**TRƯỜNG ĐẠI HỌC BÁCH KHOA HÀ NỘI**

**TRƯỜNG CÔNG NGHỆ THÔNG TIN VÀ TRUYỀN THÔNG**

**------------\*------------**

****

**CAPSTONE PROJECT REPORT**

**SUBJECT:**

**Housing price prediction**

|  |  |
| --- | --- |
| **Giáo viên hướng dẫn:** | Trần Việt Trung |
| **Sinh viên thực hiện:** | Hoàng Thanh Lâm  Phạm Thành Biên  Phạm Hải Đăng  Lê Đức Huy  Hoàng Quang Mạnh |

**TABLE OF CONTENTS**

[**I.**](#_heading=h.30j0zll) **Problem Statement** 2

[**II.**](#_heading=h.1fob9te) **Data Science methodology** 3

[**1.**](#_heading=h.3znysh7) **Data Crawling** 3

[**2.**](#_heading=h.2et92p0) **Data Preprocessing** 5

[**3.**](#_heading=h.tyjcwt) **Data Visualization** 6

[**4.**](#_heading=h.3dy6vkm) **Model Training** 15

[**III.**](#_heading=h.1t3h5sf) **Result** 18

[**1.**](#_heading=h.4d34og8) **Final Result** 18

[**2.**](#_heading=h.2s8eyo1) **Difficulties:** 20

[**3.**](#_heading=h.17dp8vu) **Future Improvement** 20

[**IV.Conclusions** 21](#_heading=h.lnxbz9)

[**IV.**](#_heading=h.35nkun2) **Reference 22**

**Foreword**

In the dynamic realm of data science, where algorithms and analytics converge to uncover patterns and insights, the topic of housing price prediction stands as a testament to the transformative power of data-driven decision-making. As we navigate an era increasingly defined by technology, the ability to forecast housing prices has become a pivotal aspect of real estate, economics, and urban planning.

The Housing Price Prediction in Data Science subject represents an exciting exploration into the intersection of advanced statistical modeling, machine learning, and domain expertise. In this era of big data, where information flows in torrents, the ability to distill meaningful predictions from the data deluge has become paramount. Predicting housing prices extends beyond the confines of academic curiosity—it has tangible implications for homeowners, investors, policymakers, and the broader community.

This subject delves into a multifaceted landscape, addressing challenges that range from feature engineering and model selection to ethical considerations in algorithmic decision-making. Through hands-on exploration and theoretical understanding, students embarking on this journey will develop a keen sense of how to navigate the complexities inherent in housing market dynamics.

|  |
| --- |
| Our Team |
| Hoàng Thanh Lâm  Lê Đức Huy  Phạm Hải Đăng  Phạm Thành Biên  Hoàng Quang Mạnh |

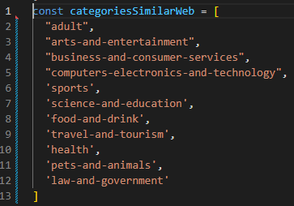
# **Problem Statement**

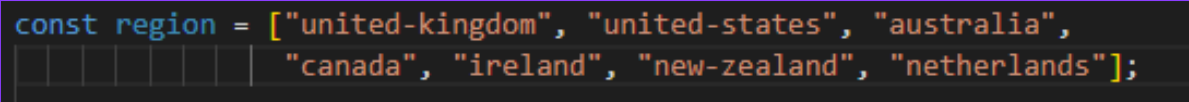
• People looking to buy a new home tend to be more conservative with their budgets and market strategies.  
• This project aims to analyse various parameters like average income, average area etc. and predict the house price accordingly.  
• This application will help customers to invest in an estate without approaching an agent  
• To provide a better and fast way of performing operations.  
• To provide proper house price to the customers.  
• To eliminate need of real estate agent to gain information regarding house prices.  
• To provide best price to user without getting cheated.  
• To enable user to search home as per the budget.  
• The aim is to predict the efficient house pricing for real estate customers with respect to their budgets and priorities. By analyzing previous market trends and price ranges, and also upcoming developments future prices will be predicted.  
• House prices increase every year, so there is a need for a system to predict house prices in the future.  
• House price prediction can help the developer determine the selling price of a  
house and can help the customer to arrange the right time to purchase a house.  
• We use linear regression algorithm in machine learning for predicting the house price trends.

