

CleaningEDA_ClassModeling

February 27, 2024

```
[328]: # Fundamentals
import pandas as pd
import numpy as np
import re
from nltk.corpus import stopwords # Import the stop word list
import matplotlib.pyplot as plt
import time

# Modeling Fundamentals
from sklearn.preprocessing import StandardScaler
from sklearn.pipeline import Pipeline, make_pipeline
from sklearn.model_selection import train_test_split, GridSearchCV, \
    cross_val_score
from sklearn.feature_extraction.text import CountVectorizer, TfidfVectorizer
from collections import Counter
from sklearn.metrics import make_scorer

# Models
from sklearn.linear_model import LogisticRegression
from sklearn.neighbors import KNeighborsClassifier
from sklearn.naive_bayes import MultinomialNB, BernoulliNB, GaussianNB
from sklearn.ensemble import BaggingClassifier, RandomForestClassifier
from sklearn.ensemble import AdaBoostClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn.svm import LinearSVC
from sklearn.pipeline import Pipeline

# Evaluation metrics
from sklearn.metrics import confusion_matrix, ConfusionMatrixDisplay
from sklearn.metrics import mean_absolute_error, mean_squared_error
from sklearn.metrics import f1_score

# Ignore Future warnings
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning);

[155]: df = pd.read_csv('../part_01/Data/united_states_headlines_last_decade.csv')
```

```
[156]: df
```

```
[156]:      Unnamed: 0      abstract \
0      0      With the New Start treaty nearly wrapped up, P...
1      1      A response to a plea by Israel for the release...
2      2      Letters to the editor regarding tensions betwe...
3      3      Canada beat the United States in the semifinal...
4      4      Kristine Lilly, who holds the world record wit...
...
25505      25505      Unconscious bias in the medical profession may...
25506      25506      The Upshot staff shares a selection of their f...
25507      25507      The move comes as Israel presses on with its o...
25508      25508      President Biden seems nervous about sealing a ...
25509      25509      The era of shrinking water resources and risin...

      headline \
0      The Next Treaties
1      Plea for Pollard's Release
2      Where Do Doctors Learn Best?
3      Canada Beats United States in World Junior Sem...
4      Lilly, Iron Lady of U.S. Soccer, Retires at 39
...
25505      How Bias Endangers Pregnant Black Women
25506      10 Data Points and Documents That Made Us in...
25507      Biden Administration Again Bypasses Congress f...
25508      Electrify All the Big, Noisy, Belching Trucks
25509      Don't Flee the American Southwest Just Yet

      pub_date      year      section_name      news_desk      keyword
0      2011-01-01T02:42:37+0000      2011      Opinion      Editorial      United States
1      2011-01-01T02:42:37+0000      2011      Opinion      Letters      United States
2      2011-01-03T03:03:04+0000      2011      Opinion      Letters      United States
3      2011-01-04T04:01:03+0000      2011      Sports      Sports      United States
4      2011-01-05T22:19:53+0000      2011      Sports      NaN      United States
...
25505      2023-12-29T16:39:00+0000      2023      Health      Health      United States
25506      2023-12-30T05:05:46+0000      2023      The Upshot      The Upshot      United States
25507      2023-12-30T11:33:49+0000      2023      World      Foreign      United States
25508      2023-12-30T12:00:14+0000      2023      Opinion      OpEd      United States
25509      2023-12-31T14:00:19+0000      2023      Opinion      OpEd      United States

[25510 rows x 8 columns]
```

```
[157]: df['section_name'].value_counts(normalize=True)
```

```
[157]: section_name
U.S.      0.364239
```

Opinion	0.234201
World	0.131253
Business Day	0.080877
Sports	0.027325
Health	0.024385
Science	0.011722
Podcasts	0.011173
Technology	0.009918
The Upshot	0.009801
New York	0.008821
Arts	0.008115
Briefing	0.008037
Magazine	0.006547
Travel	0.006508
Blogs	0.006469
Multimedia/Photos	0.005920
Books	0.005645
Food	0.005606
Climate	0.005449
Automobiles	0.003999
Your Money	0.003999
Real Estate	0.003371
Style	0.003175
Sunday Review	0.001999
Well	0.001490
Fashion & Style	0.001372
Education	0.001255
Times Insider	0.001176
Movies	0.001098
Reader Center	0.000862
T Magazine	0.000745
Crosswords & Games	0.000470
Theater	0.000353
Public Editor	0.000353
At Home	0.000314
The Learning Network	0.000274
Obituaries	0.000274
Video	0.000196
Headway	0.000196
Giving	0.000157
Parenting	0.000157
Special Series	0.000118
Job Market	0.000118
The Weekly	0.000118
Week in Review	0.000078
Universal	0.000078
Smarter Living	0.000078

```
Booming          0.000039
NYT Now          0.000039
en Español       0.000039
Name: proportion, dtype: float64
```

Idea: Only Keep Opinion Pieces

```
[158]: USA_op_pieces = df[df['section_name'] == 'Opinion']
```

```
[159]: USA_op_pieces.columns
```

```
[159]: Index(['Unnamed: 0', 'abstract', 'headline', 'pub_date', 'year',
            'section_name', 'news_desk', 'keyword'],
            dtype='object')
```

```
[160]: columns_to_drop = ['Unnamed: 0', 'keyword', 'news_desk',
                        ↪ 'keyword', 'pub_date', 'year']
```

```
[161]: df = df.drop(columns=columns_to_drop)
```

```
[162]: df
```

```
[162]:
```

	abstract \	headline	section_name
0	With the New Start treaty nearly wrapped up, P...		
1	A response to a plea by Israel for the release...		
2	Letters to the editor regarding tensions betwe...		
3	Canada beat the United States in the semifinal...		
4	Kristine Lilly, who holds the world record wit...		
...	...		
25505	Unconscious bias in the medical profession may...		
25506	The Upshot staff shares a selection of their f...		
25507	The move comes as Israel presses on with its o...		
25508	President Biden seems nervous about sealing a ...		
25509	The era of shrinking water resources and risin...		
		headline	section_name
0		The Next Treaties	Opinion
1		Plea for Pollard's Release	Opinion
2		Where Do Doctors Learn Best?	Opinion
3		Canada Beats United States in World Junior Sem...	Sports
4		Lilly, Iron Lady of U.S. Soccer, Retires at 39	Sports
...	
25505		How Bias Endangers Pregnant Black Women	Health
25506		10 Data Points and Documents That Made Us in...	The Upshot
25507		Biden Administration Again Bypasses Congress f...	World
25508		Electrify All the Big, Noisy, Belching Trucks	Opinion
25509		Don't Flee the American Southwest Just Yet	Opinion

```
[25510 rows x 3 columns]
```

First step is correctly identifying whether it's an opinion-based article or not.

‘1’ denotes positive class, i.e. Opinion piece ‘0’ not opinion piece.

```
[163]: df['section_name'] = np.where(df['section_name'] == 'Opinion', 1, 0)
```

```
[164]: df
```

```
[164]: abstract \
```

0	With the New Start treaty nearly wrapped up, P...
1	A response to a plea by Israel for the release...
2	Letters to the editor regarding tensions betwe...
3	Canada beat the United States in the semifinal...
4	Kristine Lilly, who holds the world record wit...
...	...
25505	Unconscious bias in the medical profession may...
25506	The Upshot staff shares a selection of their f...
25507	The move comes as Israel presses on with its o...
25508	President Biden seems nervous about sealing a ...
25509	The era of shrinking water resources and risin...

	headline	section_name
0	The Next Treaties	1
1	Plea for Pollard's Release	1
2	Where Do Doctors Learn Best?	1
3	Canada Beats United States in World Junior Sem...	0
4	Lilly, Iron Lady of U.S. Soccer, Retires at 39	0
...
25505	How Bias Endangers Pregnant Black Women	0
25506	10 Data Points and Documents That Made Us in...	0
25507	Biden Administration Again Bypasses Congress f...	0
25508	Electrify All the Big, Noisy, Belching Trucks	1
25509	Don't Flee the American Southwest Just Yet	1

```
[25510 rows x 3 columns]
```

Once the identification is made, classify how well it can tell and then for those Opinion pieces get a bias scale from those based on language and return that score.

That is where the AI aspect comes in

1 Train Test Split and Cleaning

```
[165]: X_train, X_test, y_train, y_test = train_test_split(df[['abstract'],  
↳ 'headline']],  
df['section_name'],  
train_size = 0.80,  
random_state = 42)
```

```
[166]: def filtered_words(train_data):  
    # Function to convert a raw post to a string of words  
    # The input is a single string (a raw subreddit title), and  
    # the output is a single string (a preprocessed subreddit post)  
  
    # 1. Remove non-letters.  
    letters_only = re.sub("[^a-zA-Z]", " ", train_data)  
  
    # 2. Convert to lower case, split into individual words.  
    words = letters_only.lower().split()  
  
    # 3. In Python, searching a set is much faster than searching  
    # a list, so convert the stop words to a set.  
    stops = set(stopwords.words('english'))  
  
    # 4. Remove stop words.  
    meaningful_words = [w for w in words if w not in stops]  
  
    # 5. Join the words back into one string separated by space,  
    # and return the result.  
    return(" ".join(meaningful_words))  
  
total_abs_headlines = df.shape[0]  
print(f'There are {total_abs_headlines} posts.')  
# Initialize an empty list to hold the clean abstracts and headlines.  
clean_train_abs = []  
clean_test_abs = []  
clean_train_lines = []  
clean_test_lines = []  
  
print("Cleaning and parsing the training set abstracts...")  
  
j = 0  
for train_abs in X_train['abstract']:  
    # Convert abstract to words, then append to clean_train_abs.  
    train_abs_str = str(train_abs)  
    clean_train_abs.append(filtered_words(train_abs_str))  
    # If the index is divisible by 5000, print a message
```

```

if (j + 1) % 5000 == 0:
    print(f'Post {j + 1} of {total_abs_headlines}.')

j += 1

print("Cleaning and parsing the testing set abstracts...")
# Do the same for testing set.
for test_abs in X_test['abstract']:
    # Convert abstract to words, then append to clean_test_abs.
    test_abs_str = str(test_abs)
    clean_test_abs.append(filtered_words(test_abs_str))

    # If the index is divisible by 500, print a message
    if (j + 1) % 500 == 0:
        print(f'Post {j + 1} of {total_abs_headlines}.')

j += 1

print("Cleaning and parsing the training set headlines...")

j = 0
for train_lines in X_train['headline']:
    # Convert headline to words, then append to clean_train_lines.
    train_lines_str = str(train_lines)
    clean_train_lines.append(filtered_words(train_lines_str))

    # If the index is divisible by 5000, print a message
    if (j + 1) % 5000 == 0:
        print(f'Post {j + 1} of {total_abs_headlines}.')

j += 1

print("Cleaning and parsing the testing set headlines...")
# Do the same for testing set.
for test_lines in X_test['headline']:
    # Convert headline to words, then append to clean_test_lines.
    test_lines_str = str(test_lines)
    clean_test_lines.append(filtered_words(test_lines_str))

    # If the index is divisible by 500, print a message
    if (j + 1) % 500 == 0:
        print(f'Post {j + 1} of {total_abs_headlines}.')

j += 1

```

There are 25510 posts.
Cleaning and parsing the training set abstracts...
Post 5000 of 25510.

```

Post 10000 of 25510.
Post 15000 of 25510.
Post 20000 of 25510.
Cleaning and parsing the testing set abstracts...
Post 20500 of 25510.
Post 21000 of 25510.
Post 21500 of 25510.
Post 22000 of 25510.
Post 22500 of 25510.
Post 23000 of 25510.
Post 23500 of 25510.
Post 24000 of 25510.
Post 24500 of 25510.
Post 25000 of 25510.
Post 25500 of 25510.
Cleaning and parsing the training set headlines...
Post 5000 of 25510.
Post 10000 of 25510.
Post 15000 of 25510.
Post 20000 of 25510.
Cleaning and parsing the testing set headlines...
Post 20500 of 25510.
Post 21000 of 25510.
Post 21500 of 25510.
Post 22000 of 25510.
Post 22500 of 25510.
Post 23000 of 25510.
Post 23500 of 25510.
Post 24000 of 25510.
Post 24500 of 25510.
Post 25000 of 25510.
Post 25500 of 25510.

```

```
[167]: clean_train_abs
```

```

[167]: ['see latest charts maps coronavirus cases deaths hospitalizations garfield
county montana',
'biggest increases come groups past far less likely babies highly educated
women women never married',
'miguel cardona education secretary said reopening nation schools without
addressing time lost learning pandemic would insufficient called schools use
federal stimulus funds invest mental health counseling tutoring',
'mohamed morsi egypt first democratically elected president said washington
revitalize alliance egypt',
'see full results maps district columbia elections',
'see full results maps arizona special election',
'nan',

```


'signatories letter sent president trump many cabinet members include former secretaries state madeleine albright john kerry',

'study facebook use suggests may become less self obsessed age',

'president trump stance legal undocumented immigrants could devastating results',

'american public never great outcry withdrawing polling suggests',

'modern medicine still depends animal blood test bacteria vaccines alternative test requires study',

'co author new heritage foundation study highly critical senate bipartisan immigration proposal also wrote doctoral dissertation argued immigrants generally q substantially lower white native population',

'interview chinese edition men health gary locke departing united states ambassador china said could hold plank position minutes',

'extreme poverty united states giving rise group infections known neglected tropical diseases ordinarily think confined developing countries',

'tracking virus wastewater helping cities hospitals respond recent wave coronavirus coordinated national effort needed experts say',

'nearly half american adults take prescription drugs new report finds',

'see latest charts maps coronavirus cases deaths hospitalizations tampa area',

'price gallon regular fallen nearly penny day last four weeks averaging nationwide tuesday',

'well intentioned moral fervor campuses today often slides dangerous type zealotry',

'representative eric cantor virginia house majority leader broke prominent republicans declined friday criticize representative michele bachmann minnesota house republicans accused top aide secretary state hillary rodman clinton links muslim brotherhood',

'million chip making tool dutch company become lever u chinese struggle also shows entrenched global supply chain',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations madison county illinois',

'francis arrived havana saturday first stop nine day papal trip includes united states first latin american pope must try open cuba roman catholic church',

'see full results maps presidential election oklahoma',

'sharpest rise negative views australia unfavorable opinions jumped united states europe pew survey found',

'red bulls defender rafael marquez spoke jack bell times',

'see full results maps illinois election',

'house straggled back capitol monday night two weeks left likely entry congressional record book underachievement',

'see full results maps california election',

'burst production solved dire shortage defined first wave coronavirus surplus may enough prevent large numbers deaths',

'latest mass shooting wide swath america populace finds engulfed collective fear fear tinged confusion exasperation',

'week polling economic data mostly good news president obama',

'see latest charts maps coronavirus cases deaths hospitalizations starkville

area',
 'president biden went southern border first time since taking office',
 'goalkeeper catalina perez given red card th minute taking alex morgan
 americans prevailed stout defense goals morgan carli lloyd',
 'international herald tribune archives secretary state william jennings bryan
 resigns',
 'series high profile episodes major airports federal aviation administration
 taken steps recent months address airport safety',
 'learned data presidential election',
 'former senator writes refusing comply president threatens erode constitution
 system checks balances',
 'senator orrin hatch used protective senate democracy anymore',
 'tight labor market raises costs employers say need low wage help met declining
 ranks native born',
 'amid humiliations world war ii inmates defiantly asserted americanism national
 pastime',
 'snowfall bring political downfall',
 'readers including two animal welfare organizations respond article said
 outdoor cats become socially unacceptable',
 'carrier ordering single aisle planes boeing airbus signaling confidence
 pandemic receding travelers spend premium service',
 'tests american students fall behind peers many countries adjusting demography
 access resources gives different picture',
 'bipartisan authors bill say breakthrough represents compromise better
 environmental standards demands industry',
 'sheefs test limits current regulations experts say embryolike structures
 created directly stem cells',
 'alterations c proposed republicans actually make sense expect stalemate end
 anytime soon',
 'secretary state john kerry held news conference cuba foreign minister
 signifying establishment relations countries',
 'gil kerlikowske america drug czar discusses drug use united states abroad',
 'fourth july mean americans northern southern black white start civil war',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 tishomingo county mississippi',
 'people doubtful safety personal information online cellphones yet necessarily
 change behavior according new poll',
 'estimated evacuees kabul remain eight military bases across country thousands
 waiting u bases abroad come united states',
 'people struck killed vehicles according state data safety improved
 infrastructure changes traffic enforcement analysis said',
 'trump disturbed growing narcissist cannot bear getting away whatever wants',
 'see latest charts maps coronavirus cases deaths hospitalizations marshall
 county mississippi',
 'chief justice faces time great testing institution heads lower courts move
 rapidly even right',
 'parts united states temperatures must historical average area two days label

heat wave applied',
 'see full results maps new york election',
 'santander consumer usa paid second quarter dividend forbidden failed stress
 test march',
 'lot americans still dark virus',
 'parents juggle demands jobs desire prepare home cooked meals men increasingly
 front stove',
 'democrats aiming run big margin victory hillary clinton extend political
 advantage congressional elections next month',
 'year signs pointing equity crisis see',
 'hospital said would become first nation perform kidney liver transplants h v
 positive donors h v positive patients',
 'germany advanced must draw win group u tops group win candidly happy draw
 advancement',
 'exemption permits american charities transfer relief rebuilding efforts
 bypassing restrictions financial transactions enforced sanctions imposed iran',
 'obama administration states tackling lack transparency rising costs',
 'many americans second fridge sometimes third another member family',
 'automaker recalling vehicles alternator defect could lead fire jeep wranglers
 wiring problem',
 'charges favoritism emerged senator robert menendez democrat new jersey since
 team republicans put cross hairs',
 'americans plenty things worry trade deficits one',
 'republican backed measures across country took hit including mississippi
 initiative known personhood amendment',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 pike county indiana',
 'president trump confronting north korean aggression set tools limited success
 united states past',
 'heartbreaking witness movement risk near irrelevance workers ready take
 action',
 'gunfire rural roadway finally stopped six children three women dead',
 'mexicans braced economic impact trade battle trump administration united
 states could hurt well',
 'change allows serve government advisory boards representing companies groups
 acting behalf',
 'deserve toppled monuments sought make union perfect stand',
 'broadly interpreting title ix supreme court made law powerful force
 advancement women recent direction court jurisprudence makes highly unlikely
 court would play similar role another rights creating statute came along',
 'british prime minister made team emmanuel macron angela merkel though pesky
 ireland also sneaked',
 'environmental think tank says turning plant matter liquid fuel electricity
 inefficient approach unlikely ever supply substantial fraction global energy
 demand',
 'political fallout four years donald j trump one question happen followers
 conspiracy theories bend americans perceptions reality',

'way forward confronting history wishing away',
 'social science confirms blindingly obvious eight examples',
 'first american gold medal golf since gap explained sport dropped games
 returning',
 'goes well carmakers could financial industrial brawn dominate history auto
 mega mergers encouraging',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 northhampton county north carolina',
 'attempt pin might come current religious liberty debate',
 'four men mexico arrested week bringing six number people charged tractor
 trailer found carrying dead migrants near san antonio last year',
 'edward j snowden former united states government contractor asked president
 vladimir v putin russia question surveillance call session broadcast russian
 television',
 'u secretary state john kerry three day visit india comes end',
 'pandemic dip number married couples living apart together started rise women
 search space driving increase',
 'see latest charts maps coronavirus cases deaths hospitalizations franklin
 parish louisiana',
 'americans international competition russia featured sport forerunner hockey',
 'catholic hospitals claiming special right conscience trumps law',
 'see latest charts maps coronavirus cases deaths hospitalizations jones county
 georgia',
 'saudi arabia russia signaling increase output crude prices declined gasoline
 could follow suit summer ahead',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 smith county tennessee',
 'douglas hampton pleaded guilty week illegally lobbying former senate boss john
 ensign resigned last year threat expulsion charged case',
 'twitter hassan rouhani described appeals president obama leaders britain
 france russia nuclear talks near deadline',
 'thought relic federal law center legal battle abortion pills',
 'inflation pressing household expenses forcing people postpone health needs
 emerging trend health experts worried conditions may worsen',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 rockingham county north carolina',
 'online political conversation united states continues dominated bitter debate
 open letter leaders iran',
 'insects emerged billions year across eastern united states curious foodies
 salivating similarities crustaceans make allergy risk health officials warned',
 'athlete takes police brutality united states talks spearheading movement
 change',
 'sixty five percent republicans nearly half americans see government threat
 according recent poll',
 'new contract would provide raises better benefits following similar deals big
 airlines',
 'jets sent ukrainian pilots trained operate',

