Project 3
Classifying Real and Fake News

Content

- Intro / Background / Problem Statement
- Data Collection
- Data Cleaning and EDA
- Preprocessing and Modelling
  - LOGISTIC REGRESSION
  - NAIVE BAYES
- Evaluation + Insights
- Conclusion, Limitations and Future Outlook

Real or Fake? Can you tell?

9,000 NYC workers on unpaid leave for not complying with vaccine requirement. 91% did get at least one dose

cnn.com/2021/1...

582 Comments Share Save Hide Report 94% Upvoted

Trump Worried Biden Will Take Credit For 500,000 Covid Deaths He Made Possible

politics.theonion.com/trump-...

7 Comments Share Save Hide Report 97% Upvoted

Real vs Fake? How can we tell the difference?

r/news Posted by u/kiddenz 2 days ago

9,000 NYC workers on unpaid leave for not complying with vaccine requirement. 91% did get at least one dose

cnn.com/2021/1...

582 Comments Share Save Hide Report 94% Upvoted

r/TheOnion Posted by u/dwaxe 8 months ago

Trump Worried Biden Will Take Credit For 500,000 Covid Deaths He Made Possible

politics.theonion.com/trump-...

FAKE NEWS

7 Comments Share Save 97% Upvoted

Problem Statement

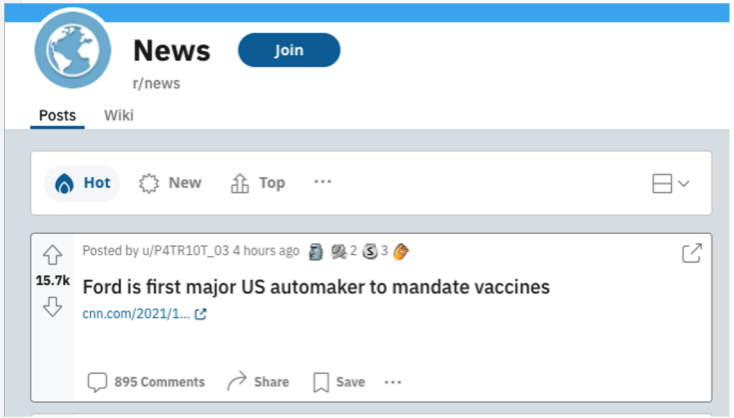
The increasing popularity and reliance on social media as a source of information worsens the problem of **misinformation** (**fake news**) today.

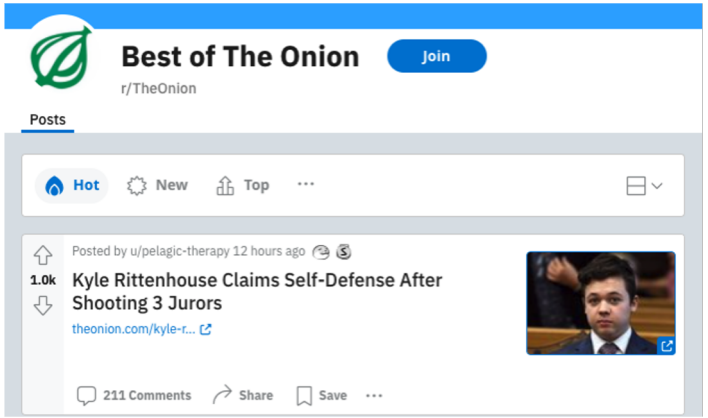
As a team of data scientist hired by a US government agency, we aim to analyse and **detect fake news** using **Natural Language Processing (NLP)** using data from the News and The Onion subreddit threads.

Why is fake news dangerous?

- Many people cannot tell the difference between real and fake news
- Creates confusion and misunderstanding about important socio-political issues
  - Cascades down to cause more dangerous widespread effects
    - Trump: used social media to spread misinformation and divide the people
    - Covid-19: Ivermectin as a cure

Background





- News articles current affairs in the US and the world
- Satirical, fake news

Data Collection

Using **PushShift API**

- PushShift allows for **only 100** posts each retrieval
  - Created a **loop** to retrieve posts from the subreddits since
  - Set a **sleep** timer between loops so we wouldn't get blocked
  - Retrieved **10,000** posts from **each subreddit**

- Filter through to obtain posts **not removed** by moderators
  - 'removed_by_category': 'Nan'

- Posts were retrieved backwards from **25th Oct 2021**
  - UTC: 1635120000

Data Cleaning

دانلود آهنگ کردی گیس چنریا از ساسان ملکی
Volcán Monte Aso entra en erupción en Japón

↓ **Remove rows that aren't in English** > 2 non-alphanumeric characters

Data Cleaning

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https://edition.cnn.com/2021/09/16/us/florida....

Remove rows with links

anything containing "http"

Data Cleaning

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test 

Ouch 

onion ice

Remove outliers in terms of length

< 5 words in length

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test 

Ouch 

onion ice

Remove outliers in terms of length

< 5 words in length

Remove duplicate headlines

r/news **9336**

r/TheOnion **8872**

Data Cleaning

I am a happy person. I am filled with happiness. 我很快乐!

↓ **Remove punctuation and non-alphanumeric characters**

I am a happy person I am filled with happiness

↓ **Tokenize**

I, am, a, happy, person, I, am, filled, with, happiness.