# **Data Science methodology**

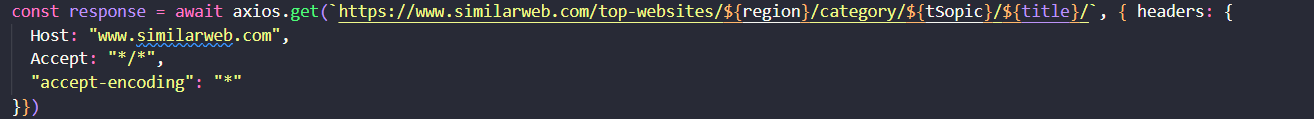
## **Data Crawling**

Our team will first use https://www.similarweb.com to compile a list of comparable websites under 11 broad categories: arts and entertainment, business and consumer services, computers electronics and technology, food and drink, health, science and education, sports, adult, travel and tourism, pets and animals, law, and government. For each issue, an average of 50–60 websites are collected, and if the information is unsatisfactory, up to 100 websites. There are just 11 websites with an adult-specific topic.



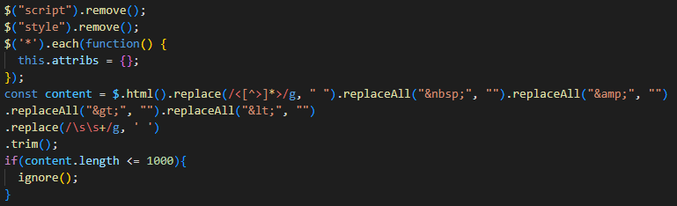
We only select websites from nations where English is widely spoken:

We crawl from websites in 3 nations using the **axios** (a library dedicated to fetching the Javascript API) tool and run a for loop across each website in each topic:



Our team removes irrelevant html, css, and js elements from data using the cheerio tool:





However, because there is a lot of crawl data from faulty websites, we have to take an extra step to filter websites that contain invalid data. Manually each member filter 2 topics, remove websites that contain non-English characters or cannot be read.

Finally, my team exported the processed data to a JSON file and then convert it to an Excel file for further processing in Python.