'much greater percentage refugees arriving since president ban blocked affected countries increase people large',
 'people seem like congress much days talk',
 'lower chamber russian parliament easily ratified new start nuclear arms control treaty key policy goal obama administration',
 'changing work hours driving farther search cheaper deals people making crafty calculations grapple expensive gasoline',
 'door opened june may close e u officials see american coronavirus cases surge',
 'chairman federal communications commission tom wheeler announced decision regulate broadband public utility called president obama',
 'makes attack tv show american muslim disturbing revealing prosecuted one person',
 'senator son times likely peers become senator',
 'mitt romney suggested american foreign aid dependent progress certain areas',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations iron county utah',
 'covid testing increasingly moved home wastewater data fell sync case hospitalization rates new study found',
 'decades blocking gay married couples receiving benefits heterosexual counterparts federal agencies treat married couples alike regardless gender',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations idaho',
 'like rodeo islam indelible part culture',
 'america increasing commitment russia mobilization show short wars become long ones',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations yell county arkansas',
 'chinese historian become outspoken recent years need china undertake ambitious economic political changes',
 'groups fighting town kobani meet politics behind turkey recent decision assist pushing back islamic state',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations ripley county missouri',
 'founder lawrence lessig harvard law school professor long opposed big money politics giving',
 'two deaths reported minnesota number people sickened salmonella doubled since outbreak announced last week federal officials said',
 'abbott nutrition issued voluntary recalls popular similac alimentum elecare formulas four infants hospitalized bacterial infections',
 'see full results maps arkansas election',
 'dana l mcintyre owned pizzeria boston suburb defrauded federal government justice department said',
 'two dozen federal agencies flagged biggest dangers posed warming planet list spreads across american society',
 'senators emerged closed door meeting saying confident agreement could reached tuesday end standoff change filibuster rules though deal struck',

'districts say want close classrooms latest wave covid cases could challenge
 rickety infrastructure kept schools running year',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 vermilion parish louisiana',
 'see latest charts maps coronavirus cases deaths hospitalizations white pine
 county nevada',
 'giant leap mankind happened thanks plenty women',
 'two g p presidential candidates also floated idea pardoning jan defendants
 elected',
 'see latest charts maps coronavirus cases deaths hospitalizations mercer county
 kentucky',
 'love watching olympics degree melodrama jingoism nbc coverage discomfiting',
 'tests producing results minutes market months short supply united states',
 'three americans discuss prospects shaped policy think future without',
 'philippine president remarks group business leaders clearest signal yet wants
 renegotiate military deal united states',
 'betsy devos education department sold predatory profit colleges welcome news
 washington taking steps protect students',
 'choice speak spanish could put pope francis middle country vicious debate
 means american',
 'gap trust military trust civilian institutions government helps explain years
 afghanistan',
 'five questions remain unanswered debt crisis moves final two weeks',
 'three companies create new venture goal simplifying coverage employees move
 unsettled health care world',
 'bald eagles lower states researchers say population',
 'nuclear regulatory commission completing ambitious study says great bulk
 radioactive material released meltdown would escape building',
 'dozen landscapes large enough sustain cougars exist states border east
 mississippi river',
 'see full results maps wyoming elections',
 'see latest charts maps coronavirus cases deaths hospitalizations ames area',
 'peek inside presidential limo joke looking thin splashy video showing benefits
 peace political theatrics riveting',
 'see full results maps missouri election',
 'two rivals middle east share similar concern iranian interests quietly
 exchanged intelligence iran years',
 'company big plans turn delivery fleet green vehicles made right',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 wake county north carolina',
 'see latest charts maps coronavirus cases deaths hospitalizations sikeston
 area',
 'late night comedy sunday morning talk shows sampling political conversation',
 'new york times reporters editors highlight great stories around web today
 great reads peter baker dan saltzstein others',
 'see latest charts maps coronavirus cases deaths hospitalizations saunders
 county nebraska',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations clinton county indiana',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations arkansas county arkansas',

'systematic flaw way military screens claims civilian casualties surely lowers numbers',

'new study suggests young buyers prevalent smaller cities way greater market share',

'see latest charts maps coronavirus cases deaths hospitalizations towns county georgia',

'estimates exit polls offer initial indication groups voted election night',

'said knew get things moving stalled',

'infections among young adults eventually may spread older vulnerable people c c reported',

'study found percent cancer deaths united states attributable cigarettes',

'see latest charts maps coronavirus cases deaths hospitalizations cherokee county iowa',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations arthur county nebraska',

'ms haley former u ambassador united nations said would hamas without iran',

'targeting debts decades old cases treasury intercepting tax refunds recipients children',

'content least channels network drew nearly million views subscribers since last year',

'see full results maps pennsylvania election',

'messages support iranian human rights activists new element emotional campaigns deal united states',

'many americans know put weight pandemic difficult experts detail scope problem',

'see latest charts maps coronavirus cases deaths hospitalizations hancock county illinois',

'see latest charts maps coronavirus cases deaths hospitalizations benton county iowa',

'miles well maintained trails north san francisco offer something anyone spry enough walk mile two budget',

'archives international herald tribune thieves detroit mistaken film actors august',

'jimmy kimmel joined p late night sweepstakes jay leno david letterman tuesday night mr leno night ratings race man behind puerto rican puppet subject media firestorm november resigned lipton launching new advertising campaign company black tea urges consumers drink positive',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations marion county ohio',

'gabby douglas first black gymnast win individual around gold medal potential make millions success also personality',

'see full results maps oklahoma election',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations

mclean county north dakota',
 'instead rooting bridge drag governor people focus issues matter elections',
 'personal trainers becoming must accessory modern life',
 'large businesses revising rules employee vaccinations wearing masks delta
 variant drives infections',
 'decade scientists identified link certain implants cancer agency ordered black
 box warnings new checklist risks patients review',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 adair county missouri',
 'america country liberals bush era pined',
 'senator marco rubio florida reintroduced legislation would end practice
 turning clocks back one hour every november bill died house last year',
 'president trump wrongly suggested amazon pay taxes company paid million last
 year collects sales taxes states levy',
 'g nato meetings week underscored pressure western leaders caused soaring
 energy costs resulting russia invasion ukraine',
 'outbreak india capturing attention pervasive reach virus means likelihood
 growing persist parts world',
 'arthur h camins reader writes rank compete test way improvement',
 'originally published series new york times magazine revised expanded book
 project edited nikole hannah jones caitlin roper ilena silverman jake
 silverstein undertakes ambitious examination slavery ongoing legacy black
 americans',
 'ng lap seng efforts delay prison ended federal judge manhattan ordered
 surrender wednesday begin serving four year term',
 'foreign travelers afraid american immigration officials terrorism crime survey
 says',
 'investigation two agents part grew larger inquiry netted members online
 pedophile ring u australia',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 franklin parish louisiana',
 'individualism may best trait',
 'jobs report released friday ought mostly reinforce pre existing impressions
 economy recovery slow nation probably verge double dip recession',
 'necessarily theological affinity jesus christ many americans drawn evangelical
 label association g p',
 'family structure one four factors clear relationship upward mobility new study
 comparing mobility across metropolitan areas',
 'see full results maps presidential election montana',
 'obama administration said secretary state john kerry would fly vienna assess
 whether deal possible talks iran nuclear activities',
 'tom steyer billionaire environmental activist wants help climate change become
 major issue next presidential campaign raising awareness pivotal states',
 'older people received smallpox vaccinations may yet immunity researchers say
 healthy children adults generally become severely ill',
 'newspaper extraordinary events past months demanded headlines take space',
 'chinese appliances company snapped g e appliances deal electrolux sweden fell

apart last year',
 'immigration officials moving deport least bosnians living united states say
 took part war crimes former yugoslavia',
 'outrageous lies destroyed guy babcock online reputation went hunting source
 discovered worse could imagined',
 'see full results maps ohio election',
 'british may dour across pond obsessive american pursuit happiness creating
 nation nervous wrecks',
 'host dignitaries relatives friends eulogized frank r lautenberg five term
 united states senator funeral service wednesday manhattan',
 'coverage might seem subdued major tv networks reflecting generally less
 enthusiasm presidential inaugurations second time around',
 'see full results maps new york election',
 'trump thinks america ripped nato obsolete war estonia east china sea could
 biggest rip',
 'euro fallen one one exchange rate u dollar two decades economic risks grow
 analysts predict deeper lows shared currency',
 'elite colleges implicit quotas asian americans jews',
 'president emmanuel macron chance reinforce france position enforcer
 international treaties prime minister theresa may britain chance prove ally u',
 'see latest charts maps coronavirus cases deaths hospitalizations henderson
 county illinois',
 'see full results maps north carolina election',
 'britain australia canada new zealand norway culture gun ownership tightened
 restrictions anyway violence statistics diverge sharply u',
 'see latest charts maps coronavirus cases deaths hospitalizations detroit
 area',
 'see full results maps oklahoma elections',
 'see full results maps california election',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 boone county indiana',
 'listen audio play shipwreck bake madeleines sur la table make dinosaur shadow
 puppets',
 'medicine must address vaccine holdouts among us',
 'dramatic crash left hole hull high tech america cup yacht round clock repair
 effort brought boat back dead',
 'compilation research suggests hatched salmon could threaten long term survival
 wild salmon unless precautions taken',
 'testosterone filled world trump adjacent online conspiracy newest theory
 stands many women falling q',
 'country finds treacherous new stage america first cut',
 'evidence strong enough form basis indictment country deputy director public
 prosecutions said',
 'see full results maps louisiana election',
 'two veteran appraisers newcomer different compatible approaches combating
 discrimination black homeowners',
 'signs pointing sizable pandemic baby bust united states implications us years

come',
 'despite eased restrictions people still avoiding malls restaurants businesses
 raising questions strength speed recovery',
 'flying commercial pets becomes increasingly difficult animal owners turning
 private aviation new airline making bid fur babies',
 'data science unlocking insights u slave system danger trying quantify
 suffering',
 'see full results maps missouri election',
 'border opening tourists thousands canadian snowbirds way florida arizona
 california campers tow',
 'ambassador ron dermer former american citizen close relationship prime
 minister benjamin netanyahu israel called bibi brain',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 griggs county north dakota',
 'diplomatic dispute lingers turks americans struggling effects united states
 demanding protection consular staff',
 'bribery scandal abhorrent completely legal industry helps many wealthy kids
 get schools dreams',
 'laser pointer reaches cockpit disorient completely incapacitate pilot said
 agency recorded cases last year',
 'see full results maps maine elections',
 'see full results maps wisconsin election',
 'national academies sciences engineering medicine says immigrants eager learn
 english burdening health care system',
 'years government tried decapitate drug cartels capturing killing leaders
 organizations often replaced smaller even vicious groups',
 'highlights international herald tribune archives reports suggest germany wants
 discuss peace',
 'fully vaccinated americans fly hundreds cities towns across country european
 capitals border rules across asia remain far stricter region world',
 'cornmeal become staple holiday table reflects millenniums work native
 americans legacy indigenous people trying keep alive',
 'declaring issue human induced climate change moved firmly present major study
 found water shortages torrential rains heat waves wildfires worsening',
 'thoughts likelihood near future inequality driven upheavals',
 'highly contagious omicron variant coronavirus become dominant worldwide
 attention paid less common omicron subvariant appears even transmissible',
 'nan',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 logan county colorado',
 'information search malaysian jetliner minute including united states silent
 role investigation withering criticism malaysia political elite',
 'syrian refugee family faces life president trump',
 'see latest charts maps coronavirus cases deaths hospitalizations humphreys
 county mississippi',
 'see latest charts maps coronavirus cases deaths hospitalizations rockdale
 county georgia',

'spoke bethany mclean joe nocera alternate take america',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 jefferson county washington',
 'bond issuance united states emerging markets risen record levels',
 'investigators looking wade page involvement white supremacist music scene
 played number bands',
 'nan',
 'see latest charts maps coronavirus cases deaths hospitalizations carroll
 county georgia',
 'air pollution improved dramatically past four decades large part federal
 regulations many areas country still high levels pollution climate change may
 make worse',
 'see latest charts maps coronavirus cases deaths hospitalizations neshoba
 county mississippi',
 'readers move toward online social networks publishers desperately seek scale
 bring revenue many deplored race toward repetitive journalism',
 'federal officials recognized danger spread coronavirus prisons early dragged
 feet releasing risk inmates',
 'employee described culture fear national association realtors powerful
 nonprofit controls access nearly every u home listing',
 'francis helped bridge divide first sending letters president obama president
 ra l castro cuba vatican host meeting october',
 'see latest charts maps coronavirus cases deaths hospitalizations taylor county
 florida',
 'country course live coronavirus vaccination drive vanishing',
 'lobbying effort install sri srinivasan prestigious appellate court test
 strategy white house hopes put republicans bind',
 'pledges battle climate change would still allow world heat level likely
 produce catastrophes scientists say',
 'hopelessness democracy could accelerate decay',
 'approved judge next month plan would resolve thousands lawsuits set motion
 release billion help cover costs opioid epidemic',
 'new satellite images obtained new york times show china allowed tankers use
 infrastructure territorial waters deliver oil north korea',
 'argument arizona state multicultural center spiraled disaster everyone
 involved blame',
 'footage showed fallen trees well damage homes buildings severe weather brought
 strong winds possible tornadoes parts alabama georgia mississippi',
 'president obama time white house almost tour honolulu found residents proud
 native son wistful coming loss attention',
 'constellation investment canopy shows far traditional alcoholic beverage
 companies willing go find growth',
 'see latest charts maps coronavirus cases deaths hospitalizations mcdowell
 county north carolina',
 'obamacare biggest challenge era fundamental distrust government',
 'readers discuss op ed essay said institutionalization would best psychiatric
 patients',

'many tons emissions trim new year',
 'new report exposes outdated data collection methods still relied public health agency',
 'voters abhor status quo someone present anything truly different',
 'see latest charts maps coronavirus cases deaths hospitalizations clarke county alabama',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations apache county arizona',
 'command sergeant major vindicated suspended cloud',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations mahaska county iowa',
 'associated press reported general motors sells diesel powered cruze overseas may begin selling one united states',
 'america fire historian elizabeth hinton offers sweeping reconsideration racial unrest shook american cities',
 'medical experimentation chimpanzees ended moving retirement difficult task',
 'workers behind hits like fortnite call duty need unions protect exploitation',
 'president biden predicts struggle democracies opponents beijing eager champion side',
 'billion two dozen presidential primary days four general election debates tv ads anyone could watch two parties essentially fought standstill',
 'study found congress overridden far fewer supreme court decisions recent years limiting usual back forth two bodies giving court power',
 'see full results maps illinois election',
 'seven months president obama pledged accept syrian refugees year united states accepted',
 'examination final paper required senator john walsh montana master degree army war college indicates least quarter appropriated without attribution',
 'may always clear kits expire',
 'covid endgame continues elude us',
 'credit card companies upended business model sex traffickers eliminating way pay advertising',
 'following annual trade commerce talks china senior obama administration official discusses hopes economic reforms announced communist party conference last month progress government procurement deal protection trade secret patents',
 'see latest charts maps coronavirus cases deaths hospitalizations calhoun county illinois',
 'exhibition match mexico many fans philadelphia least one eye americans sideline',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations thurston county nebraska',
 'soon senator utah decide make common cause donald trump',
 'new data flurry mobile analytics firm estimates number applications downloaded owners android apple devices risen percent last year firm says partially smartphone market global one also many apps available satisfy consumer appetite',

'see latest charts maps coronavirus cases deaths hospitalizations marquette area',

'major parliamentary review relations united states opened tuesday calls end drone strikes unconditional apology american attack pakistani soldiers last november',

'deal members congress aides buy insurance exchanges',

'benefits economic stagnation',

'criminal complaint eight arrested tuesday night',

'simone de beauvoir viewed america war sexes unproductive alien still shaping frenchwomen views today',

'issue whether women work religious employer receive contraception',

'anish Kapoor goes gangnam support embattled chinese artist',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations del norte county california',

'nations controlling international atomic energy agency voted end decade long effort get tehran answer questions suspected nuclear weapons related activities',

'among first offer comprehensive explanation possible solution country rising health care costs',

'new recommendations centers disease control prevention came thousands foreign students workers americans traveling abroad began arriving campuses start new school year',

'social conservatives poised heal broken pieces society rather continuing fight battles already',

'robert menendez testified government union city n j two mob figures accused trading favors vacations campaign donations',

'new york california would dominate popular vote',

'new labels help weight conscious consumers could improve public health',

'see latest charts maps coronavirus cases deaths hospitalizations ottawa area',

'long sought shift dynamic scoring widely seen way republican leaders set new ground rules overhaul entire tax code',

'general motors said vehicle sales united states fell percent increased percent fourth quarter period year earlier hopeful sign auto industry end difficult year',

'shootings tennessee virginia arizona south carolina left six dead dozens injured',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations baker county florida',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations st croix county wisconsin',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations edgar county illinois',

'say ban military style weapons would violate second amendment mr scalia disagrees',

'argue understanding solve problems computers important learning particular programming language anna north writes',

'president obama may want look back predecessors political fortunes sixth year

office may want close eyes',
 'pandemic prompted dawning realization way obsessed jobs',
 'senator john mccain said two airstrikes outside syrian capital recent days
 apparently israeli forces likely increase pressure president obama offer
 forceful support syrian rebels',
 'french sports newspaper l quipe claimed united states russia conspiring fix
 results figure skating competitions',
 'sat go completely digital amid questions whether college admissions tests fair
 even necessary',
 'higher rates infection mortality among black hispanic americans explained
 exposure job home experts said',
 'april european court rules britain extradite five terror suspects united
 states',
 'notion limiting women reproduction cure societal ills long scary history',
 'leaks investigation manchester bombing risk eroding trust intelligence
 cooperation depends',
 'getting first shots arms globally important booster program',
 'c jet made state owned manufacturer completed first commercial flight western
 rivals still supply china planes',
 'let battle begin president obama intends nominate replacement justice antonin
 scalia republicans plan ignore',
 'tactics used terror suspects sept attacks crimes perpetrators knew must
 brought justice',
 'younger asian americans creating holiday traditions putting spin lessons
 learned',
 'charges countercharges flew veracity allegations senator robert menendez new
 jersey patronized prostitutes dominican republic',
 'despite interest rate increases meant cool labor market companies outside tech
 industry worry workers many',
 'airlines united states lost billion shed jobs years sept worked economic
 tumult',
 'see latest charts maps coronavirus cases deaths hospitalizations poweshiek
 county iowa',
 'davis love iii meeting president come lifetime comes new administration',
 'big business groups spent millions help republicans win control house return
 always met expectations',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 meade county kansas',
 'startling contrast projections five years ago energy department research
 branch predicts energy related emissions rise',
 'see latest charts maps coronavirus cases deaths hospitalizations columbus
 county north carolina',
 'see full results maps minnesota elections',
 'poorly enforced trade agreement continues damage environment economy',
 'archives international herald tribune nasa astronauts streak miles space
 september',
 'see full results maps presidential election massachusetts',

'united states china others collaborated search malaysian plane way hesitant reveal extent surveillance abilities',

'senate future decided largely beyond focus presidential contest states like north dakota indiana neither presidential candidate campaigned',

'securities exchange commission moves freeze assets traders accused illegally trading shares advance announced billion acquisition nexen canadian oil producer state owned chinese oil company cnooc',

'funding health campaigns surprisingly low consider often valuable pay',

'representative john lewis led house floor sit orlando nightclub shootings said friday room society violence',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations heard county georgia',

'decision could set benchmark state governments companies grappling issue',

'see full results maps nevada election',

'confront climate change focusing single metric like greenhouse gas emissions could leave harmful practices unaddressed',

'policy makers practiced art compromise preserving power filibuster represented potential missed opportunity',

'infection president trump top associates makes clear country still throes pandemic',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations sully county south dakota',

'nan',

'people lost pandemic form portrait america series short films asked five people celebrate life someone close',

'lawmakers prepare debate strike assad government syrians sides issue work influence congress american public',

'readers respond sunday review article really makes us fat',

'spanish language credit reports available myfico com',

'brooklyn nets olympics sandy disruptions sandusky case year offered plenty compelling sports stories',

'see latest charts maps coronavirus cases deaths hospitalizations napa area',

'see latest charts maps coronavirus cases deaths hospitalizations nassau county new york',

'version star spangled banner played medal ceremonies rio grating close listeners',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations calaveras county california',

'see latest charts maps coronavirus cases deaths hospitalizations bradford county florida',

'educators respond sunday review article tests make us smarter',

'surfeit promising material upcoming tv series alien spawn eats brains congressmen',

'readers react editorial urging form clemency',

'president trump pushed imposing new percent tariff cellphones laptop computers toys goods dec items excluded altogether',