↓ **Remove stop words**

happy, person, filled, happiness

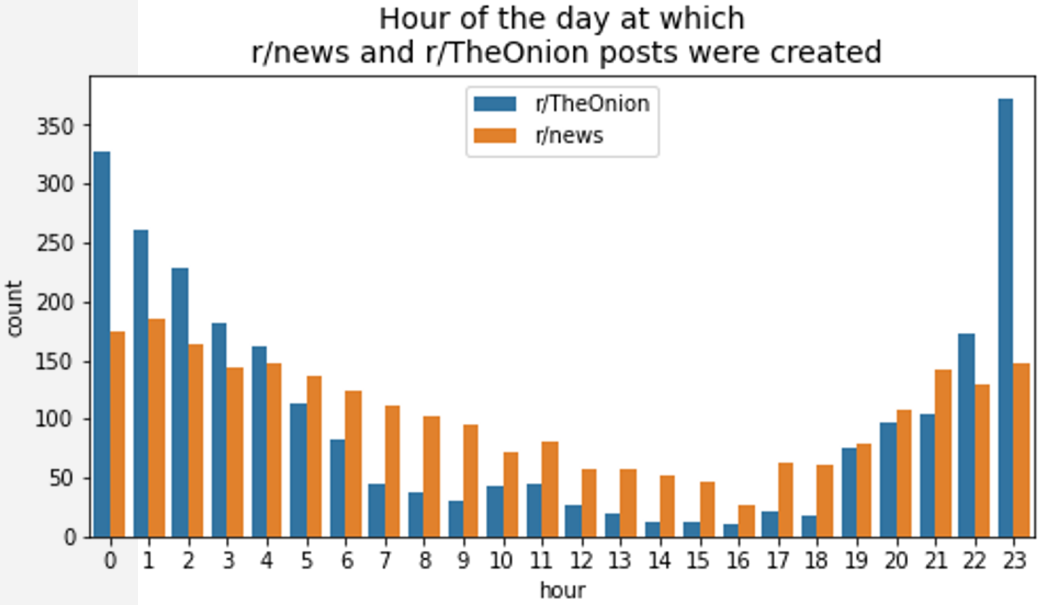
↓ **Lemmatizing**

happy, person, fill

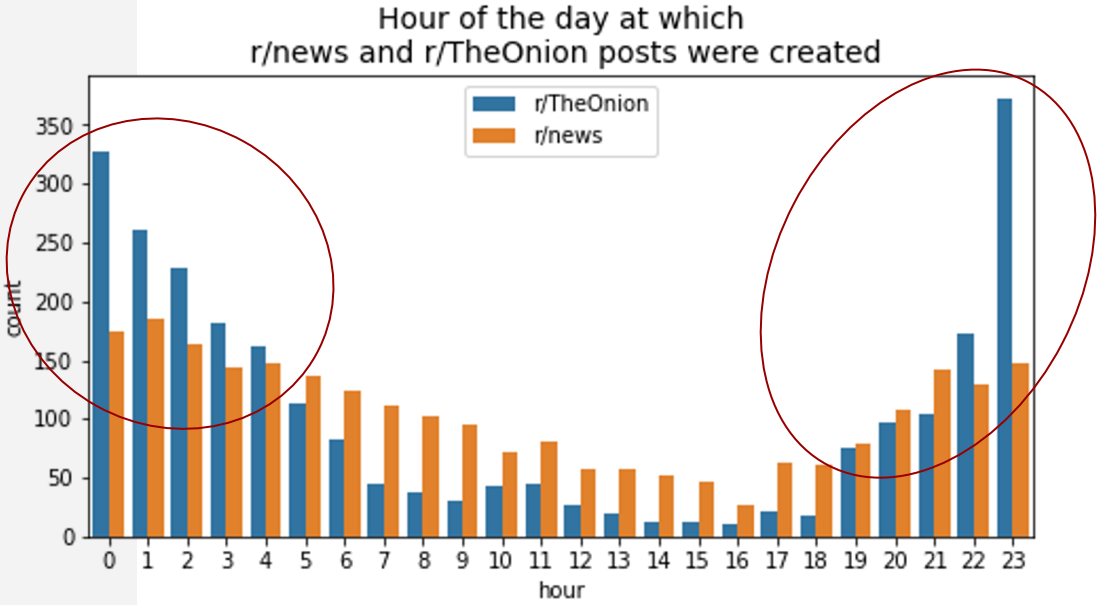
Exploratory Data Analysis

1. Hour of Posting
2. Length of Headline
3. Number of Comments
4. Month and Year of Posting
5. Headline

Time of posts

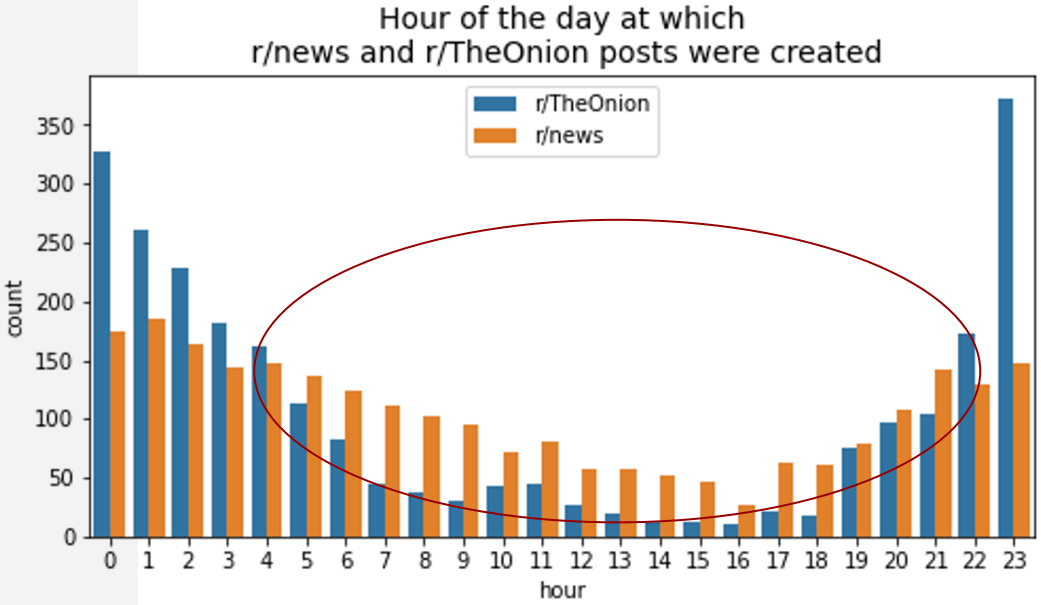


Time of posts



Between 10PM - 4AM is when the bulk of r/TheOnion posts are made.

Time of posts



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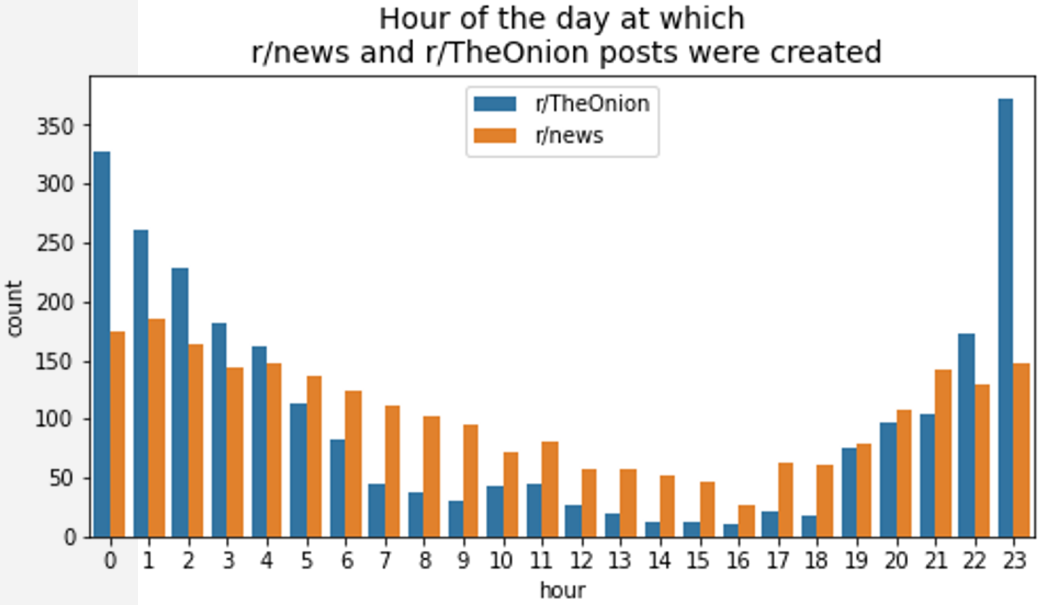