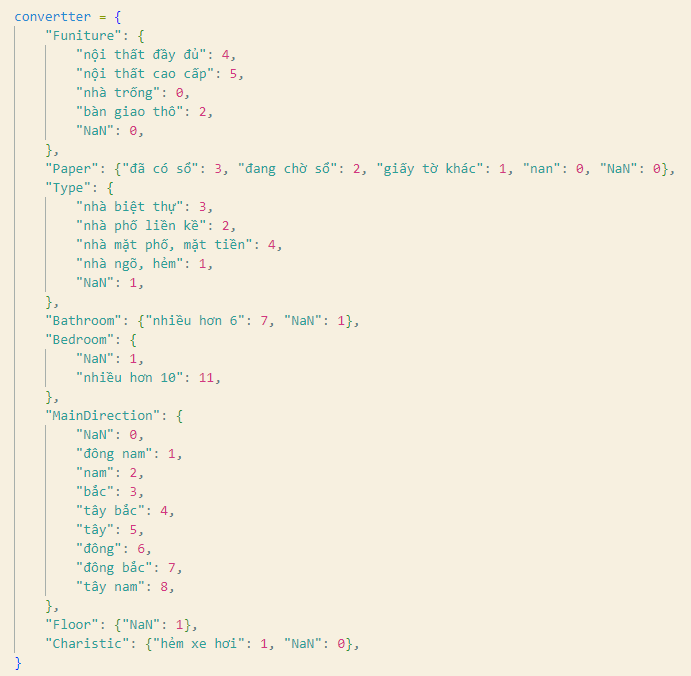
Ảnh có chứa văn bản

Mô tả được tạo tự động

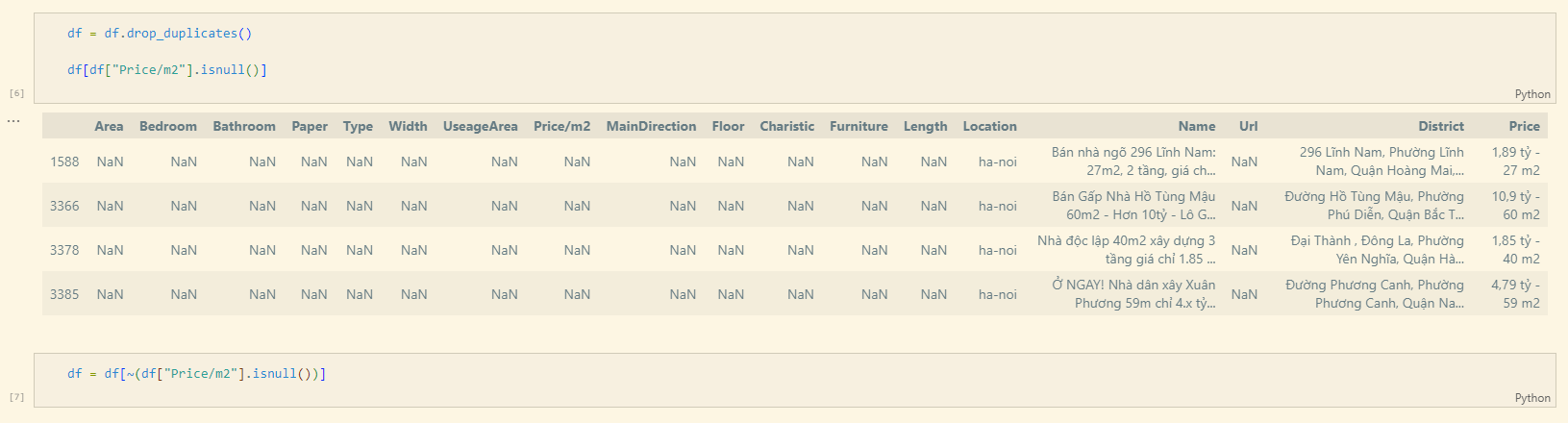
## **Data Preprocessing**

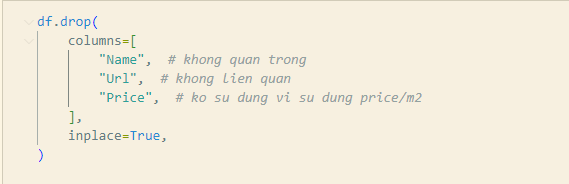
After the completion of the data crawling stage, the team proceeds to preprocess the data using the following steps [2]:

\*Data normalization:

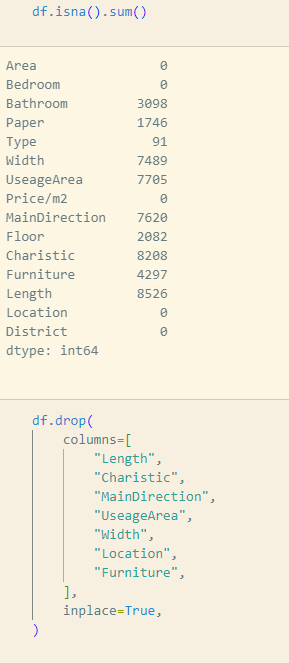


\*Remove all duplicate , and null variable at “Price/m2”:

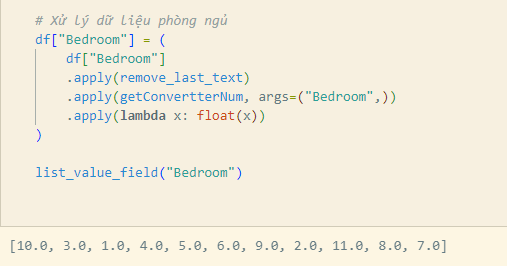


\*Remove some field are not important, irrelevant:  