'c c monday released long awaited advice immunized people glimpse next stage

coronavirus pandemic',
 'two groups americans thinking acting patriotically went war',
 'babyloids relatives rent increasingly childless japan',
 'announcement friday head beleaguered agency said would step june made world
 safer place said',
 'studied places find dallas popular',
 'j dennis hastert years lobbyist explain able according federal officials
 promise million former student claims mr hastert molested',
 'sgt first class ikaika erik kang accused trying provide equipment training
 classified military information isis',
 'chaotic year people left indelible impressions readers journalists',
 'company formed january undertake major expansion product lineup production
 volume jeep big selling brand specializes rugged sport utility vehicles',
 'bugeye sprites small roadsters might seem task collectors time hands eagerly
 made trek',
 'first interview since major surgery former vice president dick cheney also
 predicts barack obama one term president',
 'jurgen klinsmann first game coach united states national team drew exhibition
 game mexico',
 'carriers exploiting supply chain chaos breach contracts jack rates importers
 say asking federal intervention',
 'speak businesses scrambling find workers former employees unwilling return
 jobs',
 'new consumer financial protection bureau studying whether money transfers help
 build credit scores',
 'instead fanning fear president listen people sides border',
 'century ago opponents unleashed chaos try sabotage expansion voting rights
 strange interlude still holds lessons backlash works today',
 'agreement white house allow electric cars made automakers part broad effort
 improve charging increase sales battery powered vehicles',
 'gymnastics champion sprang stardom olympics became first american woman win
 gold medal around competition family raising money online saying lacks health
 insurance',
 'much political power plays state local level negligent stay home legislatures
 elected',
 'landmark agreement reflects growing recognition nature role helping address
 global warming still critics said ambitious enough',
 'senator mitch mcconnell speaker john boehner developed bond always existed
 house senate leaders party',
 'see full results maps massachusetts election',
 'never seen jumps key indicators like lead researcher said',
 'see latest charts maps coronavirus cases deaths hospitalizations warwick
 county indiana',
 'president obama honored victims sept white house argued right wage new isis
 fight legal authority used al qaeda',
 'reader responds op ed article tortured policy toward russia',
 'wealthiest country world struggling provide basic nutrition many children',

'older people nursing home residents group perhaps harder hit pandemic people diabetes experts hope policymakers take notice finally get serious tackling nation diabetes crisis',

'american canadian women great respect one another hockey rivals relish opportunity mix though women hockey prohibits body checking',

'recent decisions safeguarding pluralism taking sides culture wars',

'see latest charts maps coronavirus cases deaths hospitalizations cross county arkansas',

'everyone agrees great hair',

'head american petroleum institute says rosy oil future depends federal government raising taxes companies imposing new environmental rules',

'national museum african american music six interactive sections covering genres music focus gospel blues jazz r b hip hop',

'senator new york usually happy share opinion uncharacteristically reserved iran deal',

'study highlights effects new federal mandate health care workers inoculated covid may vulnerable populations like elderly nursing homes experts say',

'president obama suggests congressional leaders care mainly budget cuts affect republicans see political motivations behind cuts',

'senior voters could joe biden secret weapon',

'one advocating invasion need military strategy far greater sense urgency',

'scion says introduce im concept los angeles auto show next week chrysler announces pricing ram promaster city compact van',

'see latest charts maps coronavirus cases deaths hospitalizations redwood city area',

'international herald tribune archives u confirms botched c operation',

'black customers risk racially profiled everyday visits bank branches federal laws little recourse long banks ultimately complete transactions',

'alliance american german companies expected strengthen merck oncology business several important markets including united states',

'act working needs become affordable accessible',

'enhance global competence business americans need become much familiar nations work cultures',

'new oral history iraq war peter van agtmael discusses attracted photographing american led invasion roots ambitions experiences reflections',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations chowan county north carolina',

'major government assessment lays far reaching perils global warming cost effective fixes available today',

'negativity fear anger among democrats republicans rise research shows',

'emily weinstein senior staff editor food section answers questions special issue week dedicated sandwiches',

'white supremacist groups carried majority terrorist plots attacks year according report think tank center strategic international studies',

'attorney general merrick b garland shuns politics finds center storm',

'getting simple medical care hospitals cost insurance without',

'curtis means months old reflects troubling trend premature births across

united states problem research associated climate change',
 'many people worry pay much prescriptions chronically ill fear pay thousands
 expensive drugs',
 'director nation largest network food banks seeing support dwindle need rises
 middle battle people leaving field',
 'storms caused strong winds large hail several southern states threats storms
 expected persist early wednesday morning',
 'past fairy tale stage war ukraine end',
 'u midfielders stuart holden clint dempsey face weekend jermaine jones lining
 michael bradley two tantalizing games england next two weekends',
 'see full results maps ohio election',
 'national highway traffic safety administration looking unexpected braking cars
 operated cruise part general motors',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 glascock county georgia',
 'new coronavirus cases rising across united states though cases
 hospitalizations deaths remain fraction peaks',
 'henry kissinger former national security adviser secretary state helped
 richard nixon open china assailed anti china comments president obama mitt
 romney calling tough language trade extremely deplorable',
 'worried coaxing people pews rather pajamas protestant pastors canceling sunday
 services dec',
 'reason warren harding ends generally lowest rung notable presidential rankings
 conducted historians political scientists finishing dead last least half',
 'expansion u mexican migrant enforcement deal left thousands migrants stranded
 dangerous mexican cities',
 'highlights international herald tribune archives shots fired harlan mine
 strike foreign born americans keep citizenship living abroad',
 'archives international herald tribune gemini linkup target vehicle space
 delayed',
 'numbers greatly improved voters give credit',
 'let eliminate money problems admissions equation qualified students',
 'james r gaines fifties describes decade opposition stifling national consensus
 costly courageous',
 'unless america pushes unity government civil war destroy iraq',
 'plus strike roils india academy awards condemn smith',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 monroe county illinois',
 'see full results maps virginia election',
 'consumer federation america public knowledge opponents universal music group
 billion bid emi record labels asking senate judiciary subcommittee antitrust
 issues examine deal',
 'desperate improve ratings americans spend billions credit repair industry
 often deliver promises',
 'second doses delayed adults receive half doses scientists pondering ways get
 shots arms',
 'president hassan rouhani visiting europe meeting pope inking business deals

signaling iran engaging world',
 'congress would stir dysfunction enact sensible changes immigration nation
 could reap benefits',
 'prosecutors expect expand indictment two soviet born men rudolph w giuliani
 enlisted pressure ukraine president trump behalf',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 overton county tennessee',
 'american request send team experts african nation considered united nations
 human rights council special session geneva',
 'secretary interior deb haaland announced new initiative would delve records
 federal schools native american children forcibly relocated years',
 'secretary state forcefully defended decision withdraw american military
 afghanistan citing threats united states reneged peace deal',
 'cryptocurrency prices plunged funds failed strict rules risky assets helped
 wall street companies sidestep worst retail investors lucky',
 'mr trump needs mix voices advising military leaders',
 'see latest charts maps coronavirus cases deaths hospitalizations dade county
 missouri',
 'high divorce rate late early starting look like historical anomaly trend',
 'weak troubling jobs report shows employment market remains stagnant mitt
 romney said e mail statement released campaign',
 'see latest charts maps coronavirus cases deaths hospitalizations dakota county
 nebraska',
 'iranian analysts announced would examining country deal devious legal tricks
 loopholes arrogant nations might trying slip text',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 edgecombe county north carolina',
 'amending sexual assault laws need overhaul police force entrenched corruption
 political establishment',
 'post trump conservative politics seek learn something ascent simply aim
 repudiate',
 'widely circulating coronavirus variants persistent hesitancy vaccines keep
 goal reach virus stay vaccinating vulnerable may enough restore normalcy',
 'change health law intended make workers conscious price still tax free
 employer sponsored insurance',
 'fragile latin american alliance march toward dictatorship venezuela strain
 memories past invasions reawakened',
 'european union statistics agency release inflation data march monday united
 states jobs data march reported friday',
 'see latest charts maps coronavirus cases deaths hospitalizations stewart
 county georgia',
 'used fairly simple legislative action gotten tangled polarization',
 'many counties including rich ones aging experiencing deaths births without
 growth immigration migration',
 'readers react series editorials calling improved ties end cuban embargo',
 'americans view politics two camps bickering endlessly fruitlessly unimportant
 issues',

'living alone make easier social',
 'representative paul ryan gov chris christie among guests sunday talk shows
 ahead first presidential debate',
 'treasury secretary janet l yellen pointed strong labor market high business
 consumer spending strong industrial output signs economy health',
 'deadly fire immigration center mexico raised troubling questions u crackdown
 migrant crossings',
 'general motors offer stop start technology chevrolet impala congress pushes
 streamline federal paperwork dealerships',
 'times readers babies toddlers preschoolers unvaccinated coronavirus wrote
 worries strains loneliness lost time',
 'see full results maps tennessee election',
 'standard poor says predictability federal fiscal decisions used seemed accept
 forecasts federal debt would eliminated',
 'philippine officials examining potential legal violations fines united states
 million ship ran aground protected coral reef',
 'plan failures recent decision largest companies exit markets leaving large
 areas country functional monopolies',
 'among age vaccination even without booster protected strongly hospitalization
 death according new c c data',
 'democrats insulting condescending swing state voters need',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 wagoner county oklahoma',
 'legislation blunt response iran choice united nations ambassador hamid
 aboutalebi played role american hostage crisis',
 'evidence abraham lincoln ever said anything years life life years',
 'conflict revolutionized society resonated history ever since',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 barton county missouri',
 'see latest charts maps coronavirus cases deaths hospitalizations carroll
 county kentucky',
 'online violence women threat gender equality worldwide new report u n group
 makes clear',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 crittenden county kentucky',
 'traffic run moon pies anticipated places americans prepared monday eclipse
 first move coast coast nearly century',
 'election came party turned voters least another bad national showing g p',
 'farmers others respond sunday review essay let children grow farmers',
 'stephen hahn made misleading remarks coronavirus treatment happen',
 'see latest charts maps coronavirus cases deaths hospitalizations natchez
 area',
 'government reimburse funeral expenses deaths related coronavirus eligible
 survivors yet get relief',
 'employment still long way go returning pre recession level',
 'traditional automakers struggled sell electric cars could change ford
 volkswagen others introduce new models',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations dyer county tennessee',

'many ways social change made us better nation',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations minnehaha county south dakota',

'bob vila finca vig foundation discusses efforts involved getting writer papers united states',

'pandemic target protests laws intended curb powers left u less prepared ever next crisis',

'new fields americas emerging prize global energy market western oil companies looking exploit untapped reserves part world greater political stability',

'campaign end demand prostitution harm trafficking victims sex workers helps',

'require gun owners carry insurance pay annual fee fund violence prevention efforts',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations choctaw county oklahoma',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations st charles parish louisiana',

'democrats deploying black elected officials others target african american voters could help swing midterm elections turn higher forecast rates',

'feats compartmentalization mr christie seemed operate two separate identity splitting spheres mischievous pot shot taking partisan one hand sober crisis managing governor',

'daniel bodah one hundreds lawyers volunteered time airports across united states weekend executive order immigration left dozens detained described experience kennedy airport new york',

'see full results maps maine election',

'abbott nutrition issued voluntary recalls popular baby formulas retailers limited purchases leaving desperate parents searching solutions',

'move white house signals support myanmar recent governmental reforms officially opens door american investment country',

'instead punishing country u check record',

'worthy goals like freedom autonomy harm others hold else',

'sanctions intended thwart president dictatorial actions hit family inner circle hard pain expected sanctions hit russia ally',

'see latest charts maps coronavirus cases deaths hospitalizations hertford county north carolina',

'china becomes richer destined pass united states world inventive nation',

'see latest charts maps virus hospitalizations cases deaths tests vaccinations victoria county texas',

'three major network operators market united states would function similarly european markets like france according experts',

'need cars run methanol high octane fuel made converted natural gas',

'human rights groups tearing obama administration decision overriding wishes aung san suu kyí allow virtually new american investment myanmar',

'federal judge dismissal market manipulation case former barclays trader evidence difficulty proving fraud sophisticated parties involved',

'see latest charts maps coronavirus cases deaths hospitalizations warren county indiana',
 'nord stream direct pipeline russia germany going away neither clamor cancel',
 'irregular call scheduling increases workers stress family conflicts recent research shows',
 'election three weeks away polls suggest democratic hopes retain control chamber dimming though yet gone',
 'mysteries surrounding revised estimates rising white mortality',
 'gap conspiracy theory state policy vanished',
 'decline first three weeks despite resurgence covid cases economists warn job losses ahead',
 'america still federal data privacy law look found hope',
 'mexican official responds recent article united states battling mexican drug cartels',
 'two wildlife organizations praise u regulations aimed stopping slaughter elephants',
 'decade bud light faced conservative led boycott transgender influencer modelo especial track take spot',
 'republicans fought mask requirements vaccine mandates months coronavirus infections rise blaming president failing end health crisis',
 'aarp allies objecting house committees plan vote republican bill could leave people large premium increases',
 'see latest charts maps coronavirus cases deaths hospitalizations muncie area',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations liberty county montana',
 'see latest charts maps coronavirus cases deaths hospitalizations vernon county missouri',
 'japan largest foreign investors treasuries replacing china',
 'beginning july chase charge overdraft fees transactions less',
 'thousands child migrants central america crossed rio grande u soil thousands make far many end detained broke towns like reynosa mexico',
 'data show nation whole moving away exclusionary conceptions identity president trump benefited',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations polk county wisconsin',
 'busy lawmaking season reflects part tailoring president obama policy agenda find common ground republicans',
 'gov scott walker wisconsin emerging crash course foreign domestic issues aim reassuring republican activists donors',
 'regulators block comcast acquisition time warner cable would control much consumers watch read listen',
 'see latest charts maps coronavirus cases deaths hospitalizations mount sterling area',
 'living animal another species never trouble free rewards extravagant',
 'international herald tribune archives doctors monitor vital functions astronauts space',
 'america stretched thin make diplomacy harder',

'new policy seemed catch many retailers workers surprise major union food
 workers asked whether supposed serve vaccination police',
 'expected golden era federal budget policy actually ended like fiscal dark
 ages',
 'patriotism time division',
 'see latest charts maps coronavirus cases deaths hospitalizations putnam county
 indiana',
 'poll also found many unvaccinated believe push booster shots shows
 inoculations working',
 'investors corporations buying houses turning rental properties charlotte n c
 adding hurdles facing would buyers navigating brutal market',
 'see latest charts maps coronavirus cases deaths hospitalizations jo daviess
 county illinois',
 'adapt new normal office let put outmoded norms rest',
 'campaign crowdfund donations weapons producing millions dollars well bounty
 smaller weapons military equipment ukrainian military',
 'senate approved similar measure lopsided votes concealed deep disagreements
 details legislation',
 'people working abortion clinics describe likely effects patients
 constitutional right termination struck',
 'see latest charts maps coronavirus cases deaths hospitalizations carter county
 missouri',
 'president vladimir v putin russia unleashed perhaps strongest diatribe united
 states yet',
 'travel restrictions might make sense country really needs better disease
 surveillance',
 'state attorneys general asking federal education officials forgive student
 loans harmed schools',
 'president biden declared monday within days u would achieve goal administering
 million vaccination shots delivering million stimulus checks americans',
 'rising immunity modest changes behavior may explain cases declining much
 remains unknown scientists say',
 'world record x relay jamaica proved cradle sprinters usain bolt claimed sixth
 olympic gold medal',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 san diego county california',
 'dobbs v jackson decision many women discovering employer shape major decisions
 lives even week ago',
 'new figure likely raise questions sufficiency services support population may
 larger many assumed',
 'highlights international herald tribune archives fires ravage parts dakota
 ottoman government lets women study abroad',
 'revelations united states google employee informed colleagues program would
 collect personal data cast doubt company excuses',
 'see full results maps michigan election',
 'supreme court need fix daca donald trump',
 'democracy choice triumph kansas',

'using index tracks policy responses pandemic times analyzed outbreaks state
 relative state recent containment measures',
 'american ambassador bogot discusses colombia u relations cocaine production
 accuracy show narcos',
 'colleges across country figuring covid changed college experience parents
 struggling understand schools changed price tag',
 'union stepping pressure united states add european countries list entitled
 visa free travel',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 montour county pennsylvania',
 'good pay equity good managers good superstars',
 'cubans en route united states find stymied obama administration ends called
 wet foot dry foot immigration policy',
 'bacteria burkholderia pseudomallei found along gulf coast region southern
 mississippi previously detected parts asia australia',
 'see full results maps alabama election',
 'following deep losses midterm elections president obama flexed muscles climate
 change immigration internet neutrality',
 'see full results maps presidential election utah',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 clark county kansas',
 'trade case accuses chinese makers using government subsidies help gain sales
 american market',
 'third year pandemic loomed seven day average u cases topped tuesday',
 'see latest charts maps coronavirus cases deaths hospitalizations fallon county
 montana',
 'moon dust fate revealed britain national archives released pages
 correspondence subject going back years',
 'curtailing inequality saving democracy',
 'fragmented system conflicting interests poses hurdles improvements past three
 presidents called priority',
 'counties united states meet c c guidelines avoid major restrictions reopening
 schools according new york times analysis',
 'see full results maps california election',
 'also another taylor swift ticket fiasco latest end tuesday',
 'hostility trump administration rude shock germany threatening bedrock country
 economy',
 'results diverge past research said older people likely share false news
 articles social media',
 'see latest charts maps coronavirus cases deaths hospitalizations orange county
 new york',
 'nearly every ingredient turkey dinner coffee expected cost host reasons',
 'see full results maps new york election',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 crockett county tennessee',
 'health experts expressed dismay judge ruling struck c c mask mandate planes
 trains buses',

'extreme heat drought conditions fueled wildfires across west dozens actively
 burning region oregon bootleg fire burned acres',
 'coronavirus exposed european countries misplaced confidence faulty models
 bureaucratic busywork wealth',
 'officials nationwide rethinking efforts slow virus nation top infectious
 disease expert said working',
 'ruling overturned sex marriage bans gay americans broke joyous celebration
 holding rallies street parties champagne toasts instant weddings',
 'see full results maps oregon election',
 'faced barrage negative campaign ads funded republican leaning groups democrats
 moving rapidly create groups',
 'educate girl send young person college restore person sight',
 'white house push deport vietnamese came united states also resulted extended
 immigration detentions eased',
 'united states shockingly ranks near bottom compared advanced nations',
 'transportation department penalties come many travelers expressed frustration
 flight delays cancellations problems',
 'insurers say price gouging law left opening labs charge price wished',
 'increase u murders summer appear large record spike last summer',
 'look u national team roster january training camp two upcoming friendlies',
 'moscow put william f browder kremlin critic interpol list international
 fugitives hours later announced visa restored',
 'see full results maps new jersey elections',
 'second spot national network cable television intended introduce nespresso
 division nestle wider audience american coffee drinkers',
 'times photographer adam ferguson worked migrants mexico create series self
 portraits waited cross border united states',
 'five years stimulus took effect clear though program much good also political
 disaster',
 'understand results roll tuesday',
 'see latest charts maps coronavirus cases deaths hospitalizations flagstaff
 area',
 'see latest charts maps coronavirus cases deaths hospitalizations broadwater
 county montana',
 'cheaper pools private hot tubs bathtub leaving bathroom designs garden even
 treehouse',
 'different groups voted',
 'senator robert menendez democrat new jersey projected business usual
 appearance even hired team defuse crisis',
 'see latest charts maps coronavirus cases deaths hospitalizations hancock
 county kentucky',
 'vaccines effective preventing serious illness death golden shield
 coronavirus',
 'ivy leaguers need advice preserve privilege',
 'en este breve documental los latinos tratan de definir su identidad tñica
 racial',
 'rev patrick j conroy house representatives chaplain rev dr barry c black

senate chaplain try nurture civility fractious congregation',
 'united states supreme court meeting sept decide whether hear appeal ruling favoring bondholders refused join deal defaulted bonds argentina',
 'ms harris last saw president biden two days tested positive coronavirus',
 'months go caucuses republican hopefuls fighting attention expert advisers early advantage',
 'washington meeting president obama herman van rompuy jos manuel barroso came amid increasing worries future nation euro monetary union',
 'high court united methodist church admonished segments denomination allowing clergy bishop openly gay splintering church',
 'mr miller conservative trapped liberal california high school rocketed upper reaches white house influence especially immigration',
 'dispute centers called schneerson library sought hasidic group based brooklyn',
 'c c also signs broad booster requests moderna pfizer every adult fully vaccinated least six months ago would eligible could choose type booster shot get',
 'defense alarmism immigration presidential caesarism',
 'school meals reflect society true food culture well regard children',
 'president obama use state union address tuesday call congress raise taxes fees wealthiest taxpayers finance tax cuts administration officials said saturday',
 'mr sasaki one influential charismatic zen masters america tide sex abuse allegations emerged cast character legacy harsh light',
 'martin gaynor federal trade commission writes enforcing antitrust laws conflict goals health care law',
 'see full results maps rhode island election',
 'see latest charts maps coronavirus cases deaths hospitalizations roosevelt county montana',
 'many schools use fever scanners symptom checkers rigorously studied technology slowed spread covid campuses',
 'church leaders made blind cruel',
 'national association realtors facing antitrust lawsuits sexual harassment allegations real estate agents looking alternatives',
 'incompetence top really matter',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations clinton county iowa',
 'trade deficit president trump often railed hit historic highs last year',
 'thousand readers wrote personal histories lessons shared',
 'fastest growing demographic group u comes nation racial ethnic divisions fit',
 'see full results maps north carolina election',
 'civic psychic benefits life behind wheel',
 'policy allowing pharmacies dispose customers excess medications rather let fall hands drug abusers found takers',
 'day standard poor downgraded creditworthiness united states government defended decision warned downgrades may come',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations jefferson county idaho',