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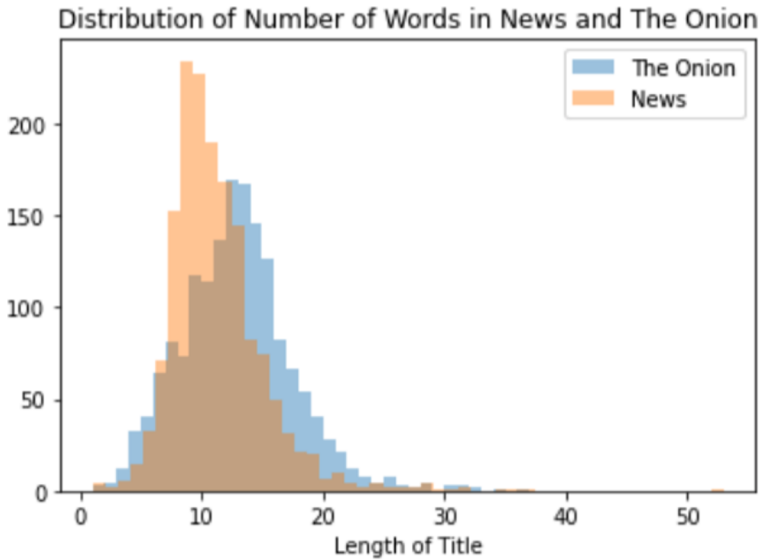
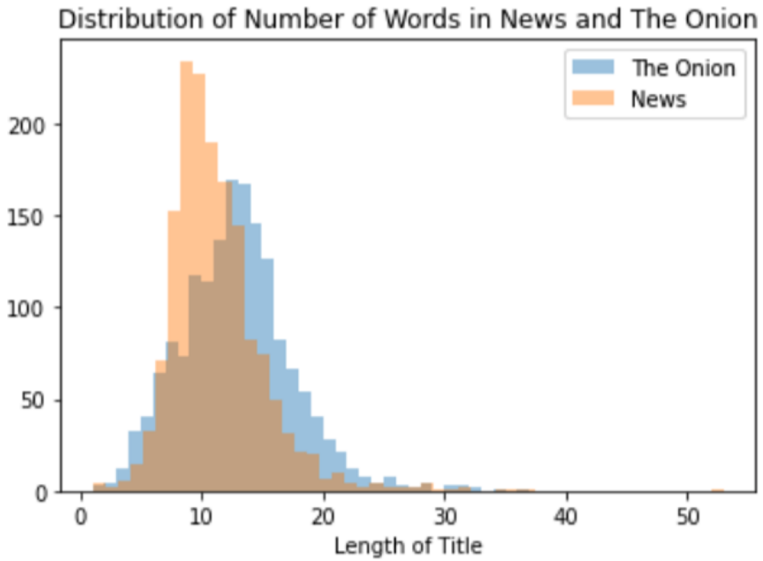
Posts on r/news were created more consistently through the day

Title length and Number of comments



Distribution has a right skew, r/news titles tend to have less words than r/TheOnion

Title length and Number of comments



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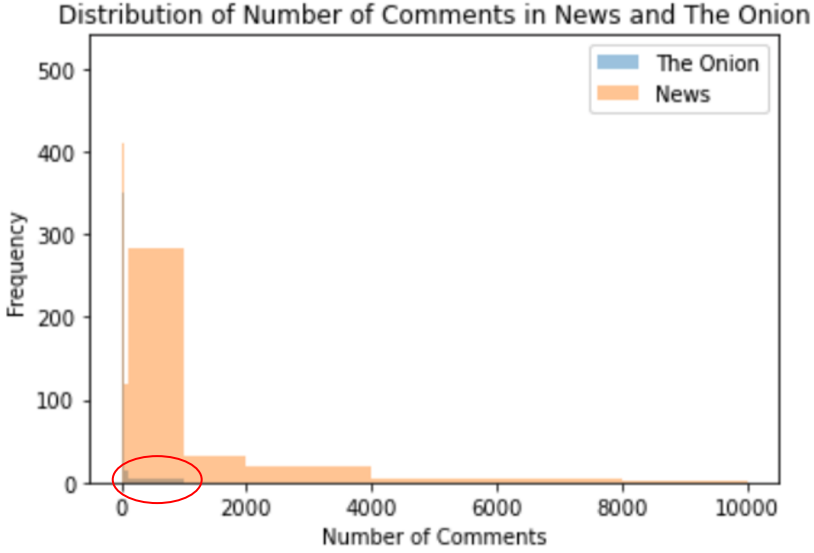
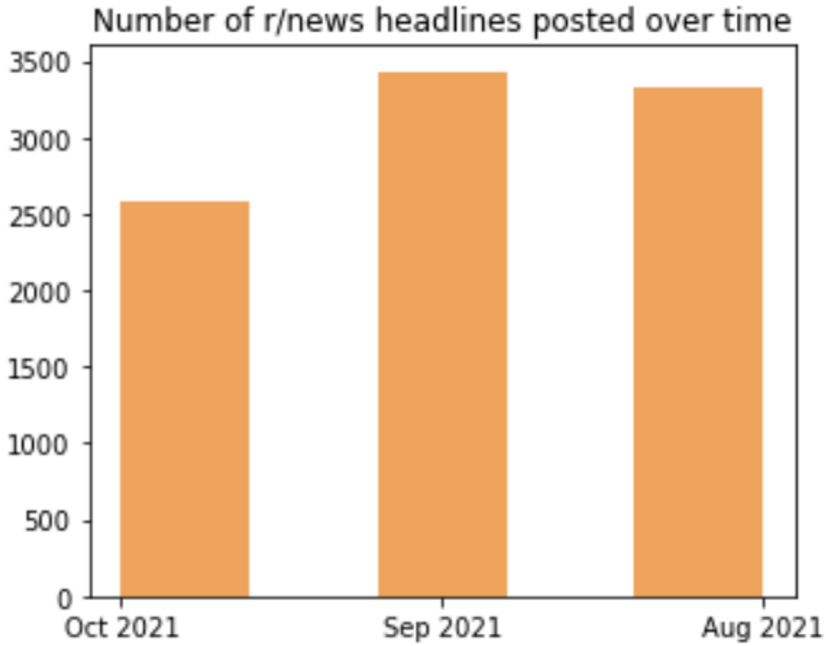


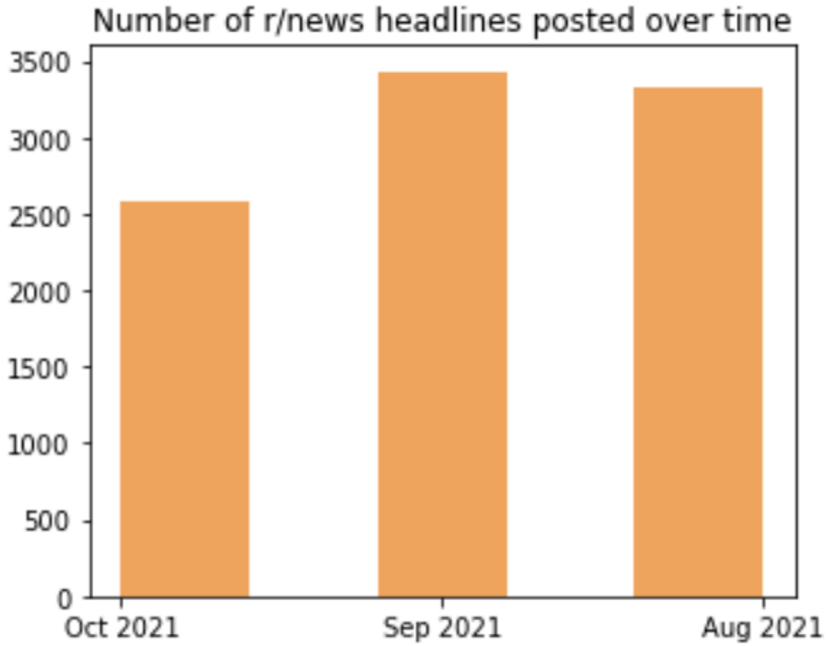
Posts from r/news generally receive more comments than posts from r/TheOnion