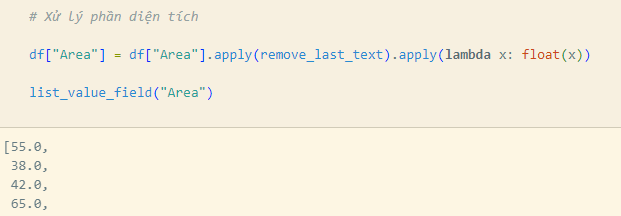
\*Remove columns have too much null, lost information:

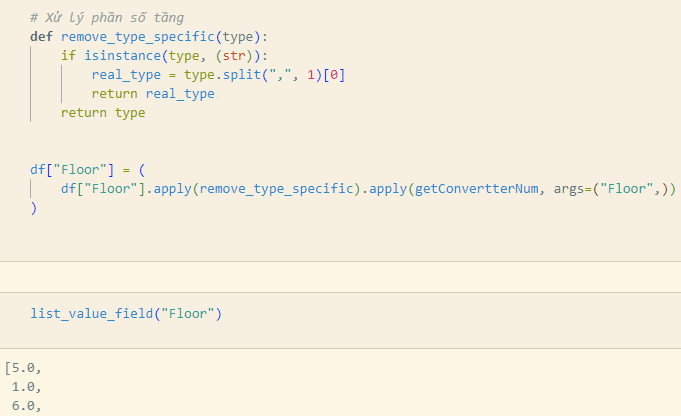


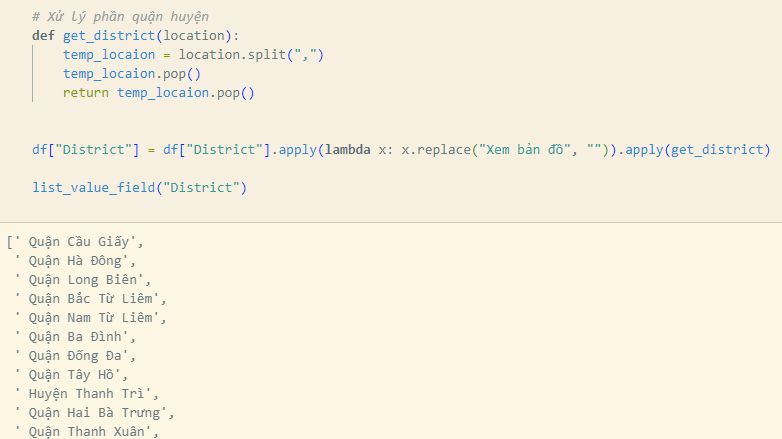
\*Process data : convert to number:











We also consider that area’s value range is small so we use math.logs to increase range that help to undertand better



## **Data Visualization**

Our team visualizes the data after it has been cleaned and normalized in order to provide a first assessment of the obtained data set.

* 1. **The histogram shows the number and percentage of valid websites crawled by topic**

1. The bar chart illustrates the amount of crawled websites

Chart, bar chart

Description automatically generated

1. The pie chart representing the percentage of the number of websites in each topic

A picture containing electronics, compact disk

Description automatically generated

* 1. **The WordCloud displays the most frequently used words by subject on websites**

*The text occurs in that topic more often when its icon is bigger.*

*Example:*

1. Sports



1. Science and Education



1. Pets and Animals

Text

Description automatically generated with low confidence

1. Travel and Tourism

Text

Description automatically generated

**3.3 The bar chart that displays top 10 most frequently used words by subject on websites:**

*Example:*

1. Sport

Chart, bar chart

Description automatically generated

1. Science and education

Chart, bar chart

Description automatically generated

c)Pet and animals

Chart, bar chart

Description automatically generated

d)Travel and tourism

Chart, bar chart, histogram

Description automatically generated

**3.4 .Vectorization for feature extraction:**

Vectorization is one of the most useful approach for converting raw data input into vectors of real number that make machine learning code become more efficient.