'declining mobility may symptomatic broader crisis faith american dream',
 'different groups voted',
 'agency also found evidence terrorism similar paris planned united states',
 'documentary hologram concert creation celebrating famous opera singer
 testament enduring legacy get line',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 pike county pennsylvania',
 'unclassified u intelligence document underscores Biden administration growing
 alarm potential Russian invasion Ukraine',
 'see latest charts maps coronavirus cases deaths hospitalizations Porter County
 Indiana',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 Forsyth County North Carolina',
 'e c actions indicate push require crypto businesses offering securities follow
 rules traditional stock bond exchanges',
 'agreement officials say replicated would send asylum seekers detained remote
 islands United States',
 'see full results maps Oregon election',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 Harnett County North Carolina',
 'see latest charts maps coronavirus cases deaths hospitalizations Noxubee
 County Mississippi',
 'federal reserve officials forecast higher interest rates week sign borrowing
 costs heading back rock bottom levels normal pandemic',
 'reporters New York Times spoke people across country understand issues split
 voters election today',
 'within days three countries could giving Pfizer BioNTech vaccine varying
 strategies challenges u plan working states least centralized',
 'Republican officeholders longer coy religion driven mission stop abortion',
 'molten core right wing nationalism furious denial America unalterably
 multiracial multicultural national character',
 'see latest charts maps coronavirus cases deaths hospitalizations Jennings
 area',
 'Hillary Clinton said path little easier women try shatter highest glass
 ceiling optimistic',
 'prices rising fast ways seem temporary yet could change expectations ways self
 reinforcing',
 'latest installment fast furious series brought money box office China United
 States',
 'good discussing trade offs need make pandemic',
 'marine request came United States intensified negotiations Iranians disputed
 nuclear program',
 'see latest charts maps coronavirus cases deaths hospitalizations Greene County
 North Carolina',
 'amid drift bipartisanship esteemed chairmanship Senate Finance Committee
 declined stature next leader likely diminished clout',
 'three new books analyze shortcomings nation criminal justice system',

'millennials lean left several characteristics may help democratic ticket november',
 'senate democrats plan force confirmation votes appointments president obama threaten rules changes thwart republican tactics like filibuster',
 'numbers lie united states gets low scores new report social justice',
 'see latest charts maps coronavirus cases deaths hospitalizations paragould area',
 'national toll shows difficult predicting virus human behavior president trump leading experts times said deaths would much lower',
 'lauded president trump symbol american manufacturing company hopes new plant thailand help clear trade barriers woo southeast asian buyers',
 'removing application federal aid would encourage qualified low income students apply college',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations jenkins county georgia',
 'advisers better intelligence could improve united states air power effort assist nuri kamal al maliki government',
 'today minute ukraine announces military operations pro russian militants',
 'see latest charts maps coronavirus cases deaths hospitalizations randolph county indiana',
 'schools used covid relief funds improve air quality properly',
 'sen barbara boxer support lend political heft bill would permit medicinal use marijuana states allow',
 'archives international herald tribune june president johnson warns vietnam heavier air attacks',
 'n f l little wiggle room regular season playoffs universities reshuffling college basketball teams college football playoff bowl games near',
 'international herald tribune archives billion u loan britain suggested',
 'see latest charts maps coronavirus cases deaths hospitalizations owsley county kentucky',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations langlade county wisconsin',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations owen county indiana',
 'miss gone',
 'see latest charts maps coronavirus cases deaths hospitalizations piscataquis county maine',
 'miss best political quotes weekend caucus rundown favorites',
 'united states host davis cup tie clay britain san diego petco park',
 'repairing nation problems take work building blocks exist good foundation would mandatory national service program',
 'administration lifting ban importing elephant parts severed trophies animals shot zimbabwe',
 'heinous act democratic government engage use law enforcement machinery political ends',
 'cities states looking toward simple solution mass unemployment hire workers directly',

'see latest charts maps coronavirus cases deaths hospitalizations washington
 county minnesota',
 'readers applaud change though one disagrees editorial board choice also
 unfairness mandatory sentencing',
 'mr godley british economist died helped develop formal models foresaw
 financial crisis late underestimated depth',
 'civilization oppresses wilderness best therapy',
 'new report shows inequality today leads future',
 'president ali abdullah saleh yemen seeking treatment injuries sustained
 presidential palace bombed june arrived saturday officials said',
 'see latest charts maps coronavirus cases deaths hospitalizations jackson
 county mississippi',
 'fallout housing crash continues affect old young renters buyers',
 'staff shortages school districts canceling classes others lowering hiring
 standards result chaotic classroom',
 'decades drought colorado river breaking point federal government may
 intervene',
 'president trump beijing indicated trade war could continue surprising
 businesses investors expected resolution week',
 'nan',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 boyle county kentucky',
 'among thousands died prisons jails coronavirus dozens people approved parole
 convicted charge arrested',
 'secretary state john kerry attended ceremony diplomatic post officially opened
 july talking dissidents separate reception',
 'workers long faced talk politics service abroad recent scrutiny made
 particularly difficult',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 ness county kansas',
 'see full results maps north dakota election',
 'booming depressed market battery powered vehicles plus climate pose big threat
 carmakers parts suppliers slow change',
 'party unyielding approach treating climate talks waste time even sympathizers
 shaking heads',
 'absence censorship chinese broadcast series somewhat surprising may indicate
 relaxed approach toward newer medium online television show imports',
 'thousands satellites vehicles orbit present possible targets attacks',
 'increasingly national problem consequences quality american family life
 economy future housing politics',
 'amazon must become leader reducing single use packaging',
 'epic tale favor currying arm twisting reputation wrecking ego massaging
 confidence betraying rumor mongering',
 'see latest charts maps coronavirus cases deaths hospitalizations poinsett
 county arkansas',
 'many people get vaccinated need keep masks handy',
 'study hundreds bald eagles golden eagles showed nearly half chronic lead

poisoning',
 'threat stops short compelling tech companies give access intelligence
 officials australia britain canada new zealand united states',
 'number large projects fallen global ccs institute says even though scientists
 say projects needed fight climate change',
 'stake majority leader battle justice scalia replacement',
 'roughly million americans enrolled medicare get eight free home coronavirus
 tests per month pharmacies health care providers move biden administration
 expand testing access',
 'drought represents opportunity reimagine manage use even think water',
 'representative jamaal bowman new york says drive ban tiktok stems anti china
 hysteria democratic colleagues disagree',
 'pretend making criminal act consequences',
 'time year television littered negative campaign ads family dinners interrupted
 calls automated voices soliciting votes election cycle machines appear losing',
 'millions people making living cobbled together proposition leaves hole safety
 net things turn bad',
 'many unknowns means manage variant',
 'flights traveling west east atlantic ocean week wind side pushing landing
 times hour ahead schedule',
 'deal latest move japanese insurer expand operations united states world
 largest insurance market',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 steuben county new york',
 'jewish lawmakers support nuclear deal iran likened nazi collaborators oppose
 called traitors',
 'decision broaden access medication abortion increasingly common method many
 conservative states already mobilizing',
 'international herald tribune',
 'trip space supposed last six months frank rubio technical difficulties kept
 crew orbit year',
 'germany halted certification pipeline linking country russia response kremlin
 recognition two separatist regions ukraine',
 'readers respond op ed article civil right unionize',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 sublette county wyoming',
 'see full results maps minnesota election',
 'studying protest music yesterday today engaging teaching tool whether goal
 better understand time period analyze power lyrics poetry understand forces
 social change respond current issues',
 'judge tanya chutkan allowed case proceed class action suggesting government
 policies infringed teenagers constitutional rights',
 'silicon chips power everything cars toys phones nukes chip war chris miller
 recounts rise chip industry outsize geopolitical implications ascendancy',
 'archives international herald tribune president harrison proclaims
 international copyright law july',
 'international survey found pandemic enhanced public faith researchers

science',
 'omicron spreads experts calling switch saliva based tests may detect
 infections days earlier nasal swabs',
 'scientists agree need ramp',
 'see latest charts maps coronavirus cases deaths hospitalizations clay county
 indiana',
 'new campaign budget estimated million million introduce theme real
 possibilities',
 'teachers hotel workers supermarket cashiers inspired general motors workers go
 strike',
 'british newspaper claim journalists working news corporation tried obtain
 phone records victims sept terrorist attacks may prompt f b inquiry',
 'president obama proposed tax oil production probably make congress important
 nonetheless',
 'new film vampire saga sucks million',
 'portraying good guy seedy corner home sales divvy received mixed early reviews
 bulk clients soon decide whether buy back',
 'word letter investors paul singer founder billion hedge fund elliot
 management attacks government officials united states europe fiscal
 recklessness',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 jackson county arkansas',
 'death toll rises latest round israeli palestinian fighting look obama
 administration strategy reaching cease fire',
 'legislation could considered week would allow younger interstate truckers
 undermine safety roads rails numerous ways',
 'donald j trump use speeches going build wall helped connect voters attacks
 boasts came back haunt',
 'federal reserve run stubborn obstacle efforts lower prices companies reluctant
 give fat profits',
 'someone living paycheck paycheck falls victim online fraud breach cascade
 repercussions devastating',
 'juneteenth made federal holiday year big box stores like walmart going themed
 party supplies sometimes crowding smaller vendors',
 'see latest charts maps coronavirus cases deaths hospitalizations grayson
 county kentucky',
 'amounts olympics culinary skill group chefs led thomas keller prevails',
 'united states men basketball team winning without james taking many shots
 throttled nigeria james play second half',
 'biden end ban midnight dec reversing restrictions imposed last month south
 africa criticized ban discriminatory',
 'world champion gymnastics even make national championships',
 'mass protests grave threat even fiercest autocrat plummeted effectiveness
 study shows factors appear include polarization social media rising nationalist
 attitudes',
 'see latest charts maps coronavirus cases deaths hospitalizations iberia parish
 louisiana',

'left right respond differently climate change',
 'public must make transition green consumers green citizens',
 'estimates exit polls offer initial indication groups voted election night',
 'gen john p abizaid led united states central command advise ways strengthen
 ukraine military',
 'undermining world trade organization judges united states could destroy one
 best tools hold china accountable',
 'end turbulent campaign global news organization big role play reporters
 collecting vote counts county clerks states',
 'see latest charts maps coronavirus cases deaths hospitalizations ste genevieve
 county missouri',
 'see latest charts maps coronavirus cases deaths hospitalizations pine county
 minnesota',
 'united states appears poised look inward growth argentina rebound damaging
 populist policies model',
 'president failed read mood congress many americans paris attacks',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 tillamook county oregon',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 crawford county wisconsin',
 'new study estimates invasive forest insects cost local governments billion
 year residential homeowners another billion lost property values',
 'first newts salamanders plain cool also many species united states may brink
 deadly fungal assault',
 'public health officials advising rituals many families cherish state travel
 large indoor gatherings',
 'trash americans want movies go',
 'queer people families registering danger states considering relocation',
 'republican gains likely add state abortion restrictions two day waiting
 periods bans weeks conception costly building requirements',
 'see full results maps presidential election iowa',
 'freedom binge media anytime see problem ahead',
 'years meeting victims families representative carolyn mccarthy move know tried
 make difference',
 'representative ted lieu democrat california called representative chris
 collins republican new york embarrassment house',
 'apple granted design patent week page turn e reader application onion',
 'see latest charts maps coronavirus cases deaths hospitalizations adams county
 idaho',
 'though americans realize south africa owes much success fight aids single
 united states program one moving elsewhere',
 'neither man seems ready harsh political reality',
 'former colonel convicted immigration violations united states suspected
 killing six priests el salvador could face trial spain',
 'african american educators left feeling used many black politicians enraged
 demanded president trump show support offering funding',
 'package bills passed bipartisan support versions already senate rare

legislative compromise might offering issue attracted growing attention',
'u make th appearance final playing japan',
'compared aloof barry desperate democrats see triangulating bill clinton mother
teresa',
'colorful democrat ohio mr traficant became second member house representatives
ousted since civil war',
'old hickory must make room indian antagonist john ross',
'health implications fracking understood argue administration approve
infrastructure would allow export vast quantities natural gas',
'see latest charts maps coronavirus cases deaths hospitalizations big horn
county montana',
'cope worsening crisis federal housing finance agency jump start trust fund
program',
'promises judicial reforms gone largely unfulfilled practices adopted united
states invasion remain core sunni grievances',
'multiracial biracial students use strength growing numbers affirm roots
portrayed tragic pitiable',
'united states five countries announced potentially game changing initiative
cut global warming gases',
'see latest charts maps virus hospitalizations cases deaths tests vaccinations
kenosha county wisconsin',
'everything need know cfda awards tonight much costs go picks winners kim
kardashian west may wear',
'men women similar opinions different racial groups generations',
'see latest charts maps coronavirus cases deaths hospitalizations humboldt
county iowa',
'international herald tribune archives government troops seek prevent indian
uprising',
'justices take hammer public sector employee unions teachers appear back public
favor',
'got wake call day massacre time act',
'see latest charts maps virus hospitalizations cases deaths tests vaccinations
ontonagon county michigan',
'paradigm shifting plan involve cities teams profit event first include teams
instead',
'many swept office last year aggressive plans cut spending curb union powers
sounding less confrontational backlash constituents',
'millions u drug users addicted several substances opioids like fentanyl heroin
shift making treatment far difficult',
'hint lost year also screen time friends good mental health',
'see latest charts maps virus hospitalizations cases deaths tests vaccinations
wilcox county alabama',
'times tagged along shift border patrol agents horseback play essential role
efforts detect illegal activity near hard patrol areas along rio grande',
'left right debate gender panic gripping american politics',
'see latest charts maps coronavirus cases deaths hospitalizations macon county
alabama',

'readers offer praise pope message critique american church',
 'stocks across wall street enduring one prolonged periods volatility past decade',
 'beijing says outposts police work chinese state media reports say collect intelligence solve crimes far outside jurisdiction',
 'covid nowhere near agency director general declared',
 'shifting u policies global migration patterns changing migrant demographics contribute record levels border crossings',
 'political news today times plus look happening washington',
 'defense secretary ashton b carter offer detailed explanation errant airstrike iraqi government said killed least nine iraqi soldiers said seemed mistake involved sides',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations cherokee county kansas',
 'employee doubts rising taiwan semiconductor manufacturing company billion investment arizona factory',
 'proposed dollar stores rejected since report shows small number compared opened evidence opposition industry',
 'director centers disease control prevention urged local leaders individuals least consider returning wearing masks indoor public settings',
 'reindeer menorah antlers retailers want inclusive holiday merchandise hit snags',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations marshall county kentucky',
 'american catfish farmers say additional program vital safety vietnam says nothing trade barrier disguise',
 'temperatures across country hit record lows tuesday morning prompting school districts close others delay opening',
 '1 season opener los angeles seattle tuesday average match league game statistics tell us league compared top european leagues',
 'shipping giant paid million naming rights fedex field sponsorship deal began',
 'e u leaders still learning navigate world ever dangerous relations united states grow awkward',
 'new american ambassador china max baucus visited ministry foreign affairs tuesday morning present copy credentials formality allowed meet journalists united states embassy afternoon',
 'see latest charts maps coronavirus cases deaths hospitalizations martin county indiana',
 'despite influx american assistance residents area honduras become way station cocaine way north say feel threatened',
 'schools run defense department educate children civilian employees service members',
 'secretary state john kerry arrived baghdad wednesday pledge united states support defeating terrorist group islamic state iraq syria',
 'see latest charts maps coronavirus cases deaths hospitalizations coffeyville area',
 'see latest charts maps coronavirus cases deaths hospitalizations marshall

county kentucky',
 'nature marriage changing contributing income inequality research shows',
 'travels george book part history part travelogue philbrick retraces washington
 steps effort understand america problems',
 'liberal groups promising furious fight judge neil gorsuch say rival memorable
 clashes candidates highest court',
 'u vice president joe biden arrived india monday four day visit',
 'tens thousands unaccompanied minors fleeing violence poverty still making
 dangerous journey north though many stopped mexico',
 'united states revived international effort stop drug planes using tiny central
 american country way station cocaine smuggling united states',
 'departures leave critical infrastructure elections data networks vulnerable',
 'see latest charts maps coronavirus cases deaths hospitalizations lake woods
 county minnesota',
 'committee announced criminal referrals donald trump legal minions',
 'cleaning house taking care children real economic value women free long',
 'bright shiny democracy may going drain holidays',
 'sometimes true costs hidden backloading',
 'get recommendations new york times reporters editors highlighting interesting
 stories around web installment great reads john leland steve lohr others',
 'see full results maps minnesota election',
 'see latest charts maps coronavirus cases deaths hospitalizations marco island
 area',
 'republican climate denial even scarier trumpism',
 'president asked court whether enjoys absolute immunity answer emphatic',
 'two decades bush administration said wanted disarm weapons mass destruction
 free iraqis debates rage knew motive mattered',
 'fiat announces ad campaign plays old derogatory acronym g announces less
 expensive way use lightweight aluminum vehicle production',
 'president afghanistan foreign press association says american support pakistan
 harmed region readers invited respond',
 'pair prominent headlines highlights reversals',
 'th congress something else well worry people next one entirely',
 'administration says actually health care worlds apart',
 'chaotic administration unexpectedly coherent grand strategy',
 'core america problems primarily economic moral',
 'times underestimate number people marched last weekend keep writing part
 country rust belt',
 'tour operator washington state accused carrying hostile acts north korean
 government',
 'seeking underscore seemingly absent history ken gonzales day altered th th
 century postcards lynchings american west removing bodies original scenes',
 'lu shaye said op ed hill times canadians applied double standards viewing
 country laws observed china',
 'many green card holders everything needed citizenship except desire feel
 american dislike american policies care',
 'see latest charts maps coronavirus cases deaths hospitalizations hidalgo

county new mexico',
 'accuracy census endangered budget staffing problems administration war facts',
 'confiscating russian state assets frozen united states europe could breach
 international law set dangerous precedent experts say',
 'reeling pandemic transit agencies grappling drastic reductions ridership
 pleading help washington',
 'dozen reasons',
 'shift americans understanding role u nature power complex unnerving
 consequences',
 'president expressed conflicting emotions brought country children attorney
 general jeff sessions expressed qualms',
 'also minute stimulant use united states rises class session new york times
 wine school',
 'russia attacked ukrainian troops near villages ukraine south day russian
 missiles killed least people president vladimir v putin acknowledged russian
 losses',
 'defense secretary resigned obama administration core military problem national
 security policy incoherent shifting',
 'slow start amid fierce political controversy obama administration said friday
 syrian refugees arrived since october',
 'see latest charts maps virus hospitalizations cases deaths tests vaccinations
 morrow county ohio',
 'see full results maps rhode island election',
 'layer ice snow accompanied plunging temperatures swept country leading
 canceled flights school closings',
 'pepsico voluntarily recalled beverages glass found bottles u food drug
 administration said',
 'also chinese hackers hit state department ocean temperatures rise milan
 kundera dies',
 'addition plethora land canada many libraries extensive literary collections
 summer nears midway point librarians offer suggestions good books canadian
 authors',
 'u china trade war intensified yesterday beijing washington outlined plans
 increase tariffs goods',
 'tens thousands open appointments sites across country forcing officials adjust
 outreach strategies zero smaller events',
 'marriott among companies stop campaign contributions lawmakers objected
 certifying election companies jpmorgan paused political donations',
 'much deliberation president obama punishing russia cyberattacks united states
 successor may seek mend fences',
 'see latest charts maps coronavirus cases deaths hospitalizations adams county
 iowa',
 'honda odyssey minivan gets insurance institute highway safety highest rating
 ford offers bacon wrapped fiestas',
 'chen guangcheng left china last year began day visit taiwan leaving new york
 amid controversy involving host new york university',
 'see full results maps rhode island election',