Month and year of posts



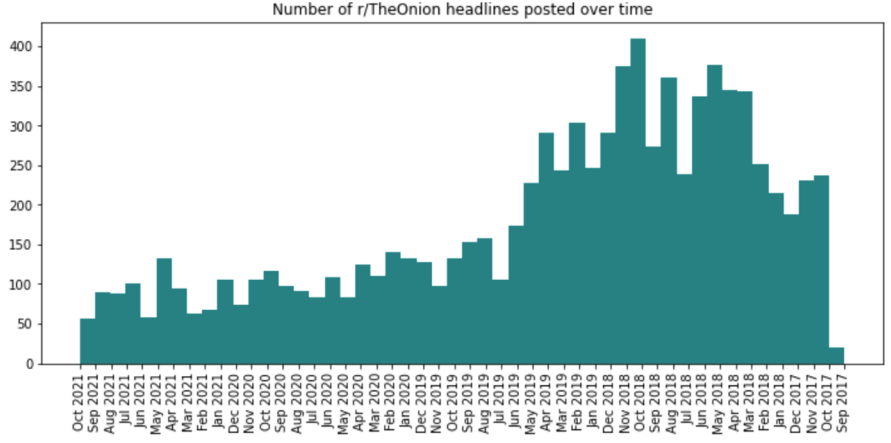
The r/news headlines were all created in the last three months from August to October

Month and year of posts



The r/news headlines were all created in the last three months from August to October

r/TheOnion headlines spanned back to 2017



Top words in r/news

Top words in r/news

Pandemic

Top words in r/news

Pandemic

Violent crimes

Top words in r/news

Pandemic

Violent crimes

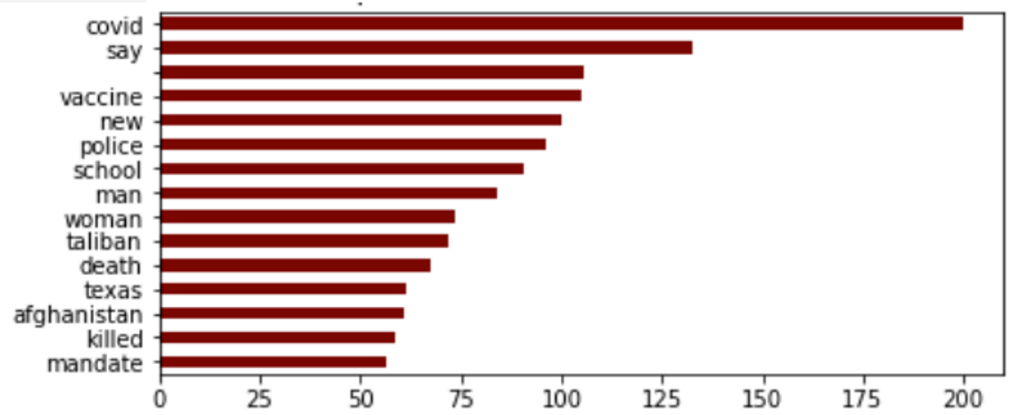
Recent politics news

Top words in r/news

Pandemic

Violent crimes

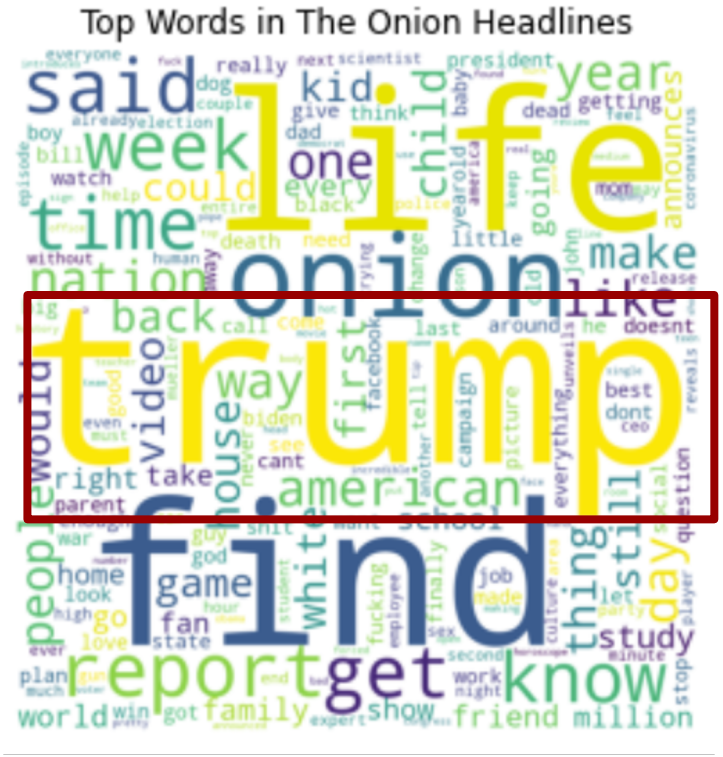
Humanitarian crises



Top words in r/TheOnion

Use of more general words

Top words in r/TheOnion



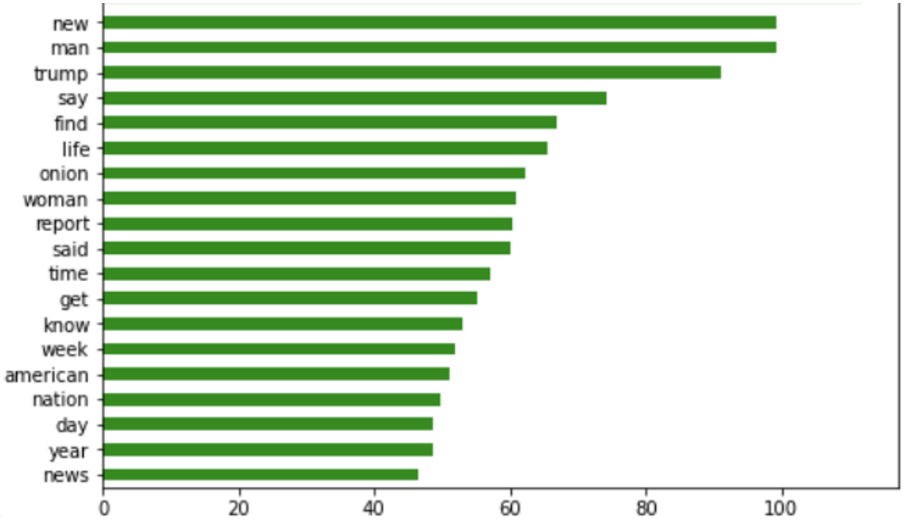
Use of more general words

(Except for Trump)

Top words in r/TheOnion

Use of more general words

(Except for Trump)



Preprocessing and Modeling - **Overview**

Human Baseline Model: 10% accuracy

4 in 5 Singaporeans confident in spotting fake news but 90 per cent wrong when put to the test: Survey

Preprocessing and Modeling – **Overview**

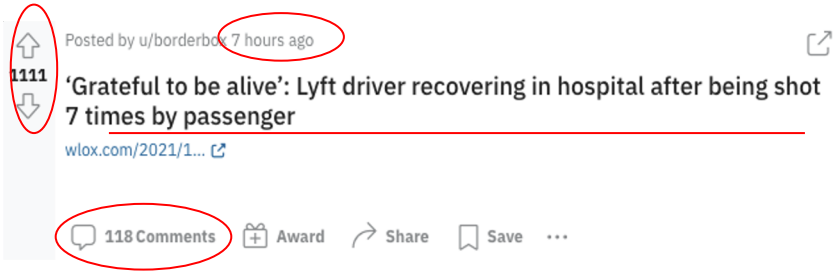
Detecting fake news (2 approaches)