CountVectorizer() from sklearn library is one of the helpful feature that help us keep dictionary of every word and also the frequency of each word in each document .However, there is a problem : as can be seen from the TOP 10 WORD’s bar chart ,the word “new” appears in most of categories and it is not really a special word that support us classify categories.TF-IDF helps us to resolve that issue by decreasing the important of the word “new”

**3.4.1 .TF-IDF Overview[3]:**

**a.TF**

TF stands for Term Frequency. It estimates the frequency of a word in an document. The formula of TF is:

**b.IDF**

IDF stands for Inverse Document Frequency .It estimates the importance of a word amongst the documents. The formula of IDF is :

Obviously, by taking IDF , we can downscale the frequent words while making the infrequent words have higher impact

The final formula to caculate TF-IDF score:

**3.4.2 .Apply TfIdfVectorizer:**



We use TfidVectorizer to vectorize our clean text.There are some parameters we use:

- min\_df=0.01 means we ignore all the word that only appear less than 1% of all documents

-max\_df=0.85 means we ignore all the word that appear more than 85% of all documents

-max\_features=1500 means we only extract maximun 1500 features

-ngram\_range=(1,3) means we also consider a sequence of 2 words ,3 words

After apply and extract top importance word, we can see the word “new” not appear in top 10 importance words of pets-and-animals or travel-and-tourism

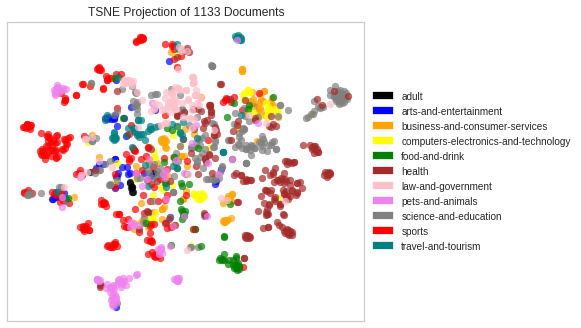
Ảnh có chứa bàn

Mô tả được tạo tự động Ảnh có chứa bàn

Mô tả được tạo tự động Ảnh có chứa bàn

Mô tả được tạo tự động

**3.4.3: t-SNE Visualization**



## **Model Training**

**4.1:Overview about Naïve Bayes Classifier[4]**

**4.1.1 MAP hypothesis:**

Given the set H of possible hypotheses, the learner find the most probable hypothesis h H given the observed data D

Such a maximally probable hypothesis is called a maximum a posteriori (MAP) hypothesis:

By Bayes theorem the above expression can convert to:

Since P(D) is the same for all classes, we can have the final formula:

**4.1.2 Naïve Bayes classifier**

Given a training set D, where each training instance x represented as an n-dimensional attribute vector : (x1,x2,…xn).A pre-defined set of classes {c1,c2,…,cm}.Given a new instance z,where should we classify z into:

From MAP hypothesis, we have:

Apply Bayes theorem :

Since is the same for all classes, the most probable class for z is identified by:

Apply conditional probability rule:

Apply Chain rule, can decompose to:

However, the above formula is not easy to compute In this case, we use assumption in Naïve Bayes classifier: the attributes are conditionally independent given classification

Finally, we have Naïve Bayes classifier to finds the most probable class for z:

**4.2.Split dataset:**

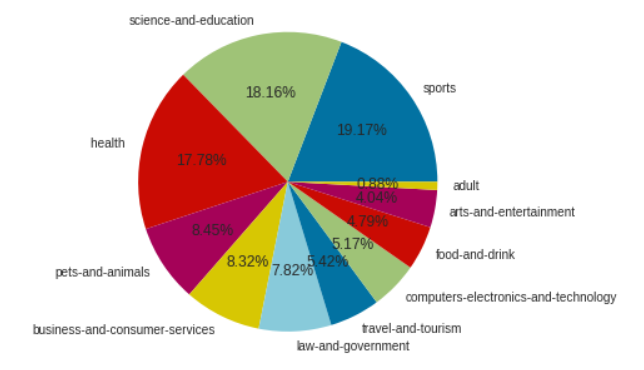
We split the dataset into train set and test set (with ratio 7:3) and also keep the ratio between categories in training set and test set similar to the original ratio between them

Ảnh có chứa văn bản

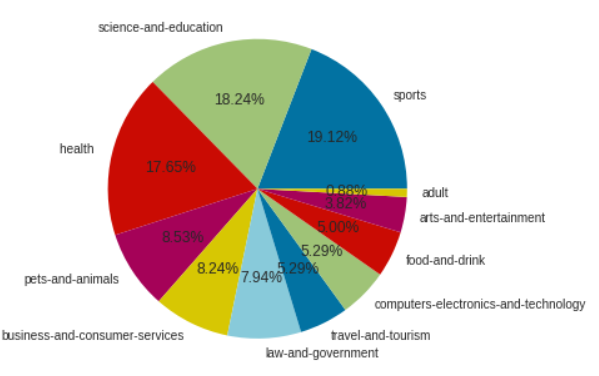
Mô tả được tạo tự động

Train set include 793 records while this number in test set is 340:

**-**Train set :

.