'important reflections progress dr ashish k jha said would whether health care systems strained whether people hospitalized dying covid',
'state department former top lawyer wrote legal opinion legally available policy makers claim application abroad',
'modeling key battleground states',
'nation ports suggest holiday shopping season may disappoint wall street protests continued continued provoke europe pressed harder find solution deepening debt crisis iphone went sale',
'main reason discrepancies state county data always properly link record people booster shots initial vaccinations',
'stop worrying monopoly power',
'see latest charts maps coronavirus cases deaths hospitalizations chautauqua county new york',
'party establishment wing series primaries year leaders considering tough tactics head attacks tea party',
'resumption negotiations could relieve rising pressure israel use military force iran buy tehran time relocate centrifuges',
'let show unsung heroes heroines appreciation next week sending mother special teacher message twitter',
'prime minister narendra modi cracked dissent india new york wednesday stressed inclusivity',
'skate parks considered menace booming everywhere around world head toward first skateboarding olympics',
'estimates exit polls offer initial indication groups voted election night',
'peaking june back march offering relief consumers policymakers amid inflation worries',
'senator carl levin michigan done anyone expose financial industry past years',
'forgetting society',
'parts existing tax code different biden proposed tax ultrawealthy',
'julian assange quickly became partisan issue britain experts noted united states lost high profile extradition cases',
'united states similar developing countries percentage mothers give birth child due according world health organization agencies',
'american investigators increasingly focusing venezuelan officials suspected corruption including officials government owned oil company petr leos de venezuela',
'president biden led group counterparts agree plan would cap price russian oil daunting goal risks kremlin restricting supply even',
'detailed economic study yet global warming cost united states finds southeast midwest hardest hit',
'samsung innovation strategy team announced plans open platform developers medical professionals hardware makers push forward idea intelligent digital health',
'see latest charts maps coronavirus cases deaths hospitalizations st charles parish louisiana',
'prime minister benjamin netanyahu devoted first part speech general assembly harsh denunciation accord iran',

```
'shifts brought pandemic favoring online retailers bookstores established
authors new ones change publishing forever',
'people whose home vehicle knock visceral even existential threat',
...]
```

```
[168]: clean_train_abs = pd.Series(clean_train_abs)
clean_train_lines = pd.Series(clean_train_lines)

# Combine the lists element-wise
clean_train_total = clean_train_abs + ' ' + clean_train_lines

# Display the result
clean_train_total
```

```
[168]: 0      see latest charts maps coronavirus cases death...
      1      biggest increases come groups past far less li...
      2      miguel cardona education secretary said reopen...
      3      mohamed morsi egypt first democratically elect...
      4      see full results maps district columbia electi...

      ...
20403    americans extremely attuned cost living midter...
20404    quest community leads superstar back ohio look...
20405    american rugby team members discuss world cup ...
20406    see full results maps florida election florida...
20407    see latest charts maps virus hospitalizations ...
Length: 20408, dtype: object
```

```
[169]: #ensure this worked
clean_train_lines[456]
```

```
[169]: 'u partisanship highest decades pew study finds'
```

```
[170]: clean_train_abs[456]
```

```
[170]: 'negativity fear anger among democrats republicans rise research shows'
```

```
[171]: clean_train_total[456]
```

```
[171]: 'negativity fear anger among democrats republicans rise research shows u
partisanship highest decades pew study finds'
```

```
[172]: clean_test_abs = pd.Series(clean_test_abs)
clean_test_lines = pd.Series(clean_test_lines)

# Combine the lists element-wise
clean_test_total = clean_test_abs + ' ' + clean_test_lines

# Display the result
```

```
clean_test_total
```

```
[172]: 0      see full results maps california election cali...
      1      campuses challenging definition rape many stat...
      2      move radical departure country historically de...
      3      appeal help united states rushing dozens missi...
      4      see latest charts maps coronavirus cases death...

      ...
5097      abdicated parental rights duties new societal ...
5098      overcame desperation felt stepping congress st...
5099      former n f l wide receiver joined premier lacr...
5100      placing tracking devices netbooks discarded ce...
5101      sales alternative fuel vehicle fallen along ga...
Length: 5102, dtype: object
```

```
[173]: clean_test_abs[456]
```

```
[173]: 'two recent supreme court decisions reduce abusive frivolous patent litigation
increased sharply recent years'
```

```
[174]: clean_test_lines[456]
```

```
[174]: 'clarifying tightening patent law'
```

```
[175]: clean_test_total[456]
```

```
[175]: 'two recent supreme court decisions reduce abusive frivolous patent litigation
increased sharply recent years clarifying tightening patent law'
```

The element-wise concatenation worked proceed to modeling section

```
[176]: type(clean_train_total)
```

```
[176]: pandas.core.series.Series
```

```
[177]: clean_train_total = clean_train_total.tolist()
```

```
[178]: clean_test_total = clean_test_total.tolist()
```

```
[179]: type(clean_train_total)
```

```
[179]: list
```

```
[180]: type(clean_test_total)
```

```
[180]: list
```

2 Preliminary Modeling Section

3 Baseline accuracy

Calculate baseline accuracy in order to tell if model is better than null model (predicting the plurality class).

```
[194]: df['section_name'].value_counts(normalize=True)
```

```
[194]: section_name
0      0.765817
1      0.234183
Name: proportion, dtype: float64
```

```
[195]: # Baseline prediction dem 1 rep 0
y_train.value_counts(normalize=True)
```

```
[195]: section_name
0      0.765729
1      0.234271
Name: proportion, dtype: float64
```

```
[196]: print(f"Difference metric | {round(np.abs(np.mean(df['section_name'])-np.
      ↪mean(y_train)), 5)}")
```

Difference metric | 9e-05

4 Classification Modeling Section

4.1 Logistic regression

```
[220]: pipe1 = Pipeline([
      ('cvec', CountVectorizer()),
      # ('ss', StandardScaler(with_mean=False)),
      ('lr', LogisticRegression())
    ])

    pipe2 = Pipeline([
      ('tvec', TfidfVectorizer()),
      # ('ss', StandardScaler(with_mean=False)),
      ('lr', LogisticRegression())
    ])

    pipe_params1 = {'cvec__max_features': list(np.arange(5000, 10000, 1000)),
                    'cvec__ngram_range': [(1,1), (1,2)],
                    'cvec__min_df': [0.00005, 0.0001],
                    'cvec__max_df': [0.6,0.65,0.7],
                    'lr__C': [0.1, 1, 10, 100],
```



```

        'lr__penalty': ['l1', 'l2'],
        'lr__max_iter': [1000],
    }

pipe_params2 = {'tvec__max_features' : list(np.arange(5000, 10000, 1000)),
                'tvec__ngram_range' : [(1, 1), (1, 2)],
                'tvec__min_df': [0.00005, 0.0001],
                'tvec__max_df': [0.6, 0.65, 0.7],
                'lr__C': [0.1, 1, 10, 100],
                'lr__penalty': ['l1', 'l2'],
                'lr__max_iter': [1000], # Do not go lower than 1000 fail to
↳converge
    }

# Instantiate GridSearchCV.

gs1 = GridSearchCV(pipe1, # what object are we optimizing?
                   param_grid=pipe_params1, # what parameters values are we
↳searching?
                   cv=5,
                   n_jobs=-1) # 5-fold cross-validation.

gs2 = GridSearchCV(pipe2, # what object are we optimizing?
                   param_grid=pipe_params2, # what parameters values are we
↳searching?
                   cv=5,
                   n_jobs=-1) # 5-fold cross-validation.

gs1.fit(clean_train_total, y_train)

gs2.fit(clean_train_total, y_train)

```

/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/model_selection/_validation.py:425: FitFailedWarning:
1200 fits failed out of a total of 2400.
The score on these train-test partitions for these parameters will be set to nan.
If these failures are not expected, you can try to debug them by setting error_score='raise'.

Below are more details about the failures:

```

-----
1200 fits failed with the following error:
Traceback (most recent call last):
  File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/model_selection/_validation.py", line 732, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)

```

```

File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/base.py",
line 1151, in wrapper
    return fit_method(estimator, *args, **kwargs)
File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/pipeline.py",
line 420, in fit
    self._final_estimator.fit(Xt, y, **fit_params_last_step)
File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/base.py",
line 1151, in wrapper
    return fit_method(estimator, *args, **kwargs)
File "/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/linear_model/_logistic.py", line 1168, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
File "/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/linear_model/_logistic.py", line 56, in _check_solver
    raise ValueError(
ValueError: Solver lbfgs supports only 'l2' or 'none' penalties, got l1 penalty.

```

```

warnings.warn(some_fits_failed_message, FitFailedWarning)
/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/model_selection/_search.py:976: UserWarning: One or more of the
test scores are non-finite: [          nan 0.87921426          nan 0.88073352
nan 0.86324036

```

nan 0.84736415	nan 0.87906721	nan 0.87916538
nan 0.86181942	nan 0.8436403	nan 0.87921431
nan 0.87941057	nan 0.86275048	nan 0.84751122
nan 0.87838121	nan 0.87975328	nan 0.86113323
nan 0.84486525	nan 0.87970434	nan 0.88141943
nan 0.86544543	nan 0.85206823	nan 0.88004723
nan 0.8809784	nan 0.86363234	nan 0.85118626
nan 0.87990035	nan 0.88161546	nan 0.86583748
nan 0.85275435	nan 0.87999818	nan 0.88019441
nan 0.86446542	nan 0.85123528	nan 0.8801943
nan 0.88298745	nan 0.86789553	nan 0.8564784
nan 0.88078222	nan 0.88220329	nan 0.86750337
nan 0.85544939	nan 0.87990034	nan 0.88269345
nan 0.86681769	nan 0.8540284	nan 0.88068421
nan 0.88141939	nan 0.86716047	nan 0.85451829
nan 0.8805373	nan 0.88352648	nan 0.86970862
nan 0.85853642	nan 0.8811252	nan 0.88230141
nan 0.86853247	nan 0.85907531	nan 0.88024335
nan 0.88230163	nan 0.86882677	nan 0.85780146
nan 0.88127221	nan 0.88308528	nan 0.86833635
nan 0.85770321	nan 0.88088029	nan 0.88352653
nan 0.86892467	nan 0.85932053	nan 0.88146825
nan 0.88225243	nan 0.86887549	nan 0.86039822
nan 0.88068433	nan 0.88269358	nan 0.87005165
nan 0.86128053	nan 0.88137026	nan 0.88293839
nan 0.86760145	nan 0.8584382	nan 0.87921426

nan 0.88073352	nan 0.86324036	nan 0.84736415
nan 0.87906721	nan 0.87916538	nan 0.86181942
nan 0.8436403	nan 0.87921431	nan 0.87941057
nan 0.86275048	nan 0.84751122	nan 0.87838121
nan 0.87975328	nan 0.86113323	nan 0.84486525
nan 0.87970434	nan 0.88141943	nan 0.86544543
nan 0.85206823	nan 0.88004723	nan 0.8809784
nan 0.86363234	nan 0.85118626	nan 0.87990035
nan 0.88161546	nan 0.86583748	nan 0.85275435
nan 0.87999818	nan 0.88019441	nan 0.86446542
nan 0.85123528	nan 0.8801943	nan 0.88298745
nan 0.86789553	nan 0.8564784	nan 0.88078222
nan 0.88220329	nan 0.86750337	nan 0.85544939
nan 0.87990034	nan 0.88269345	nan 0.86681769
nan 0.8540284	nan 0.88068421	nan 0.88141939
nan 0.86716047	nan 0.85451829	nan 0.8805373
nan 0.88352648	nan 0.86970862	nan 0.85853642
nan 0.8811252	nan 0.88230141	nan 0.86853247
nan 0.85907531	nan 0.88024335	nan 0.88230163
nan 0.86882677	nan 0.85780146	nan 0.88127221
nan 0.88308528	nan 0.86833635	nan 0.85770321
nan 0.88088029	nan 0.88352653	nan 0.86892467
nan 0.85932053	nan 0.88146825	nan 0.88225243
nan 0.86887549	nan 0.86039822	nan 0.88068433
nan 0.88269358	nan 0.87005165	nan 0.86128053
nan 0.88137026	nan 0.88293839	nan 0.86760145
nan 0.8584382	nan 0.87921426	nan 0.88073352
nan 0.86324036	nan 0.84736415	nan 0.87906721
nan 0.87916538	nan 0.86181942	nan 0.8436403
nan 0.87921431	nan 0.87941057	nan 0.86275048
nan 0.84751122	nan 0.87838121	nan 0.87975328
nan 0.86113323	nan 0.84486525	nan 0.87970434
nan 0.88141943	nan 0.86544543	nan 0.85206823
nan 0.88004723	nan 0.8809784	nan 0.86363234
nan 0.85118626	nan 0.87990035	nan 0.88161546
nan 0.86583748	nan 0.85275435	nan 0.87999818
nan 0.88019441	nan 0.86446542	nan 0.85123528
nan 0.8801943	nan 0.88298745	nan 0.86789553
nan 0.8564784	nan 0.88078222	nan 0.88220329
nan 0.86750337	nan 0.85544939	nan 0.87990034
nan 0.88269345	nan 0.86681769	nan 0.8540284
nan 0.88068421	nan 0.88141939	nan 0.86716047
nan 0.85451829	nan 0.8805373	nan 0.88352648
nan 0.86970862	nan 0.85853642	nan 0.8811252
nan 0.88230141	nan 0.86853247	nan 0.85907531
nan 0.88024335	nan 0.88230163	nan 0.86882677
nan 0.85780146	nan 0.88127221	nan 0.88308528
nan 0.86833635	nan 0.85770321	nan 0.88088029

nan 0.88352653	nan 0.86892467	nan 0.85932053
nan 0.88146825	nan 0.88225243	nan 0.86887549
nan 0.86039822	nan 0.88068433	nan 0.88269358
nan 0.87005165	nan 0.86128053	nan 0.88137026
nan 0.88293839	nan 0.86760145	nan 0.8584382]

```
warnings.warn(
/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/model_selection/_validation.py:425: FitFailedWarning:
1200 fits failed out of a total of 2400.
The score on these train-test partitions for these parameters will be set to
nan.
If these failures are not expected, you can try to debug them by setting
error_score='raise'.
```

Below are more details about the failures:

```
-----
1200 fits failed with the following error:
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packages/sklearn/model_selection/_validation.py", line 732, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/base.py",
line 1151, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/pipeline.py",
line 420, in fit
    self._final_estimator.fit(Xt, y, **fit_params_last_step)
  File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/base.py",
line 1151, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/linear_model/_logistic.py", line 1168, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
  File "/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/linear_model/_logistic.py", line 56, in _check_solver
    raise ValueError(
ValueError: Solver lbfgs supports only 'l2' or 'none' penalties, got l1 penalty.
```

```
warnings.warn(some_fits_failed_message, FitFailedWarning)
/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/model_selection/_search.py:976: UserWarning: One or more of the
test scores are non-finite: [      nan      nan      nan      nan
nan      nan
      nan      nan      nan      nan      nan      nan
      nan      nan      nan      nan      nan      nan
      nan      nan      nan      nan      nan      nan
      nan      nan      nan      nan      nan      nan
      nan      nan      nan      nan      nan      nan]
```

nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
0.78253626	0.7829773	0.78253625	0.78292826	0.78072322	0.78096827
0.78047822	0.78106625	0.7791062	0.77954728	0.7791552	0.77949823
0.77822418	0.77832224	0.7779792	0.77827322	0.77734216	0.77739122
0.77729316	0.77734223	0.78253626	0.7829773	0.78253625	0.78292826
0.78072322	0.78096827	0.78047822	0.78106625	0.7791062	0.77954728
0.7791552	0.77949823	0.77822418	0.77832224	0.7779792	0.77827322
0.77734216	0.77739122	0.77729316	0.77734223	0.78253626	0.7829773
0.78253625	0.78292826	0.78072322	0.78096827	0.78047822	0.78106625
0.7791062	0.77954728	0.7791552	0.77949823	0.77822418	0.77832224
0.7779792	0.77827322	0.77734216	0.77739122	0.77729316	0.77734223
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
0.8585363	0.85990811	0.85863429	0.85976115	0.8587813	0.85936913
0.85838932	0.85966317	0.85858532	0.85995718	0.85878133	0.85985918
0.85843829	0.85956513	0.85883028	0.85941813	0.85785027	0.85887913
0.85706622	0.85902618	0.8585363	0.85990811	0.85863429	0.85976115
0.8587813	0.85936913	0.85838932	0.85966317	0.85858532	0.85995718
0.85878133	0.85985918	0.85843829	0.85956513	0.85883028	0.85941813
0.85785027	0.85887913	0.85706622	0.85902618	0.8585363	0.85990811
0.85863429	0.85976115	0.8587813	0.85936913	0.85838932	0.85966317
0.85858532	0.85995718	0.85878133	0.85985918	0.85843829	0.85956513
0.85883028	0.85941813	0.85785027	0.85887913	0.85706622	0.85902618
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
0.86921842	0.86716031	0.86931645	0.86779733	0.86961046	0.86941435
0.86882631	0.86985531	0.87088459	0.86970848	0.8706886	0.87059038
0.86961067	0.86946332	0.86887573	0.86926747	0.8686796	0.87039443
0.8688757	0.86990452	0.86921842	0.86716031	0.86931645	0.86779733

```

0.86961046 0.86941435 0.86882631 0.86985531 0.87088459 0.86970848
0.8706886 0.87059038 0.86961067 0.86946332 0.86887573 0.86926747
0.8686796 0.87039443 0.8688757 0.86990452 0.86921842 0.86716031
0.86931645 0.86779733 0.86961046 0.86941435 0.86882631 0.86985531
0.87088459 0.86970848 0.8706886 0.87059038 0.86961067 0.86946332
0.86887573 0.86926747 0.8686796 0.87039443 0.8688757 0.86990452
nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan
nan nan nan nan nan nan
0.85172532 0.85515516 0.85255843 0.85388121 0.85187244 0.8520192
0.85324448 0.85344035 0.85451859 0.85437139 0.85285254 0.85491057
0.85505757 0.85500816 0.85500872 0.85476326 0.85515554 0.85638031
0.85647848 0.85589026 0.85172532 0.85515516 0.85255843 0.85388121
0.85187244 0.8520192 0.85324448 0.85344035 0.85451859 0.85437139
0.85285254 0.85491057 0.85505757 0.85500816 0.85500872 0.85476326
0.85515554 0.85638031 0.85647848 0.85589026 0.85172532 0.85515516
0.85255843 0.85388121 0.85187244 0.8520192 0.85324448 0.85344035
0.85451859 0.85437139 0.85285254 0.85491057 0.85505757 0.85500816
0.85500872 0.85476326 0.85515554 0.85638031 0.85647848 0.85589026]
warnings.warn(

```

```

[220]: GridSearchCV(cv=5,
                estimator=Pipeline(steps=[('tvec', TfidfVectorizer()),
                                           ('lr', LogisticRegression())]),
                n_jobs=-1,
                param_grid={'lr__C': [0.1, 1, 10, 100], 'lr__max_iter': [1000],
                           'lr__penalty': ['l1', 'l2'],
                           'tvec__max_df': [0.6, 0.65, 0.7],
                           'tvec__max_features': [5000, 6000, 7000, 8000, 9000],
                           'tvec__min_df': [5e-05, 0.0001],
                           'tvec__ngram_range': [(1, 1), (1, 2)]})

```

```

[222]: # max iter was 1000 before non convergence warnings all other parameters were
↳ defaults
'''
gs1:
{'cvec__max_df': 0.6,
 'cvec__max_features': 9000,
 'cvec__min_df': 5e-05,
 'cvec__ngram_range': (1, 1),

```

```

    'lr__C': 1,
    'lr__max_iter': 1000,
    'lr__penalty': 'l2'}
'''
print(gs1.best_params_)

```

```

{'cvec__max_df': 0.6, 'cvec__max_features': 9000, 'cvec__min_df': 5e-05,
'cvec__ngram_range': (1, 1), 'lr__C': 1, 'lr__max_iter': 1000, 'lr__penalty':
'l2'}

```

```

[199]: cvec_lr_optimized = CountVectorizer(max_df = 0.6,
      max_features = 9000,
      min_df = 5e-05,
      ngram_range= (1, 1))

```

```

[201]: tvec_lr_optimized = TfidfVectorizer(max_df= 0.6,max_features= 7000,min_df=
      ↪5e-05,ngram_range= (1, 1))

```

```

[202]: lr_cvec_opt = LogisticRegression(C = 1, max_iter = 1000, penalty= 'l2')

```

```

[203]: lr_tvec_opt = LogisticRegression(C = 10, max_iter = 1000, penalty = 'l2')

```

```

[205]: cvec_lr_optimized_clean_train_total = cvec_lr_optimized.
      ↪fit_transform(clean_train_total)

```

```

[215]: cvec_lr_optimized_clean_test_total = cvec_lr_optimized.
      ↪transform(clean_test_total)

```

```

[206]: tvec_lr_optimized_clean_train_total = tvec_lr_optimized.
      ↪fit_transform(clean_train_total)

```

```

[210]: tvec_lr_optimized_clean_test_total = tvec_lr_optimized.
      ↪transform(clean_test_total)

```

```

[207]: lr_cvec_opt.fit(cvec_lr_optimized_clean_train_total, y_train)

```

```

[207]: LogisticRegression(C=1, max_iter=1000)