Non-text features

- Score
- Comments
- Length of post
- Time

Text features

- Headline text



Preprocessing and Modeling - **Non-text features**

- **Preprocessing:**
  - One-hot encoded `hours` from time (epoch)
  - Scaling of data

num_comments	score	num_char	title	created_utc
9093	67198	49	FBI raids New York City po..	1633449271
17764	54117	74	Capitol Police officer who..	1629487987
4675	51147	63	Third Sandy Hook parent wi..	1633475492

num_comments	score	num_char	title	hour_0	hour_1	hour_2	hour_3	hour_4	hour_5	hour_6
0.511878	1.000000	0.163823	FBI raids New Yo...	0	0	0	0	0	0	0
1.000000	0.805334	0.249147	Capitol Police o...	0	0	0	1	0	0	0
0.263173	0.761135	0.211604	Third Sandy Hook...	0	0	0	0	0	0	0

Preprocessing and Modeling - **Non-text features**

- **Modeling:**
  - Logistic Regression
  - K-Nearest Neighbors
  - Naive Bayes

- Hyperparameter tuning thru GridSearchCV

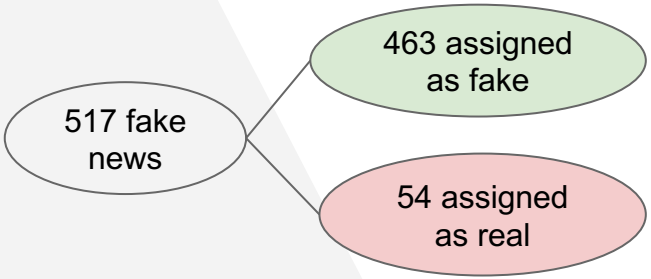
Best model: Logistic Regression

	Train Accuracy	Test Accuracy
Before hyperparameter tuning	0.8445	0.852
After hyperparameter tuning	**0.906**	**0.904**

features	coef
num_comments	77.436814
score	20.938244
num_char	0.489549
hour_23	0.148621
hour_21	0.140427
hour_1	0.129548
hour_17	0.121468

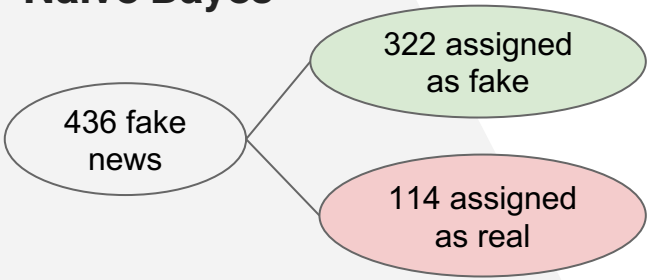
Comparison (Non-text features)

- **Logistic Regression**

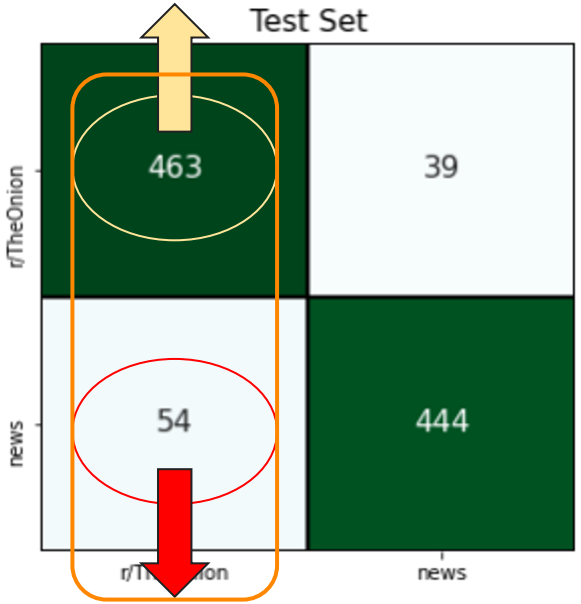


90%

- **Naive Bayes**



74%



Preprocessing and Modeling - **Text features (NLP)**

- **Preprocessing:**
  - Conversion of textual data into vectorized forms:
    - Count Vectorizer (1, 3)
    - TF-IDF Vectorizer (1, 3)

Illegal Immigrants Returning To Mexico For American Jobs
News: Box Office Failure: The $450 Million 'The Last Jedi' Made On Its Opening Weekend Is Less Than A Third Of What The Cast And Crew Spent On Paper Towels
News: Accessibility FTW! Tic Tac Is Making Its Breath Mints 500 Times Larger For The Visually Impaired
Middle-Aged Woman Angrily Demanding Price Check Was Once Carefree Youth, Onlookers Speculate

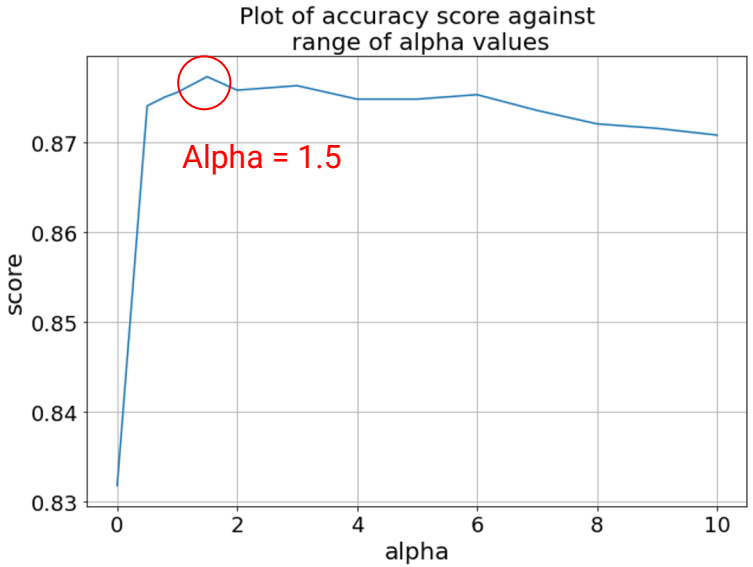
columbus
loan
whenever
senseless
halloween
gunned
employee
settling
play
antigovernment

activist	afghan	afterlife	allegedly	allows	angeles	animatronic
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.377964
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.447214	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.383687	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.395751	0.000000

Preprocessing and Modeling - **Text features (NLP)**

- **Modeling:**
  - Logistic Regression
  - K-Nearest Neighbors
  - Naive Bayes

- Hyperparameter tuning thru GridSearchCV
  - Optimized alpha value of 1.5

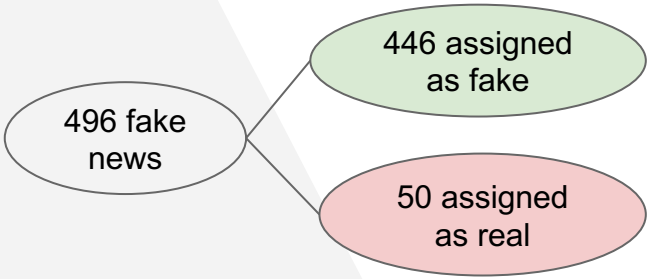


Best model: Multinomial Naive Bayes (TFIDF)

	Train Accuracy	Test Accuracy
Before hyperparameter tuning	0.875	0.829
After hyperparameter tuning	**0.877**	**0.904**