-Test set:



**4.3. Apply Multinomial Naïve Bayes:**

Ảnh có chứa văn bản

Mô tả được tạo tự động

# **Result**

## **Final Result**

**a)Training:**

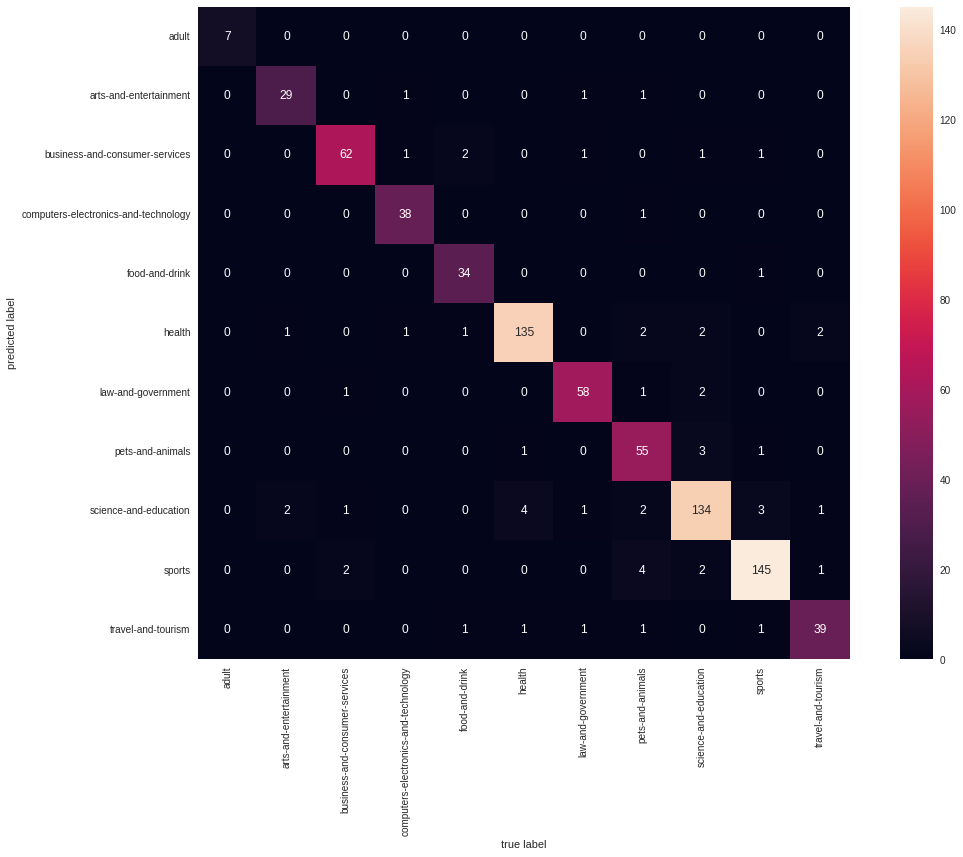
\*Accuracy: 0.93

\*Classification report:

Ảnh có chứa bàn

Mô tả được tạo tự động

Confusion Matrix:



