 Gantt chart

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## 7. Appendix

### Appendix 1: GDPR six principles

1. Information must be gathered legally and transparently
2. It must be gathered for specific reasons
3. No more can be gathered than what is necessary to the legal goals of the enterprise
4. The information has to be accurate
5. The information must be held for a limited time
6. Information must be processed in a way that ensures security

## Appendix 2: DAMA 8 dimensions in data quality

1. Accuracy: check if the data correctly represent 'real-life' entities, including inspecting the extreme value in the dataset.
2. Completeness: check if all required data is present.
3. Consistency: check if data values are consistently represented within a data set and between data sets, and consistently associated across data sets.
4. Data Integrity: check if her referential integrity (consistency between data objects via a reference key contained in both objects) or internal consistency within a data set such that there are no holes or missing parts.
5. Reasonability: cheek if the data pattern meets expectations.
6. Timeliness: check if the data values are up-to-date versions of the information.
7. Uniqueness: check if there is no entity existing more than once within the data set.
8. Validity: check if the data values are consistent with a defined domain of values.

## Appendix 3: Confusion Matrix

TP : The cases in which we predicted True and the actual output was also True.

TN : The cases in which we predicted Fake and the actual output was Fake.

FP : The cases in which we predicted True and the actual output was Fake.

FN : The cases in which we predicted Fake and the actual output was True.

1. Accuracy: the most common metric to evaluate a model, state the percentage that the correct predicted numbers out of all the predicted

$$\frac{TP + TN}{TP + FP + TN + FN}$$

numbers

2. Precision: state the percentage of positive instances out of total predicted positive instances

$$\frac{TP}{TP + FP}$$

3. Recall: state the percentage of positive instance out of the total actual positive instances

$$\frac{TP}{TP + FN}$$

4. F1 score: represent the harmonic mean of precision and recall

$$\frac{2}{\frac{1}{precision} + \frac{1}{recall}} = \frac{2 * precision * recall}{precision + recall}$$

## Appendix 4: Trust rate UI survey

Ring (test version):

What do you think the red ring tells about the news article? \*



### U.S. to Accuse Google of Protecting Illegal Monopoly

A victory for the government could remake one of America's most recognizable companies and the internet economy that it has helped define.

an hour ago | The New York Times

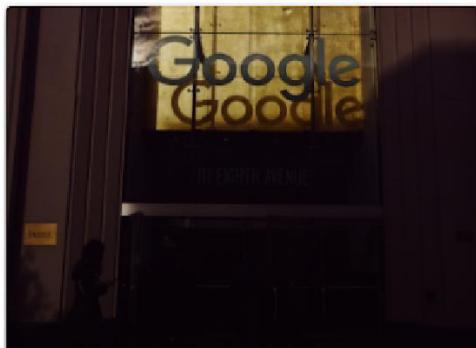
100



- This news is trustworthy
- This news is fake
- The red ring is just a separator
- Nothing can be said about this news being fake/real

Bar (control version):

What do you think the red bar tells about the news article? \*



### U.S. to Accuse Google of Protecting Illegal Monopoly

A victory for the government could remake one of America's most recognizable companies and the internet economy that it has helped define.

an hour ago | The New York Times



- This news is trustworthy
- This news is fake
- The red bar is just a separator
- Nothing can be said about this news being fake/real

## Appendix 5: IcyeFauxNews Website Evaluation Checklist

### Testability

Criteria	Yes/No, supporting comments if warranted
Project has unit tests.	Yes.
Test coverage can be checked automatically.	Yes. Jest gives a coverage when using the command "npm test -- --coverage".
A minimum test coverage level has been defined.	Yes. Our test's line coverage should be above 80%.
Tests are automatically run whenever the source code changes.	No. Tests are run by command "npm test".
Test results are visible to all developers.	Yes.
Test creates their own databases.	Yes.

## Changeability

Criteria	Yes/No, supporting comments if warranted
Anyone in the team can contribute to the development.	Yes. Everyone in our team has access to the GitHub repository.
Project has defined a contribution policy.	Yes. Everyone makes changes in their own branches and create pull requests when an issue or some issues are finished. Change is only merged to <i>master</i> branch when all reviewers approved.
Frontend code is structured in an easily changeable manner.	Yes. We separate small block of UI into Vue.js components so that change to a function will be very likely happen in a single file and adding a new function will be adding in new files without big modification to existing UI.
Backend code is structured in an easily changeable manner.	Yes. We structured backend into <i>Controller, Service, Model</i> and <i>Middleware</i> . <i>Controller</i> deals with the request. <i>Service</i> implements business logic. <i>Model</i> reflects data. And <i>Middleware</i> provides common capabilities to APIs.

## Usability

### Understandability

Criteria	Yes/No, supporting comments if warranted
Description of who the software is for is available.	Yes. Available in User Scenario section of this report.
Description of what the software does is available.	Yes. Available in Technical Solution section of this report.
Description of how the software works is available.	Yes. Available in Technical Solution section of this report.
Explanation of why the system is designed in such a way is available.	Yes. Available in Technical Solution section of this report.
Architecture overview of the system is available.	Yes. Available in Technical Solution section of this report.
Description of use cases is available.	Yes. Available in User Scenario section of this report.

### News Visualization Evaluation

<b>Criteria</b>	<b>Yes/No, supporting comments if warranted</b>
What is the language of the website? Does it have English?	Yes. The website is available in English only.
The grammar, punctuation and spelling of news articles are correct.	Mostly yes. The news articles derived from several APIs that we are using. In most cases they are correct.
The trust rate of news articles is clearly presented.	Yes. A survey is conducted through A/B Testing to decide which trust rate UI works better.
The trust rate of news articles is understandable by users.	Yes. A survey is conducted through A/B Testing to decide which trust rate UI is more understandable.
The layout of the news articles page is consistent and fluent.	Yes.

### News Configuration Evaluation

<b>Criteria</b>	<b>Yes/No, supporting comments if warranted</b>
User can easily filter news by one news source.	To do
User is able to filter news by multiple sources.	To do
User is able to mute/unmute sources.	To do
User is able to go back to home page after filtering.	To do
User can easily filter news by one topic.	To do
User is able to filter news by multiple topics.	To do
User is able to mute/unmute topics.	To do
User is able to filter news by sources and topics at the same time.	To do
User can search on news sources and topics.	To do

### User Interaction Evaluation

<b>Criteria</b>	<b>Yes/No, supporting comments if warranted</b>
User is aware when he clicks on the like button.	To do
User is aware when he clicks on the dislike button.	To do
User is aware when he clicks on the save button.	To do
"Easy share" is available for popular social media platforms.	To do
Copy share link is easy and fast.	To do

User can access all the news article comments.	To do
User is aware when his comments get new replies.	To do