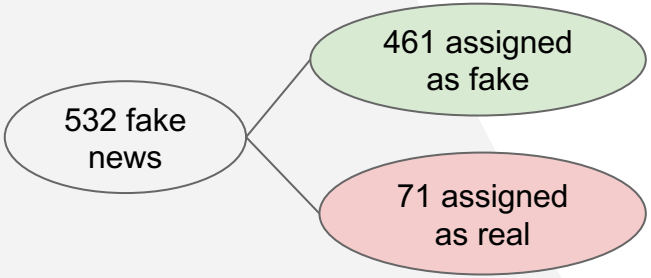
Comparison (Text features)

- **Naive Bayes**

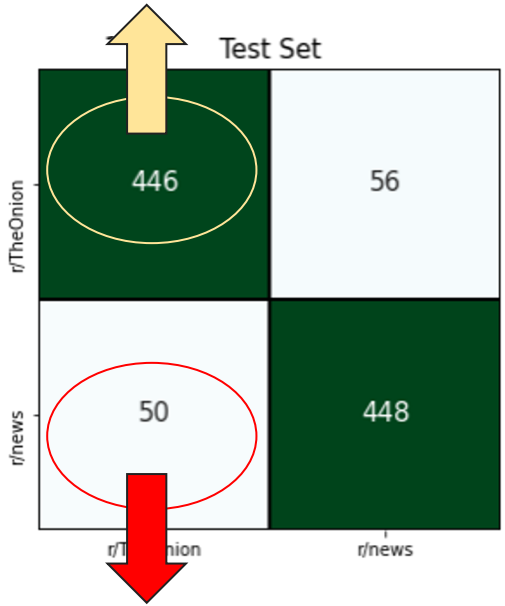


90%

- **Logistic Regression**



87%



Evaluation: Modeling for Non-Text Features

	Logistic Regression	Naive Bayes Multinomial	K-Nearest Neighbour
Train Accuracy	0.930	0.704	0.857
Mean CV Accuracy	0.918	0.693	0.725
Test Accuracy	**0.907**	**0.706**	**0.743**
Precision	**0.919**	**0.681**	**0.722**
Recall	0.892	0.771	0.787
F1-Score	0.905	0.723	0.753

Precision = True Positive / (True Positive + False Positive)

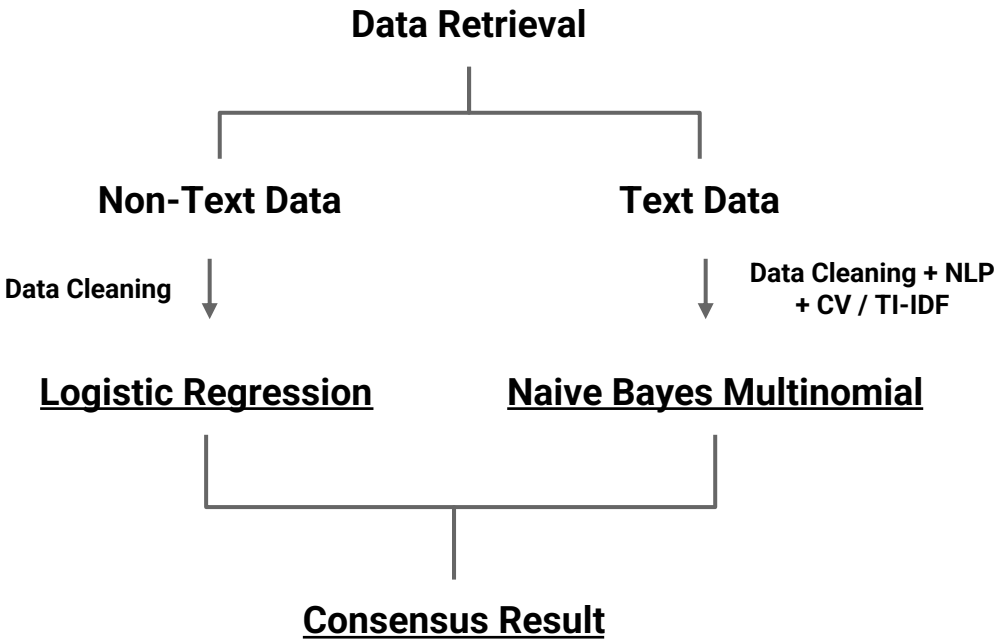
Evaluation: Modeling for Text Features

	Logistic Regression	Naive Bayes Multinomial	K-nearest neighbour
Train Accuracy	0.995	0.967	0.865
Mean CV Accuracy	0.876	0.877	0.774
Test Accuracy	**0.888**	**0.894**	**0.78**
Precision	**0.905**	**0.889**	**0.713**
Recall	0.865	0.90	0.933
F1-Score	0.885	0.894	0.809

Evaluation: Combining both models

What have we done so far and why?

Correct prediction of real news by Log Reg (Non-text data):	91.9%
Correct prediction of real news by Naive Bayes (Text data):	89%
Correct prediction by consensus result :	97.8%



Extra explanation of consensus result

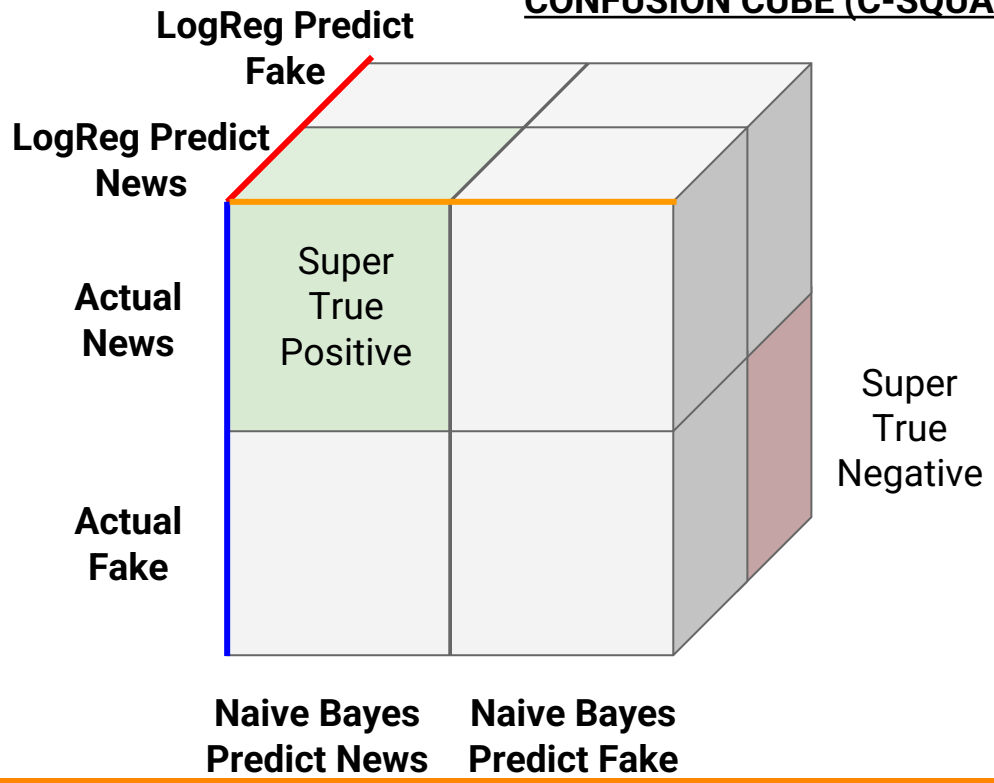
Model Results Confusion Matrix

	Predicted News	Predicted Fake
Actual News	TP	FN
Actual Fake	FP	TN

Prob that a post is real given both models predicted it as real news = 0.978

Prob that a post is fake given both models predicted it as fake = 0.988

CONFUSION CUBE (C-SQUARED)



Evaluation: Illustration of both models in practice

An illustration

Evaluation: Illustration of both models in practice

An illustration

Logistic Regression using non-text features: **REAL NEWS**

Naive Bayes using Subreddit title (text) features: **REAL NEWS**

Evaluation: Illustration of both models in practice

An illustration

Logistic Regression using non-text features: **REAL NEWS**

Naive Bayes using Subreddit title (text) features: **REAL NEWS**

Conclusion

When non-text data is used, such as time the post was created, post score and number of comments, Logistic Regression far outperforms the rest of the models.