**b)Test:**

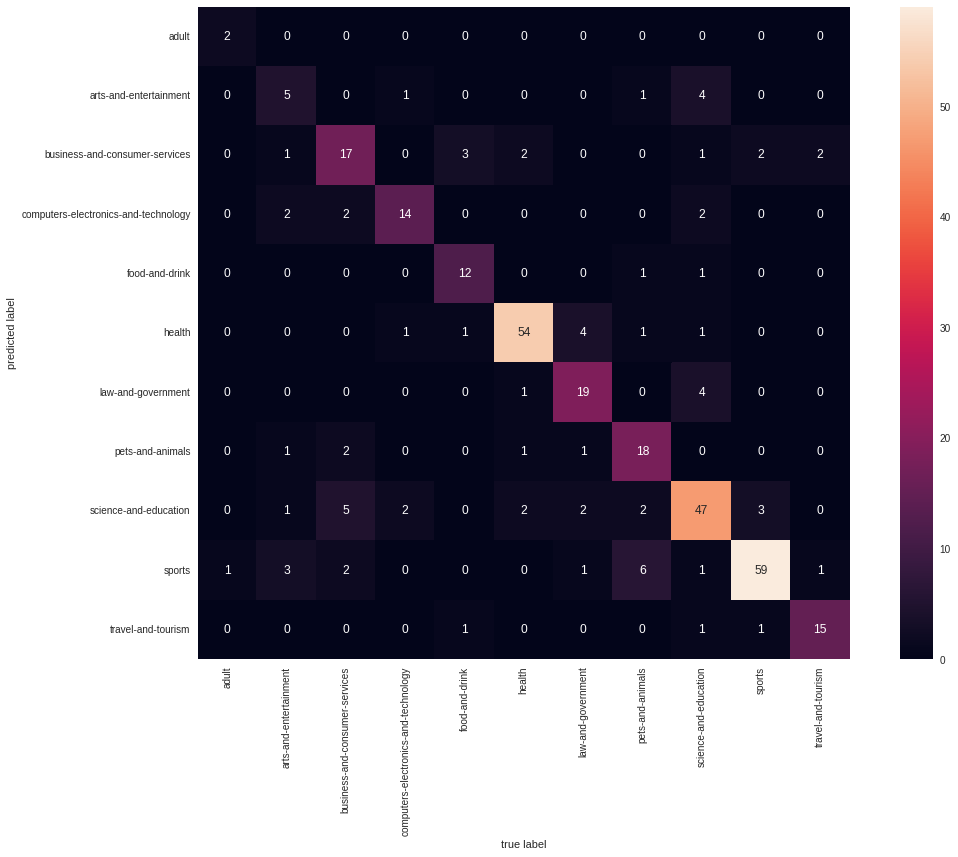
\*Accuracy:0.77

\*Classification Report:

Ảnh có chứa bàn

Mô tả được tạo tự động

\*Confusion Matrix:



## **Difficulties:**

- The collected data is not large but it is time-consuming to collect. Difficult to continue if there is an error while crawling.

- The model accuracy is not bad but also not good. Especially , art-and-entertainment category always have a low precision in test.

## **Future Improvement**

## **-** In the future, for improvement, we are going to collect more data to increase the accuracy and detect if there are any noises in our dataset

## - In addition, we will try our best to handle the multi-class problem . Because some website we have had crawled may belong to more than 1 category and this can be the reason that make our model not work so well

-We will also try another model (SVM, Random Forest ,…) to make more improvement

## 

## **IV.Conclusions**

The report summarized the process our team did, with data science methodology. From the steps of problem statement, data collection, cleaning, model training as well as model evaluation with test set.

In this project, we tried our best to collect data, although we had to deal with a lot of faulty websites and websites that preventing us from crawling. We also learned Naïve Bayes classifier -an easy-to-implement algorithm for text classification .Despite its conditional independence assumption that rarely happening in real life, Naïve Bayes shows not bad performance in website categoring

Finally, completing this project in accordance with the data science methodology gave the team a true understanding of the process. It is not a process of downloading an existing dataset and then training to refine the model, but a practical process.

# Reference

1. <https://medium.com/website-categorization/website-categorization-api-ca6c3e0f6c4d>
2. Previous project : Email spam filtering. Nguyen Minh Tuan, Nguyen Thu Hieu
3. Understanding tf idf: <https://www.capitalone.com/tech/machine-learning/understanding-tf-idf/>
4. Slide L5-Probabilistic\_learning ,PhD Nguyen Nhat Quang,Ha noi University of Science and Technology