```

```

[208]: lr_tvec_opt.fit(tvec_lr_optimized_clean_train_total, y_train)

```

```

[208]: LogisticRegression(C=10, max_iter=1000)

```

```

[218]: print(f"Train Accuracy Score CVec LR| {round(lr_cvec_opt.
      ↪score(cvec_lr_optimized_clean_train_total, y_train),3)}")
      print(f"Test Accuracy Score CVec LR| {round(lr_cvec_opt.
      ↪score(cvec_lr_optimized_clean_test_total, y_test),3)}")

```

```

Train Accuracy Score CVec LR| 0.974
Test Accuracy Score CVec LR| 0.665

```

```
[219]: print(f"Train Accuracy Score TVec LR| {round(lr_tvec_opt.
        ↳score(tvec_lr_optimized_clean_train_total, y_train),3)}")
print(f"Test Accuracy Score TVec LR| {round(lr_tvec_opt.
        ↳score(tvec_lr_optimized_clean_test_total, y_test),3)}")
```

Train Accuracy Score TVec LR| 0.962

Test Accuracy Score TVec LR| 0.875

```
[ ]: gs2.best_params_
'''
gs2:
{'lr__C': 10,
 'lr__max_iter': 1000,
 'lr__penalty': 'l2',
 'tvec__max_df': 0.6,
 'tvec__max_features': 7000,
 'tvec__min_df': 5e-05,
 'tvec__ngram_range': (1, 1)}
'''
```

```
[223]: print(f"Train Accuracy Score CVec LR| {round(gs1.score(clean_train_total,
        ↳y_train),3)}")
print(f"Test Accuracy Score CVec LR| {round(gs1.score(clean_test_total,
        ↳y_test),3)}")
```

Train Accuracy Score CVec LR| 0.974

Test Accuracy Score CVec LR| 0.889

```
[224]: print(f"Train Accuracy Score TVec LR| {round(gs2.score(clean_train_total,
        ↳y_train),3)}")
print(f"Test Accuracy Score TVec LR| {round(gs2.score(clean_test_total,
        ↳y_test),3)}")
```

Train Accuracy Score TVec LR| 0.962

Test Accuracy Score TVec LR| 0.875

```
[351]: # Get predictions from optimal LR model
preds = gs1.predict(clean_test_total)
# Save confusion matrix values
tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
```



```
ConfusionMatrixDisplay.from_estimator(gs1, clean_test_total, y_test,
    cmap='Blues');
plt.title('Confusion Matrix for the Logistic Regression CVec
    Predictions',fontsize=16, loc='center');

print(find_cm(y_test, preds))
```

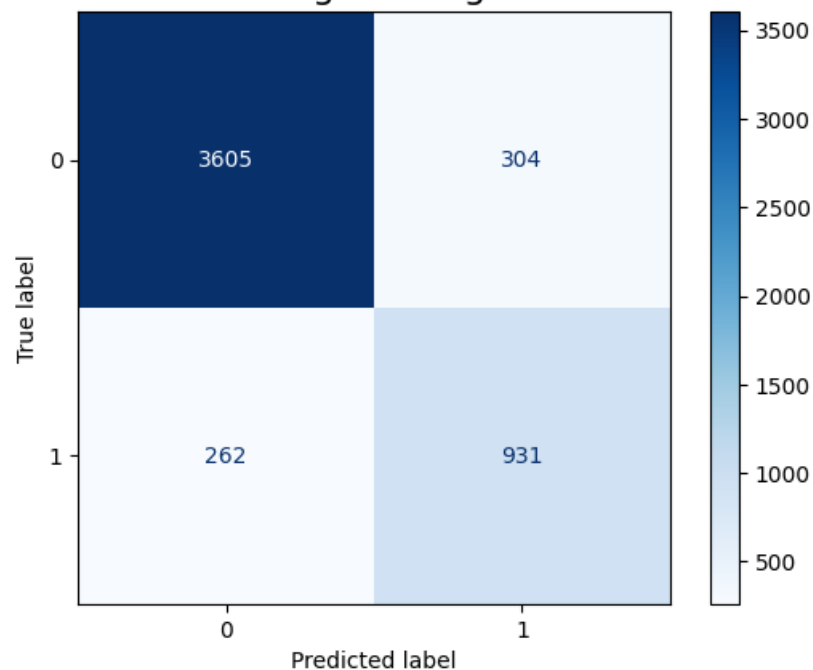
TN: 3605

FP: 304

FN: 262

TP: 931

Confusion Matrix for the Logistic Regression CVec Predictions



```
[352]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp/(tp+fn),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn/(tn+fp),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp+tn)/(tp+fp+tn+fn),3)}")
# Calculate Precision
print(f"Precision | {round(tp/(tp+fp),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp+fn)/(tp+fp+tn+fn),3)}")
```

Sensitivity | 0.78

Specificity | 0.922
Accuracy | 0.889
Precision | 0.754
Miscalculation Rate | 0.111

At the moment we are optimizing specificity, i.e. minimizing false positives (incorrectly telling the viewer that the abstract/headline pair belongs to an **Opinion** section) and this comes at the expense of increasing false negatives.

Precision is improving but still not quite what it needs to be and thus we must continue along with other models in order to fine-tune to find the best classification model before we proceed to sentiment analysis of those articles within the **Opinion** section.

```
[287]: # Get predictions from optimal LR model
preds = gs2.predict(clean_test_total)
# Save confusion matrix values
tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

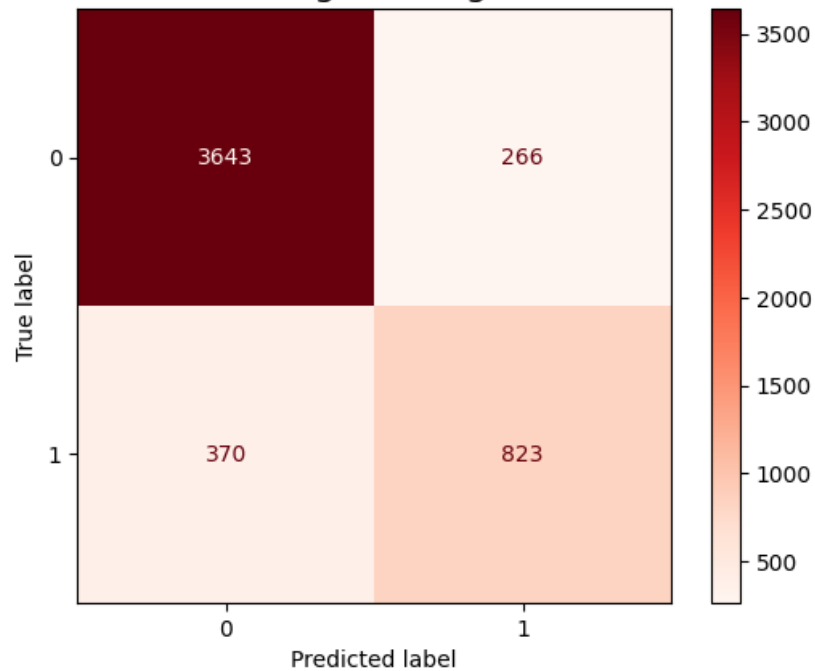
    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs2, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Logistic Regression TVec
    Predictions', fontsize=16, loc='center');

print(find_cm(y_test, preds))
```

TN: 3643
FP: 266
FN: 370
TP: 823

Confusion Matrix for the Logistic Regression TVec Predictions



```
[289]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp/(tp+fn),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn/(tn+fp),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp+tn)/(tp+fp+tn+fn),3)}")
# Calculate Precision
print(f"Precision | {round(tp/(tp+fp),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp+fn)/(tp+fp+tn+fn),3)}")
```

```
Sensitivity | 0.69
Specificity | 0.932
Accuracy | 0.875
Precision | 0.756
Miscalculation Rate | 0.125
```

At the moment we are optimizing specificity, i.e. minimizing false positives (incorrectly telling the viewer that the abstract/headline pair belongs to an **Opinion** section) and this comes at the expense of increasing false negatives.

Precision is improving but still not quite what it needs to be and thus we must continue along with other models in order to fine-tune to find the best classification model before we proceed to sentiment analysis of those articles within the **Opinion** section.

Combine preds with original dataframe and check how our predictions performed

```
[353]: # Combine predictions with the original DataFrame
df_test_outcomes = pd.DataFrame({'X_test': clean_test_total, 'y_test': y_test,
    ↪ 'Predictions_LR_CVec': preds})

# Calculate confusion matrix
conf_matrix = pd.crosstab(df_test_outcomes['y_test'],
    ↪ df_test_outcomes['Predictions_LR_CVec'], rownames=['Actual'],
    ↪ colnames=['Predicted'])

# Extract values from the confusion matrix
true_negatives = conf_matrix[0][0]
false_positives = conf_matrix[0][1]
false_negatives = conf_matrix[1][0]
true_positives = conf_matrix[1][1]

# Display the confusion matrix
print("Confusion Matrix:")
print(conf_matrix)

# Create lists for false positives and false negatives
false_positives_list = df_test_outcomes[(df_test_outcomes['y_test'] == 0) &
    ↪ (df_test_outcomes['Predictions_LR_CVec'] == 1)]['X_test'].tolist()
false_negatives_list = df_test_outcomes[(df_test_outcomes['y_test'] == 1) &
    ↪ (df_test_outcomes['Predictions_LR_CVec'] == 0)]['X_test'].tolist()
```

Confusion Matrix:

Predicted	0	1
Actual		
0	3605	304
1	262	931

```
[ ]: # Function to get the most common words from a list
def get_most_common_words(text_list, top_n=10):
    all_text = ' '.join(text_list)
    words = all_text.split()
    counter = Counter(words)
    most_common_words = counter.most_common(top_n)
    return [word for word, _ in most_common_words]

# Get most common words from false positives and false negatives lists
top_words_false_positives = get_most_common_words(false_positives_list)
top_words_false_negatives = get_most_common_words(false_negatives_list)

# Combine the lists of most common words
common_stopwords = list(top_words_false_positives + top_words_false_negatives)
```

```

# Display the most common words
print("Most common words in False Positives:")
print(top_words_false_positives)

print("\nMost common words in False Negatives:")
print(top_words_false_negatives)

print("\nCombined stopwords for CountVectorizer:")
print(common_stopwords)

```

```

[340]: custom_scorer = make_scorer(f1_score)

# Common stopwords from the previous example
# common_stopwords = set(common_stopwords) # Replace with your actual common_
↳ stopwords

# Pipeline with CountVectorizer
pipe1_a = Pipeline([
    ('cvec', CountVectorizer(stop_words=common_stopwords)),
    ('lr', LogisticRegression())
])

# Pipeline with TfidfVectorizer
pipe2_a = Pipeline([
    ('tvec', TfidfVectorizer(stop_words=common_stopwords)),
    ('lr', LogisticRegression())
])

# Parameter grids with common stopwords
pipe_params1_a = {
    'cvec__max_features': list(np.arange(5000, 10000, 1000)),
    'cvec__ngram_range': [(1, 1), (1, 2)],
    'cvec__min_df': [0.00005, 0.0001],
    'cvec__max_df': [0.6, 0.65, 0.7],
    'lr__C': [0.1, 1, 10, 100],
    'lr__penalty': ['l1', 'l2'],
    'lr__max_iter': [1000],
}

pipe_params2_a = {
    'tvec__max_features': list(np.arange(5000, 10000, 1000)),
    'tvec__ngram_range': [(1, 1), (1, 2)],
    'tvec__min_df': [0.00005, 0.0001],
    'tvec__max_df': [0.6, 0.65, 0.7],
    'lr__C': [0.1, 1, 10, 100],
    'lr__penalty': ['l1', 'l2'],
}

```

```

    'lr__max_iter': [1000], # Do not go lower than 1000 fail to converge
}

# Instantiate GridSearchCV.
gs1_a = GridSearchCV(pipe1_a,
                      param_grid=pipe_params1_a,
                      cv=5,
                      n_jobs=-1,
                      scoring=custom_scorer)

gs2_a = GridSearchCV(pipe2_a,
                      param_grid=pipe_params2_a,
                      cv=5,
                      n_jobs=-1,
                      scoring=custom_scorer)

# Measure the time taken for the parameter search
start_time = time.time()
gs1_a.fit(clean_train_total, y_train)
end_time = time.time()
print(f"Time taken for GridSearchCV with CountVectorizer: {end_time -
↪start_time:.2f} seconds")

start_time = time.time()
gs2_a.fit(clean_train_total, y_train)
end_time = time.time()
print(f"Time taken for GridSearchCV with TfidfVectorizer: {end_time -
↪start_time:.2f} seconds")

```

/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/model_selection/_validation.py:425: FitFailedWarning:
1200 fits failed out of a total of 2400.
The score on these train-test partitions for these parameters will be set to nan.

If these failures are not expected, you can try to debug them by setting `error_score='raise'`.

Below are more details about the failures:

```

1200 fits failed with the following error:
Traceback (most recent call last):
  File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/model_selection/_validation.py", line 732, in _fit_and_score
    estimator.fit(X_train, y_train, **fit_params)
  File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/base.py", line 1151, in wrapper
    return fit_method(estimator, *args, **kwargs)
  File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/pipeline.py",

```

```

line 420, in fit
    self._final_estimator.fit(Xt, y, **fit_params_last_step)
File "/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/base.py",
line 1151, in wrapper
    return fit_method(estimator, *args, **kwargs)
File "/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/linear_model/_logistic.py", line 1168, in fit
    solver = _check_solver(self.solver, self.penalty, self.dual)
File "/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/linear_model/_logistic.py", line 56, in _check_solver
    raise ValueError(
ValueError: Solver lbfgs supports only 'l2' or 'none' penalties, got l1 penalty.

```

```

warnings.warn(some_fits_failed_message, FitFailedWarning)
/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/model_selection/_search.py:976: UserWarning: One or more of the
test scores are non-finite: [          nan 0.71674737          nan 0.73716092
nan 0.70932207

```

nan 0.67616636	nan 0.714263	nan 0.7372136
nan 0.70396406	nan 0.67101171	nan 0.71684458
nan 0.73715912	nan 0.7097887	nan 0.68048197
nan 0.71410274	nan 0.73726504	nan 0.70296272
nan 0.67051724	nan 0.71846207	nan 0.74128019
nan 0.7162244	nan 0.68351256	nan 0.71803269
nan 0.74147272	nan 0.71089926	nan 0.68192522
nan 0.71969064	nan 0.74132165	nan 0.71581669
nan 0.68917061	nan 0.71889528	nan 0.74198389
nan 0.71071828	nan 0.68325803	nan 0.72049631
nan 0.74596243	nan 0.72413657	nan 0.69948876
nan 0.72099619	nan 0.7420142	nan 0.72035637
nan 0.69700341	nan 0.72064755	nan 0.74555889
nan 0.72334226	nan 0.69878911	nan 0.72084844
nan 0.74293333	nan 0.71974566	nan 0.69765316
nan 0.72119728	nan 0.74558975	nan 0.72639558
nan 0.70434766	nan 0.72159791	nan 0.74511479
nan 0.71942164	nan 0.7016852	nan 0.72021369
nan 0.7458712	nan 0.72370801	nan 0.70449108
nan 0.72104621	nan 0.74377946	nan 0.71925686
nan 0.6991139	nan 0.72190729	nan 0.74661
nan 0.7277118	nan 0.70779836	nan 0.72182628
nan 0.74902978	nan 0.72403196	nan 0.70504628
nan 0.72131352	nan 0.74610783	nan 0.72399767
nan 0.7054782	nan 0.72274936	nan 0.74760767
nan 0.72301334	nan 0.70726826	nan 0.71674737
nan 0.73716092	nan 0.70932207	nan 0.67616636
nan 0.714263	nan 0.7372136	nan 0.70396406
nan 0.67101171	nan 0.71684458	nan 0.73715912
nan 0.7097887	nan 0.68048197	nan 0.71410274

nan 0.73726504	nan 0.70296272	nan 0.67051724
nan 0.71846207	nan 0.74128019	nan 0.7162244
nan 0.68351256	nan 0.71803269	nan 0.74147272
nan 0.71089926	nan 0.68192522	nan 0.71969064
nan 0.74132165	nan 0.71581669	nan 0.68917061
nan 0.71889528	nan 0.74198389	nan 0.71071828
nan 0.68325803	nan 0.72049631	nan 0.74596243
nan 0.72413657	nan 0.69948876	nan 0.72099619
nan 0.7420142	nan 0.72035637	nan 0.69700341
nan 0.72064755	nan 0.74555889	nan 0.72334226
nan 0.69878911	nan 0.72084844	nan 0.74293333
nan 0.71974566	nan 0.69765316	nan 0.72119728
nan 0.74558975	nan 0.72639558	nan 0.70434766
nan 0.72159791	nan 0.74511479	nan 0.71942164
nan 0.7016852	nan 0.72021369	nan 0.7458712
nan 0.72370801	nan 0.70449108	nan 0.72104621
nan 0.74377946	nan 0.71925686	nan 0.6991139
nan 0.72190729	nan 0.74661	nan 0.7277118
nan 0.70779836	nan 0.72182628	nan 0.74902978
nan 0.72403196	nan 0.70504628	nan 0.72131352
nan 0.74610783	nan 0.72399767	nan 0.7054782
nan 0.72274936	nan 0.74760767	nan 0.72301334
nan 0.70726826	nan 0.71674737	nan 0.73716092
nan 0.70932207	nan 0.67616636	nan 0.714263
nan 0.7372136	nan 0.70396406	nan 0.67101171
nan 0.71684458	nan 0.73715912	nan 0.7097887
nan 0.68048197	nan 0.71410274	nan 0.73726504
nan 0.70296272	nan 0.67051724	nan 0.71846207
nan 0.74128019	nan 0.7162244	nan 0.68351256
nan 0.71803269	nan 0.74147272	nan 0.71089926
nan 0.68192522	nan 0.71969064	nan 0.74132165
nan 0.71581669	nan 0.68917061	nan 0.71889528
nan 0.74198389	nan 0.71071828	nan 0.68325803
nan 0.72049631	nan 0.74596243	nan 0.72413657
nan 0.69948876	nan 0.72099619	nan 0.7420142
nan 0.72035637	nan 0.69700341	nan 0.72064755
nan 0.74555889	nan 0.72334226	nan 0.69878911
nan 0.72084844	nan 0.74293333	nan 0.71974566
nan 0.69765316	nan 0.72119728	nan 0.74558975
nan 0.72639558	nan 0.70434766	nan 0.72159791
nan 0.74511479	nan 0.71942164	nan 0.7016852
nan 0.72021369	nan 0.7458712	nan 0.72370801
nan 0.70449108	nan 0.72104621	nan 0.74377946
nan 0.71925686	nan 0.6991139	nan 0.72190729
nan 0.74661	nan 0.7277118	nan 0.70779836
nan 0.72182628	nan 0.74902978	nan 0.72403196
nan 0.70504628	nan 0.72131352	nan 0.74610783
nan 0.72399767	nan 0.7054782	nan 0.72274936

nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
0.08833965	0.09477779	0.08796578	0.09359392	0.07657846	0.07964791
0.07506158	0.07882793	0.06731634	0.0700031	0.06808974	0.07000736
0.0614729	0.06300925	0.06107395	0.06223043	0.05478114	0.05400044
0.05518421	0.05399607	0.08833965	0.09477779	0.08796578	0.09359392
0.07657846	0.07964791	0.07506158	0.07882793	0.06731634	0.0700031
0.06808974	0.07000736	0.0614729	0.06300925	0.06107395	0.06223043
0.05478114	0.05400044	0.05518421	0.05399607	0.08833965	0.09477779
0.08796578	0.09359392	0.07657846	0.07964791	0.07506158	0.07882793
0.06731634	0.0700031	0.06808974	0.07000736	0.0614729	0.06300925
0.06107395	0.06223043	0.05478114	0.05400044	0.05518421	0.05399607
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
0.62136264	0.62011085	0.62272635	0.61874459	0.62038036	0.61884752
0.61991987	0.62142784	0.61746415	0.61993157	0.61604714	0.62018171
0.6167007	0.6176651	0.61566829	0.61804774	0.6142212	0.61432783
0.61333793	0.61453604	0.62136264	0.62011085	0.62272635	0.61874459
0.62038036	0.61884752	0.61991987	0.62142784	0.61746415	0.61993157
0.61604714	0.62018171	0.6167007	0.6176651	0.61566829	0.61804774
0.6142212	0.61432783	0.61333793	0.61453604	0.62136264	0.62011085
0.62272635	0.61874459	0.62038036	0.61884752	0.61991987	0.62142784
0.61746415	0.61993157	0.61604714	0.62018171	0.6167007	0.6176651
0.61566829	0.61804774	0.6142212	0.61432783	0.61333793	0.61453604
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
nan	nan	nan	nan	nan	nan
0.69585822	0.69631173	0.69537791	0.69590868	0.69483666	0.69610014
0.69300843	0.69660251	0.69664103	0.69569841	0.6956452	0.69457736
0.69370914	0.69457697	0.69378562	0.69284629	0.69415883	0.6965829
0.69201253	0.69382664	0.69585822	0.69631173	0.69537791	0.69590868
0.69483666	0.69610014	0.69300843	0.69660251	0.69664103	0.69569841
0.6956452	0.69457736	0.69370914	0.69457697	0.69378562	0.69284629

```

0.69415883 0.6965829 0.69201253 0.69382664 0.69585822 0.69631173
0.69537791 0.69590868 0.69483666 0.69610014 0.69300843 0.69660251
0.69664103 0.69569841 0.6956452 0.69457736 0.69370914 0.69457697
0.69378562 0.69284629 0.69415883 0.6965829 0.69201253 0.69382664
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
    nan        nan        nan        nan        nan        nan
0.67143624 0.67660031 0.67211129 0.67306634 0.67554954 0.6742142
0.6762771 0.67600826 0.67854097 0.67842594 0.6777015 0.67867178
0.67777392 0.6791198 0.68068903 0.67858285 0.67811521 0.68243982
0.67507622 0.68152267 0.67143624 0.67660031 0.67211129 0.67306634
0.67554954 0.6742142 0.6762771 0.67600826 0.67854097 0.67842594
0.6777015 0.67867178 0.67777392 0.6791198 0.68068903 0.67858285
0.67811521 0.68243982 0.67507622 0.68152267 0.67143624 0.67660031
0.67211129 0.67306634 0.67554954 0.6742142 0.6762771 0.67600826
0.67854097 0.67842594 0.6777015 0.67867178 0.67777392 0.6791198
0.68068903 0.67858285 0.67811521 0.68243982 0.67507622 0.68152267]
warnings.warn(