	Logistic Regression	Naive Bayes Multinomial	K-Nearest Neighbour
Train Accuracy	0.930	0.704	0.857
Mean CV Accuracy	0.918	0.693	0.725
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Precision	**0.919**	**0.681**	**0.722**
Recall	0.892	0.771	0.787
F1-Score	0.905	0.723	0.753

Conclusion

Both Logistic Regression and Naive Bayes perform quite similarly when classifying text.

	Logistic Regression	Naive Bayes Multinomial
Train Accuracy	0.995	0.967
Mean CV Accuracy	0.876	0.877
Test Accuracy	**0.888**	**0.894**
Precision	**0.905**	**0.889**
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Recommendations

It was interesting to note that Logistic Regression on non-text features had better scores overall when predicting whether a title was legit or not.

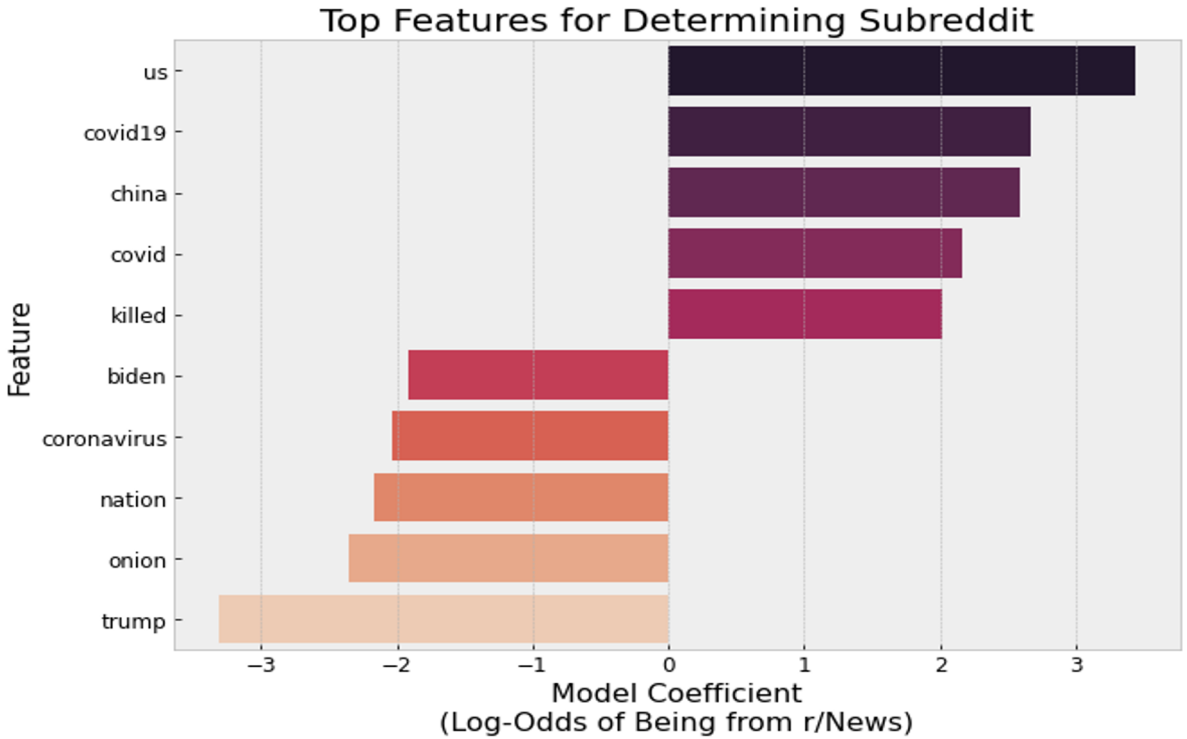
Recommendations

It was interesting to note that Logistic Regression on non-text features had better scores overall when predicting whether a title was legit or not.

However;

Our group recommends the textual count vectorized Naive Bayes model.

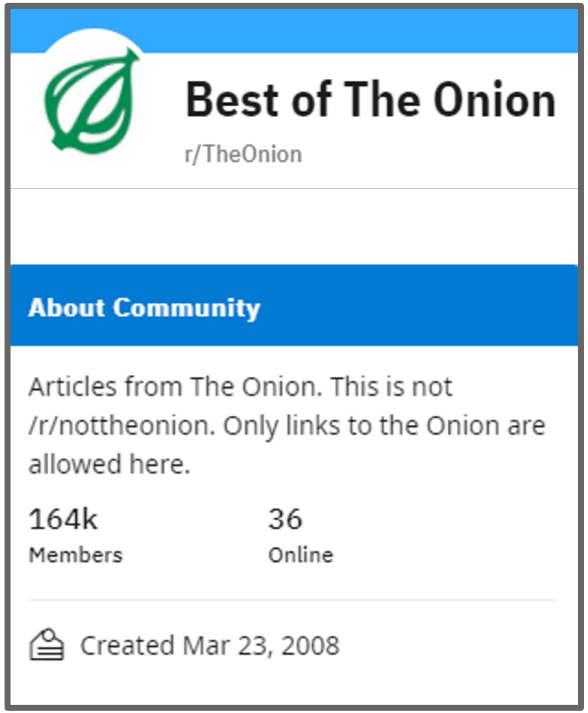
Limitations



Misclassified r/TheOnion posts

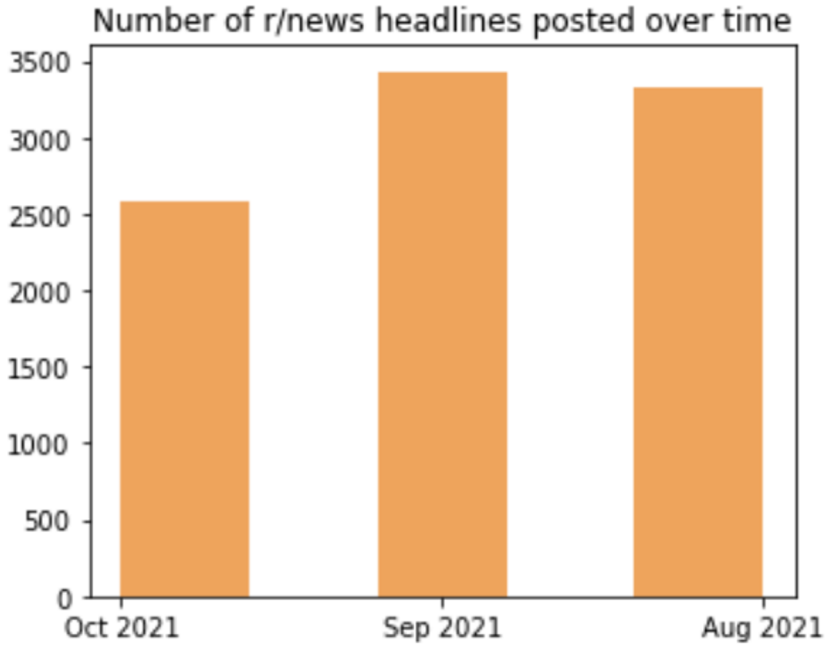
D.C Police Preemptively Deploy 3 Officers For Inauguration Day
Covid Denier Struggling To Protest State’s Incoherent, Constantly Changing Coronavirus Policies
Unvaccinated Mom Wants To Know If You’re Coming Home For Covid This Year
U.N. Court Orders U.S. To Ease Sanctions Against Iran

Subreddit Members



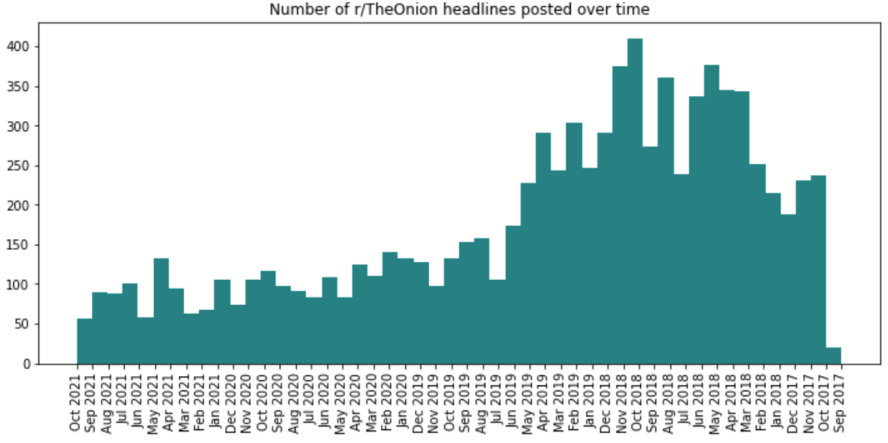
Limitations

Limitations

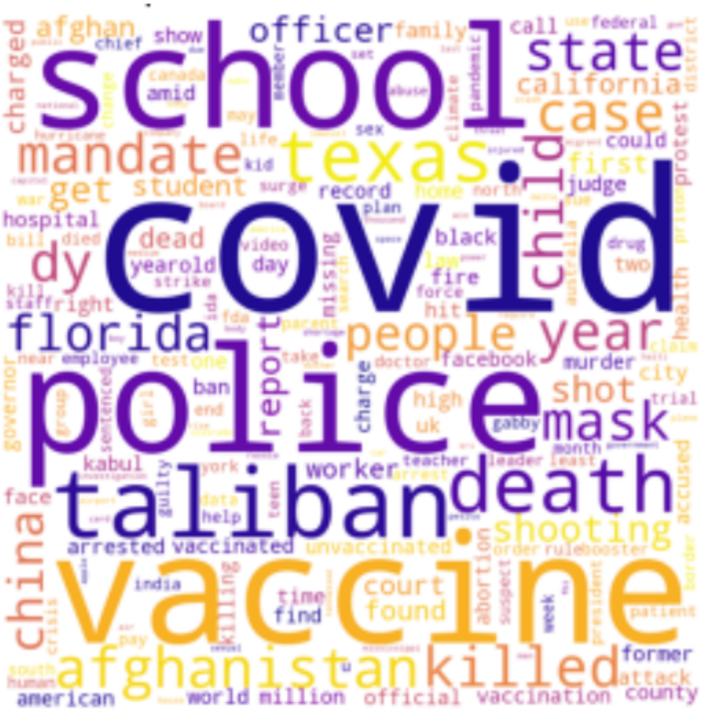


The r/news headlines were all created in the last three months from August to October

r/TheOnion headlines spanned back to 2017



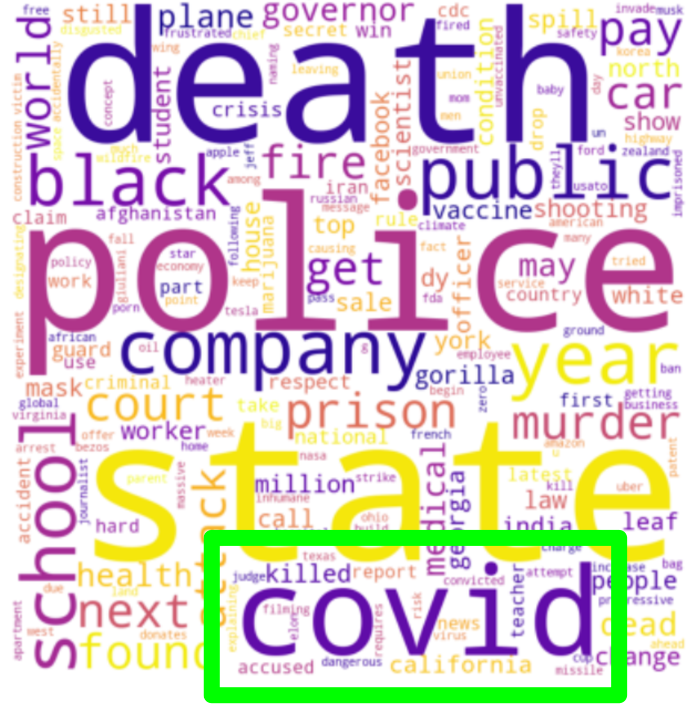
Top Words in Wrongly Identified Onion Headlines




Top Words in Wrongly Identified Onion Headlines
death
police
state
covid
school
public
black
company
year
prison
murder
court
attack
governor
plane
pay
car
world
health
next
found
vaccine
shooting
get
may
medical
georgia
india
people
dead
change
california
killed
million


school
covid
police
vaccine
taliban
death
texas
mandate
florida
people
year
officer
state
california
case
child
china
afghanistan
killed
shooting
mask
court
found
student
afghan
american
world million
official
vaccination
county

Top Words in Wrongly Identified Onion Headlines




death
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plane
governor
car
show
north
vaccine
shooting
get
may
white
sale
gorilla
million
india
law
killed
people
dead
change
california
accused
afghanistan
mask
criminal
worker
medical
georgia
call
hard
leaf


school
covid
police
vaccine
taliban
death
texas
mandate
florida
people
year
state
case
california
officer
afghan
child
afghanistan
killed
china
student
get
dy
dead
shot
mask
hospital
yearold
court
found
american
world
million
official
vaccination
county
former
attack
arrested
vaccinated


Top Words in Wrongly Identified Onion Headlines
death
police
state
covid
black
public
company
year
prison
murder
court
school
fire
get
may
plane
governor
pay
car
world
vaccine
shooting
gorilla
attack
next
found
health
medical
georgia
million
killed
people
dead
change
california
india
law
leaf
white
sale
crisis
student
scientist
facebook
afghanistan

school
covid
police
vaccine
taliban
death
afghanistan
killed
florida
people
year
mask
shot
shooting
china
officer
state
afghan
california
texas
mandate
get
student
dead
dy
child
court
found
worker
american
world
million
official
vaccination
county
arrested
vaccinated
unvaccinated
facebook
murder
hospital

Future Outlook

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- Perform sentiment analysis.

Thank you!
Any Questions?