```

Time taken for GridSearchCV with TfidfVectorizer: 556.42 seconds

```
[341]: gs1_a.best_params_
```

```
[341]: {'cvec__max_df': 0.6,
        'cvec__max_features': 9000,
        'cvec__min_df': 5e-05,
        'cvec__ngram_range': (1, 2),
        'lr__C': 1,
        'lr__max_iter': 1000,
        'lr__penalty': 'l2'}
```

```
[342]: gs2_a.best_params_
```

```
[342]: {'lr__C': 10,
        'lr__max_iter': 1000,
        'lr__penalty': 'l2',
        'tvec__max_df': 0.6,
        'tvec__max_features': 7000,
        'tvec__min_df': 5e-05,
        'tvec__ngram_range': (1, 1)}
```

```
[343]: print(f"Train Accuracy Score CVec LR Stopwords| {round(gs1_a.
        ↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score CVec LR Stopwords| {round(gs1_a.
        ↪score(clean_test_total, y_test),3)}")
```

Train Accuracy Score CVec LR Stopwords| 0.945
 Test Accuracy Score CVec LR Stopwords| 0.77

```
[344]: print(f"Train Accuracy Score TVec LR Stopwords| {round(gs2_a.
        ↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score TVec LR Stopwords| {round(gs2_a.
        ↪score(clean_test_total, y_test),3)}")
```

Train Accuracy Score TVec LR Stopwords| 0.918
 Test Accuracy Score TVec LR Stopwords| 0.714

```
[345]: # Get predictions from optimal LR model
preds_stp = gs1_a.predict(clean_test_total)
# Save confusion matrix values
tn1, fp1, fn1, tp1 = confusion_matrix(y_test, preds_stp).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

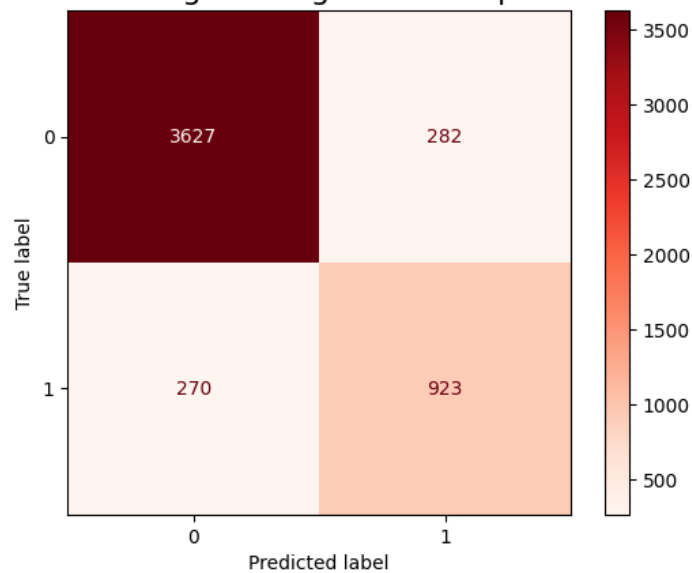
    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs1_a, clean_test_total, y_test,
    ↪cmap='Reds');
plt.title('Confusion Matrix for the Logistic Regression Stopwords CVec
    ↪Predictions',fontsize=16, loc='center');

print(find_cm(y_test, preds_stp))
```

TN: 3627
 FP: 282
 FN: 270
 TP: 923

Confusion Matrix for the Logistic Regression Stopwords CVec Predictions



```
[346]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp1/(tp1+fn1),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn1/(tn1+fp1),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp1+tn1)/(tp1+fp1+tn1+fn1),3)}")
# Calculate Precision
print(f"Precision | {round(tp1/(tp1+fp1),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp1+fn1)/(tp1+fp1+tn1+fn1),3)}")
```

```
Sensitivity | 0.774
Specificity | 0.928
Accuracy | 0.892
Precision | 0.766
Miscalculation Rate | 0.108
```

```
[349]: # Get predictions from optimal LR model
preds_stp2 = gs2_a.predict(clean_test_total)
# Save confusion matrix values
tn2, fp2, fn2, tp2 = confusion_matrix(y_test, preds_stp2).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"
```

```
# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs2_a, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Logistic Regression Stopwords CVec
    Predictions', fontsize=16, loc='center');

print(find_cm(y_test, preds_stp2))
```

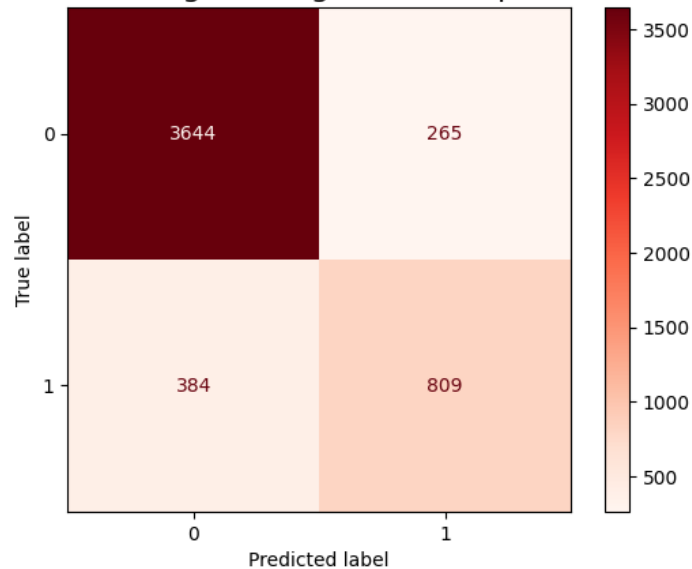
TN: 3644

FP: 265

FN: 384

TP: 809

Confusion Matrix for the Logistic Regression Stopwords CVec Predictions



```
[350]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp2/(tp2+fn2),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn2/(tn2+fp2),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp2+tn2)/(tp2+fp2+tn2+fn2),3)}")
# Calculate Precision
print(f"Precision | {round(tp2/(tp2+fp2),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp2+fn2)/(tp2+fp2+tn2+fn2),3)}")
```

Sensitivity | 0.678

Specificity | 0.932

Accuracy | 0.873
Precision | 0.753
Miscalculation Rate | 0.127

4.2 Simple Bagging Regressor only tuned for cvec and tvec

```
[229]: pipe11 = Pipeline([
    ('cvec', CountVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('bg', BaggingClassifier())
])

pipe12 = Pipeline([
    ('tvec', TfidfVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('bg', BaggingClassifier())
])

pipe_params11 = {'cvec__max_features': list(np.arange(5000, 10000, 1000)),
    'cvec__ngram_range': [(1,1), (1,2)],
    'cvec__min_df': [0.00005, 0.0001],
    'cvec__max_df': [0.6,0.65,0.7],
    }

pipe_params12 = {'tvec__max_features' : list(np.arange(5000, 10000, 1000)),
    'tvec__ngram_range' : [(1, 1), (1, 2)],
    'tvec__min_df': [0.00005, 0.0001],
    'tvec__max_df': [0.6,0.65,0.7],
    }

# Instantiate GridSearchCV.

gs11 = GridSearchCV(pipe11, # what object are we optimizing?
    param_grid=pipe_params11, # what parameters values are we
    ↪searching?
    cv=5,
    n_jobs=-1) # 5-fold cross-validation.

gs12 = GridSearchCV(pipe12, # what object are we optimizing?
    param_grid=pipe_params12, # what parameters values are we
    ↪searching?
    cv=5,
    n_jobs=-1) # 5-fold cross-validation.

gs11.fit(clean_train_total, y_train)

gs12.fit(clean_train_total, y_train)
```

```
[229]: GridSearchCV(cv=5,
                  estimator=Pipeline(steps=[('tvec', TfidfVectorizer()),
                                           ('bg', BaggingClassifier())]),
                  n_jobs=-1,
                  param_grid={'tvec__max_df': [0.6, 0.65, 0.7],
                              'tvec__max_features': [5000, 6000, 7000, 8000, 9000],
                              'tvec__min_df': [5e-05, 0.0001],
                              'tvec__ngram_range': [(1, 1), (1, 2)]})
```

```
[230]: gs11.best_params_
```

```
[230]: {'cvec__max_df': 0.6,
        'cvec__max_features': 8000,
        'cvec__min_df': 0.0001,
        'cvec__ngram_range': (1, 1)}
```

```
[231]: gs12.best_params_
```

```
[231]: {'tvec__max_df': 0.65,
        'tvec__max_features': 9000,
        'tvec__min_df': 5e-05,
        'tvec__ngram_range': (1, 1)}
```

```
[232]: print(f"Train Accuracy Score CVec Bagging Classifier| {round(gs11.
        ↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score CVec Bagging Classifier| {round(gs11.
        ↪score(clean_test_total, y_test),3)}")
```

```
Train Accuracy Score CVec Bagging Classifier| 0.985
Test Accuracy Score CVec Bagging Classifier| 0.847
```

```
[233]: print(f"Train Accuracy Score TVec Bagging Classifier| {round(gs12.
        ↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score TVec Bagging Classifier| {round(gs12.
        ↪score(clean_test_total, y_test),3)}")
```

```
Train Accuracy Score TVec Bagging Classifier| 0.989
Test Accuracy Score TVec Bagging Classifier| 0.859
```

```
[357]: # Get predictions from optimal KNN model
preds = gs11.predict(clean_test_total)
# Save confusion matrix values
tn11, fp11, fn11, tp11 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()
```



```

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

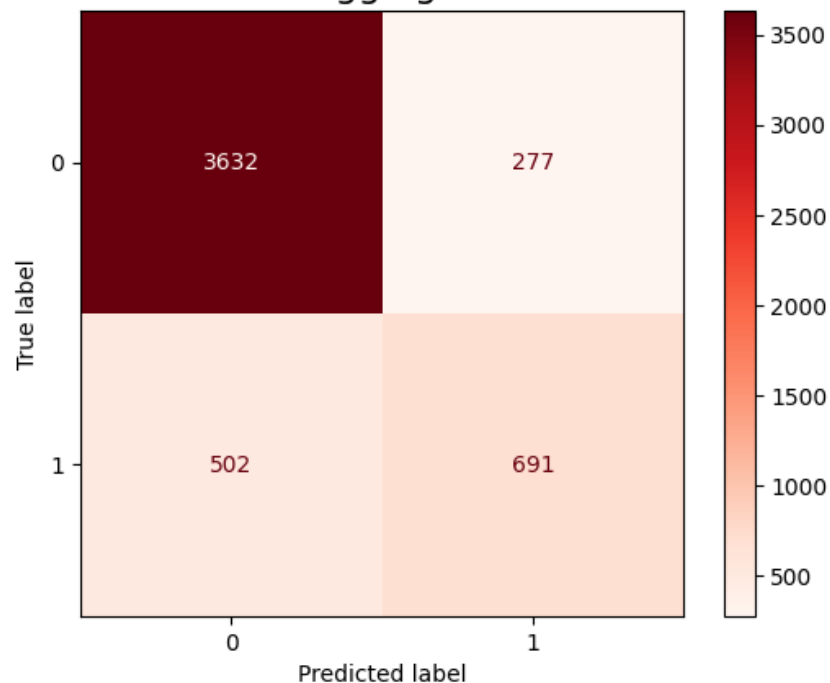
# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs11, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Bagging Classifier CVec
    Predictions',fontsize=16, loc='center');

print(find_cm(y_test, preds))

```

TN: 3632
 FP: 277
 FN: 502
 TP: 691

Confusion Matrix for the Bagging Classifier CVec Predictions



```

[358]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp11/(tp11+fn11),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn11/(tn11+fp11),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp11+tn11)/(tp11+fp11+tn11+fn11),3)}")
# Calculate Precision
print(f"Precision | {round(tp11/(tp11+fp11),3)}")

```

```
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp11+fn11)/(tp11+fp11+tn11+fn11),3)}")
```

```
Sensitivity | 0.579
Specificity | 0.929
Accuracy | 0.847
Precision | 0.714
Miscalculation Rate | 0.153
```

```
[354]: # Get predictions from optimal KNN model
preds = gs12.predict(clean_test_total)
# Save confusion matrix values
tn12, fp12, fn12, tp12 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

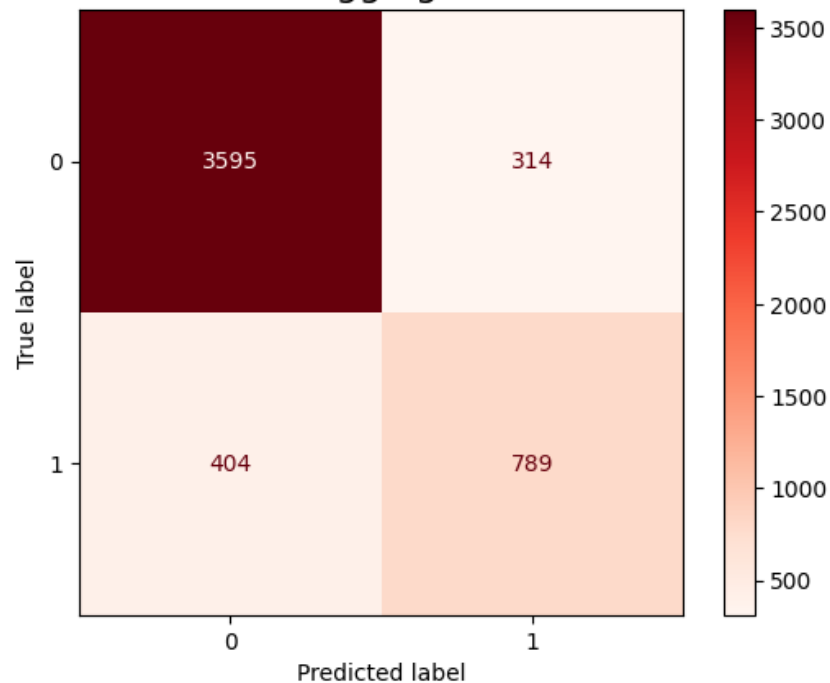
    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs12, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Bagging Classifier TVec
    Predictions',fontsize=16, loc='center');

print(find_cm(y_test, preds))
```

```
TN: 3595
FP: 314
FN: 404
TP: 789
```

Confusion Matrix for the Bagging Classifier TVec Predictions



```
[355]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp12/(tp12+fn12),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn12/(tn12+fp12),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp12+tn12)/(tp12+fp12+tn12+fn12),3)}")
# Calculate Precision
print(f"Precision | {round(tp12/(tp12+fp12),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp12+fn12)/(tp12+fp12+tn12+fn12),3)}")
```

```
Sensitivity | 0.661
Specificity | 0.92
Accuracy | 0.859
Precision | 0.715
Miscalculation Rate | 0.141
```

```
[359]: # Combine predictions with the original DataFrame
df_test_outcomes = pd.DataFrame({'X_test': clean_test_total, 'y_test': y_test,
    ↳ 'Predictions_Bagging_CVec': preds})

# Calculate confusion matrix
```

```

conf_matrix = pd.crosstab(df_test_outcomes['y_test'],
    ↪df_test_outcomes['Predictions_Bagging_CVec'], rownames=['Actual'],
    ↪colnames=['Predicted'])

# Extract values from the confusion matrix
true_negatives = conf_matrix[0][0]
false_positives = conf_matrix[0][1]
false_negatives = conf_matrix[1][0]
true_positives = conf_matrix[1][1]

# Display the confusion matrix
print("Confusion Matrix:")
print(conf_matrix)

# Create lists for false positives and false negatives
false_positives_list = df_test_outcomes[(df_test_outcomes['y_test'] == 0) &
    ↪(df_test_outcomes['Predictions_Bagging_CVec'] == 1)]['X_test'].tolist()
false_negatives_list = df_test_outcomes[(df_test_outcomes['y_test'] == 1) &
    ↪(df_test_outcomes['Predictions_Bagging_CVec'] == 0)]['X_test'].tolist()

```

Confusion Matrix:

Predicted	0	1
Actual		
0	3632	277
1	502	691

```

[360]: # Function to get the most common words from a list
def get_most_common_words(text_list, top_n=10):
    all_text = ' '.join(text_list)
    words = all_text.split()
    counter = Counter(words)
    most_common_words = counter.most_common(top_n)
    return [word for word, _ in most_common_words]

# Get most common words from false positives and false negatives lists
top_words_false_positives = get_most_common_words(false_positives_list)
top_words_false_negatives = get_most_common_words(false_negatives_list)

# Combine the lists of most common words
common_stopwords = list(top_words_false_positives + top_words_false_negatives)

# Display the most common words
print("Most common words in False Positives:")
print(top_words_false_positives)

print("\nMost common words in False Negatives:")
print(top_words_false_negatives)

```

```
print("\nCombined stopwords for CountVectorizer:")
print(common_stopwords)
```

Most common words in False Positives:

```
['u', 'america', 'trump', 'new', 'president', 'need', 'obama', 'may', 'still',
'people']
```

Most common words in False Negatives:

```
['american', 'new', 'states', 'united', 'trump', 'president', 'americans', 'u',
'people', 'many']
```

Combined stopwords for CountVectorizer:

```
['u', 'america', 'trump', 'new', 'president', 'need', 'obama', 'may', 'still',
'people', 'american', 'new', 'states', 'united', 'trump', 'president',
'americans', 'u', 'people', 'many']
```

```
[361]: # Pipeline with CountVectorizer and BaggingClassifier
bagging_pipe1_a = Pipeline([
    ('cvec', CountVectorizer(stop_words=common_stopwords)),
    ('bagging', BaggingClassifier(base_estimator=DecisionTreeClassifier()))
])

# Pipeline with TfidfVectorizer and BaggingClassifier
bagging_pipe2_a = Pipeline([
    ('tvec', TfidfVectorizer(stop_words=common_stopwords)),
    ('bagging', BaggingClassifier(base_estimator=DecisionTreeClassifier()))
])

# Parameter grids for BaggingClassifier
bagging_params1_a = {
    'cvec__max_features': list(np.arange(5000, 10000, 1000)),
    'cvec__ngram_range': [(1, 1), (1, 2)],
    'cvec__min_df': [0.00005, 0.0001],
    'cvec__max_df': [0.6, 0.65, 0.7],
    'bagging__n_estimators': [10, 50, 100],
    'bagging__max_samples': [0.5, 0.7, 1.0],
    'bagging__max_features': [0.5, 0.7, 1.0],
}

bagging_params2_a = {
    'tvec__max_features': list(np.arange(5000, 10000, 1000)),
    'tvec__ngram_range': [(1, 1), (1, 2)],
    'tvec__min_df': [0.00005, 0.0001],
    'tvec__max_df': [0.6, 0.65, 0.7],
    'bagging__n_estimators': [10, 50, 100],
    'bagging__max_samples': [0.5, 0.7, 1.0],
}
```

```

    'bagging__max_features': [0.5, 0.7, 1.0],
}

# Instantiate GridSearchCV for BaggingClassifier
gs_bagging1_a = GridSearchCV(bagging_pipe1_a,
                             param_grid=bagging_params1_a,
                             cv=5,
                             n_jobs=-1,
                             scoring=custom_scorer)

gs_bagging2_a = GridSearchCV(bagging_pipe2_a,
                             param_grid=bagging_params2_a,
                             cv=5,
                             n_jobs=-1,
                             scoring=custom_scorer)

# Measure the time taken for the parameter search
start_time = time.time()
gs_bagging1_a.fit(clean_train_total, y_train)
end_time = time.time()
print(f"Time taken for GridSearchCV with BaggingClassifier and CountVectorizer:␣
↪{end_time - start_time:.2f} seconds")

start_time = time.time()
gs_bagging2_a.fit(clean_train_total, y_train)
end_time = time.time()
print(f"Time taken for GridSearchCV with BaggingClassifier and TfidfVectorizer:␣
↪{end_time - start_time:.2f} seconds")

```

```

/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/ensemble/_base.py:156: FutureWarning: `base_estimator` was
renamed to `estimator` in version 1.2 and will be removed in 1.4.

```

```

warnings.warn(

```

```

/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/ensemble/_base.py:156: FutureWarning: `base_estimator` was
renamed to `estimator` in version 1.2 and will be removed in 1.4.

```

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```

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```

```

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/Users/ben/miniforge3/lib/python3.10/site-
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```



```

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/Users/ben/miniforge3/lib/python3.10/site-
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/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/ensemble/_base.py:156: FutureWarning: `base_estimator` was
renamed to `estimator` in version 1.2 and will be removed in 1.4.
    warnings.warn(
/Users/ben/miniforge3/lib/python3.10/site-
packages/sklearn/ensemble/_base.py:156: FutureWarning: `base_estimator` was
renamed to `estimator` in version 1.2 and will be removed in 1.4.
    warnings.warn(

```

```
/Users/ben/miniforge3/lib/python3.10/site-  
packages/sklearn/ensemble/_base.py:156: FutureWarning: `base_estimator` was  
renamed to `estimator` in version 1.2 and will be removed in 1.4.
```

```
warnings.warn(  
/Users/ben/miniforge3/lib/python3.10/site-  
packages/sklearn/ensemble/_base.py:156: FutureWarning: `base_estimator` was  
renamed to `estimator` in version 1.2 and will be removed in 1.4.  
warnings.warn(  
  
Time taken for GridSearchCV with BaggingClassifier and TfidfVectorizer: 8319.41  
seconds
```

```
[362]: gs_bagging1_a.best_params_
```

```
[362]: {'bagging__max_features': 0.7,  
       'bagging__max_samples': 0.5,  
       'bagging__n_estimators': 100}
```

```
[363]: gs_bagging2_a.best_params_
```

```
[363]: {'bagging__max_features': 0.5,  
       'bagging__max_samples': 1.0,  
       'bagging__n_estimators': 100}
```

```
[364]: print(f"Train Accuracy Score CVec Bagging Classifier Stopwords|  
       ↳{round(gs_bagging1_a.score(clean_train_total, y_train),3)}")  
print(f"Test Accuracy Score CVec Bagging Classifier Stopwords|  
       ↳{round(gs_bagging1_a.score(clean_test_total, y_test),3)}")
```

```
Train Accuracy Score CVec Bagging Classifier Stopwords| 0.943  
Test Accuracy Score CVec Bagging Classifier Stopwords| 0.667
```

```
[365]: print(f"Train Accuracy Score TVec Bagging Classifier Stopwords|  
       ↳{round(gs_bagging2_a.score(clean_train_total, y_train),3)}")  
print(f"Test Accuracy Score TVec Bagging Classifier Stopwords|  
       ↳{round(gs_bagging2_a.score(clean_test_total, y_test),3)}")
```

```
Train Accuracy Score TVec Bagging Classifier Stopwords| 1.0  
Test Accuracy Score TVec Bagging Classifier Stopwords| 0.744
```

```
[366]: # Get predictions from optimal KNN model  
preds_bg_c = gs_bagging1_a.predict(clean_test_total)  
# Save confusion matrix values  
tn_bg_c, fp_bg_c, fn_bg_c, tp_bg_c = confusion_matrix(y_test, preds).ravel()  
  
# Generate values of confusion matrix for reference  
def find_cm(y_test, preds):  
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()
```

```

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

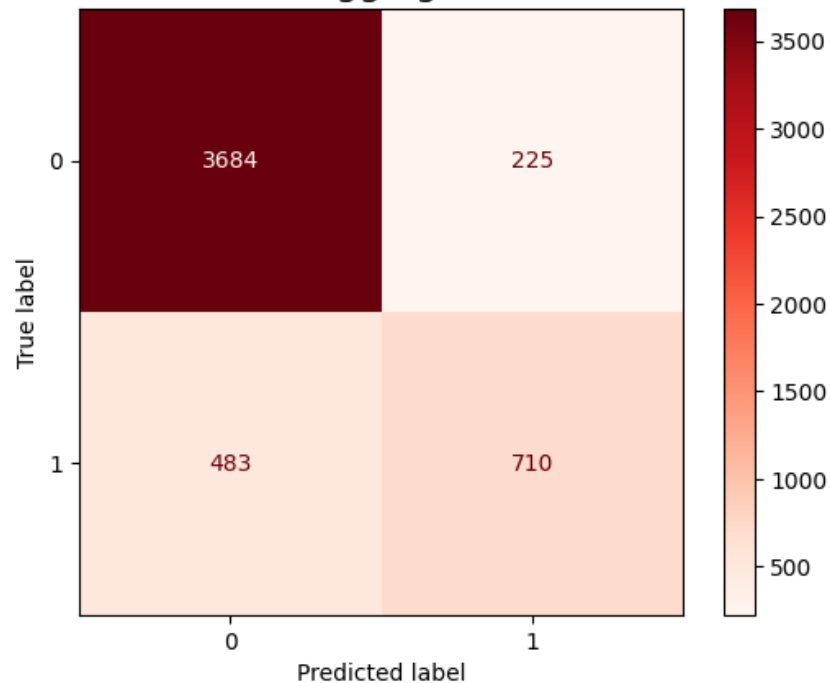
# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_bagging1_a, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Bagging Classifier TVec
    Predictions', fontsize=16, loc='center');

print(find_cm(y_test, preds_bg_c))

```

TN: 3684
 FP: 225
 FN: 483
 TP: 710

Confusion Matrix for the Bagging Classifier TVec Predictions



```

[367]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp_bg_c/(tp_bg_c+fn_bg_c),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn_bg_c/(tn_bg_c+fp_bg_c),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp_bg_c+tn_bg_c)/
    (tp_bg_c+fp_bg_c+tn_bg_c+fn_bg_c),3)}")
# Calculate Precision

```

```

print(f"Precision | {round(tp_bg_c/(tp_bg_c+fp_bg_c),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp_bg_c+fn_bg_c)/
↳(tp_bg_c+fp_bg_c+tn_bg_c+fn_bg_c),3)}")

```

Sensitivity | 0.579
 Specificity | 0.929
 Accuracy | 0.847
 Precision | 0.714
 Miscalculation Rate | 0.153

```

[368]: # Get predictions from optimal KNN model
preds_bg_t = gs_bagging2_a.predict(clean_test_total)
# Save confusion matrix values
tn_bg_t, fp_bg_t, fn_bg_t, tp_bg_t = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

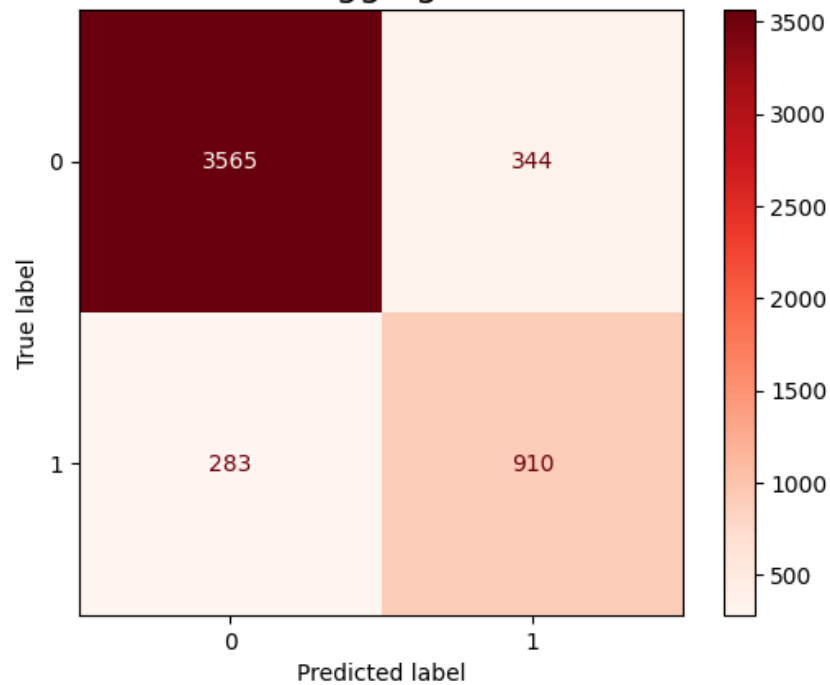
# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_bagging2_a, clean_test_total, y_test,
↳cmap='Reds');
plt.title('Confusion Matrix for the Bagging Classifier TVec_
↳Predictions',fontsize=16, loc='center');

print(find_cm(y_test, preds_bg_t))

```

TN: 3565
 FP: 344
 FN: 283
 TP: 910

Confusion Matrix for the Bagging Classifier TVec Predictions



```
[369]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp_bg_t/(tp_bg_t+fn_bg_t),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn_bg_t/(tn_bg_t+fp_bg_t),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp_bg_t+tn_bg_t)/
    ↳(tp_bg_t+fp_bg_t+tn_bg_t+fn_bg_t),3)}")
# Calculate Precision
print(f"Precision | {round(tp_bg_t/(tp_bg_t+fp_bg_t),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp_bg_t+fn_bg_t)/
    ↳(tp_bg_t+fp_bg_t+tn_bg_t+fn_bg_t),3)}")
```

```
Sensitivity | 0.579
Specificity | 0.929
Accuracy | 0.847
Precision | 0.714
Miscalculation Rate | 0.153
```


4.3 Random Forest

```
[239]: pipe13 = Pipeline([
    ('cvec', CountVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('rf', RandomForestClassifier())
])

pipe14 = Pipeline([
    ('tvec', TfidfVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('rf', RandomForestClassifier())
])

pipe_params13 = {'cvec__max_features': list(np.arange(5000, 10000, 1000)),
    'cvec__ngram_range': [(1,1), (1,2)],
    'cvec__min_df': [0.00005, 0.0001],
    'cvec__max_df': [0.6,0.65,0.7],
    }

pipe_params14 = {'tvec__max_features' : list(np.arange(5000, 10000, 1000)),
    'tvec__ngram_range' : [(1, 1), (1, 2)],
    'tvec__min_df': [0.00005, 0.0001],
    'tvec__max_df': [0.6,0.65,0.7],
    }

# Instantiate GridSearchCV.

gs13 = GridSearchCV(pipe13, # what object are we optimizing?
    param_grid=pipe_params13, # what parameters values are we
    ↪searching?
    cv=5,
    n_jobs=-1) # 5-fold cross-validation.

gs14 = GridSearchCV(pipe14, # what object are we optimizing?
    param_grid=pipe_params14, # what parameters values are we
    ↪searching?
    cv=5,
    n_jobs=-1) # 5-fold cross-validation.

# Start the timer
start_time = time.time()

gs13.fit(clean_train_total, y_train)
```

```

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Cvec: {elapsed_time:.4f} seconds")

# Start the timer
start_time = time.time()

gs14.fit(clean_train_total, y_train)

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Tvec: {elapsed_time:.4f} seconds")

```

Computation Time Cvec: 853.1806 seconds
 Computation Time Tvec: 902.0361 seconds

[240]: gs13.best_params_

```
{'cvec__max_df': 0.7,
 'cvec__max_features': 7000,
 'cvec__min_df': 0.0001,
 'cvec__ngram_range': (1, 1)}
```

[241]: gs14.best_params_

```
{'tvec__max_df': 0.7,
 'tvec__max_features': 9000,
 'tvec__min_df': 0.0001,
 'tvec__ngram_range': (1, 1)}
```

```
[242]: print(f"Train Accuracy Score CVec Random Forest| {round(gs13.
↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score CVec Random Forest| {round(gs13.
↪score(clean_test_total, y_test),3)}")
```

Train Accuracy Score CVec Random Forest| 1.0
 Test Accuracy Score CVec Random Forest| 0.869

```
[243]: print(f"Train Accuracy Score TVec Random Forest| {round(gs14.
        ↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score TVec Random Forest| {round(gs14.
        ↪score(clean_test_total, y_test),3)}")
```

```
Train Accuracy Score TVec Random Forest| 1.0
Test Accuracy Score TVec Random Forest| 0.886
```

```
[295]: # Get predictions from optimal KNN model
preds = gs13.predict(clean_test_total)
# Save confusion matrix values
tn13, fp13, fn13, tp13 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

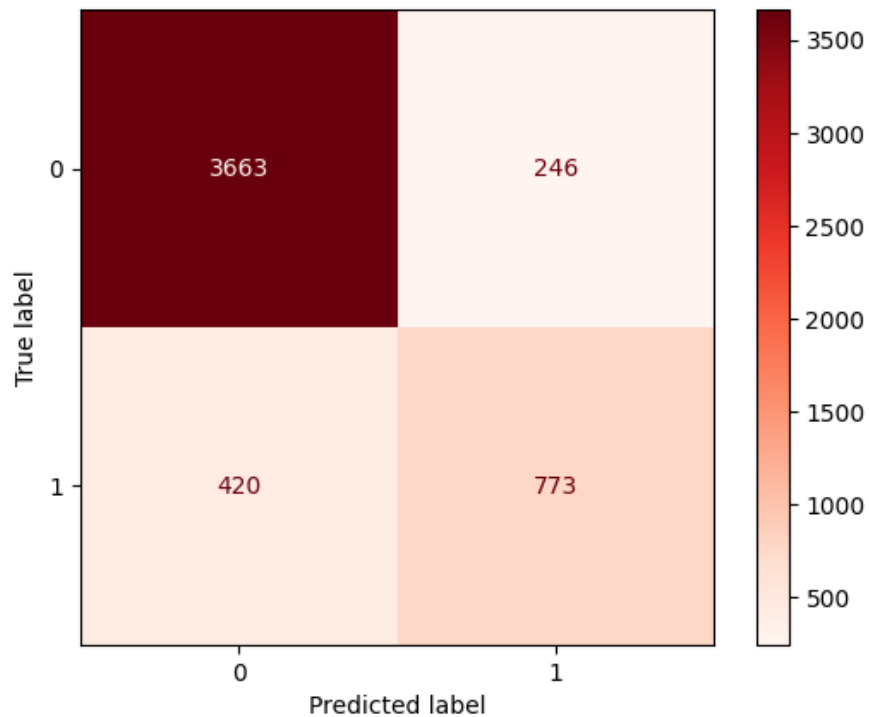
    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs13, clean_test_total, y_test,
    ↪cmap='Reds');
plt.title('Confusion Matrix for the Random Forest Cvec
    ↪Predictions',fontsize=16, loc='center');

print(find_cm(y_test, preds))
```

```
TN: 3663
FP: 246
FN: 420
TP: 773
```

Confusion Matrix for the Random Forest Cvec Predictions



```
[297]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp13/(tp13+fn13),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn13/(tn13+fp13),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp13+tn13)/(tp13+fp13+tn13+fn13),3)}")
# Calculate Precision
print(f"Precision | {round(tp13/(tp13+fp13),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp13+fn13)/(tp13+fp13+tn13+fn13),3)}")
```

```
Sensitivity | 0.648
Specificity | 0.937
Accuracy | 0.869
Precision | 0.759
Miscalculation Rate | 0.131
```

```
[370]: # Get predictions from optimal KNN model
preds = gs14.predict(clean_test_total)
# Save confusion matrix values
tn14, fp14, fn14, tp14 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
```

```
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

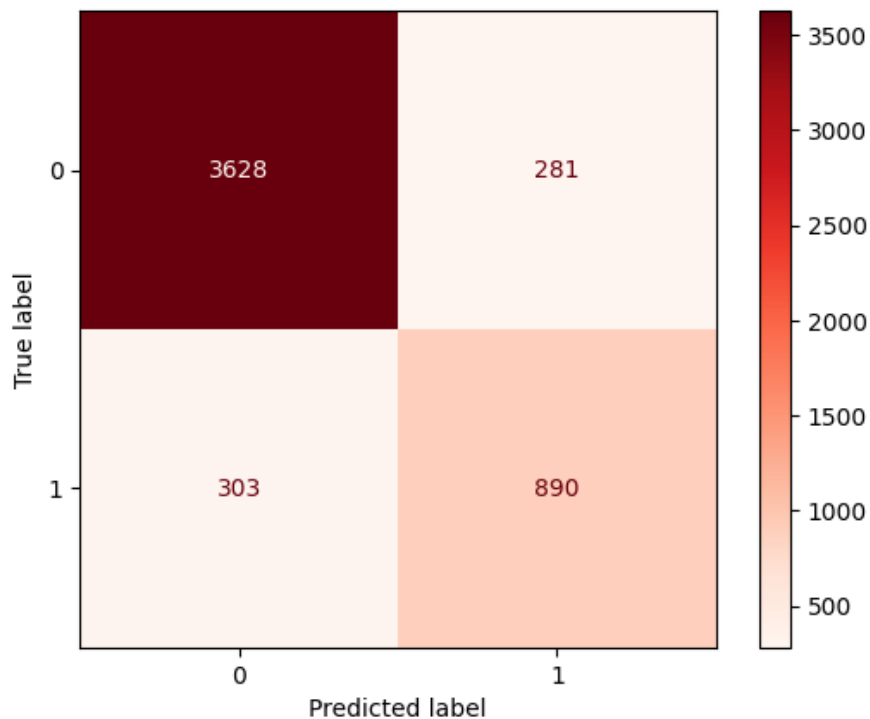
    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs14, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Random Forest TVec
    Predictions', fontsize=16, loc='center');

print(find_cm(y_test, preds))
```

TN: 3628
 FP: 281
 FN: 303
 TP: 890

Confusion Matrix for the Random Forest TVec Predictions



```
[371]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp14/(tp14+fn14),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn14/(tn14+fp14),3)}")
```

```

# Calculate Accuracy
print(f"Accuracy | {round((tp14+tn14)/(tp14+fp14+tn14+fn14),3)}")
# Calculate Precision
print(f"Precision | {round(tp14/(tp14+fp14),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp14+fn14)/(tp14+fp14+tn14+fn14),3)}")

```

```

Sensitivity | 0.746
Specificity | 0.928
Accuracy | 0.886
Precision | 0.76
Miscalculation Rate | 0.114

```

```

[372]: # Combine predictions with the original DataFrame
df_test_outcomes = pd.DataFrame({'X_test': clean_test_total, 'y_test': y_test,
    ↪ 'Predictions_RandomForest_CVec': preds})

# Calculate confusion matrix
conf_matrix = pd.crosstab(df_test_outcomes['y_test'],
    ↪ df_test_outcomes['Predictions_RandomForest_CVec'], rownames=['Actual'],
    ↪ colnames=['Predicted'])

# Extract values from the confusion matrix
true_negatives = conf_matrix[0][0]
false_positives = conf_matrix[0][1]
false_negatives = conf_matrix[1][0]
true_positives = conf_matrix[1][1]

# Display the confusion matrix
print("Confusion Matrix:")
print(conf_matrix)

# Create lists for false positives and false negatives
false_positives_list = df_test_outcomes[(df_test_outcomes['y_test'] == 0) &
    ↪ (df_test_outcomes['Predictions_RandomForest_CVec'] == 1)]['X_test'].tolist()
false_negatives_list = df_test_outcomes[(df_test_outcomes['y_test'] == 1) &
    ↪ (df_test_outcomes['Predictions_RandomForest_CVec'] == 0)]['X_test'].tolist()

```

```

Confusion Matrix:
Predicted      0      1
Actual
0           3628  281
1           303  890

```

```

[373]: # Get most common words from false positives and false negatives lists
top_words_false_positives = get_most_common_words(false_positives_list)
top_words_false_negatives = get_most_common_words(false_negatives_list)

```

```

# Combine the lists of most common words
common_stopwords = list(top_words_false_positives + top_words_false_negatives)

# Display the most common words
print("Most common words in False Positives:")
print(top_words_false_positives)

print("\nMost common words in False Negatives:")
print(top_words_false_negatives)

print("\nCombined stopwords for CountVectorizer:")
print(common_stopwords)

```

Most common words in False Positives:

```
['americans', 'u', 'america', 'trump', 'american', 'life', 'president',
'people', 'many', 'would']
```

Most common words in False Negatives:

```
['states', 'united', 'new', 'american', 'president', 'u', 'trump', 'americans',
'america', 'would']
```

Combined stopwords for CountVectorizer:

```
['americans', 'u', 'america', 'trump', 'american', 'life', 'president',
'people', 'many', 'would', 'states', 'united', 'new', 'american', 'president',
'u', 'trump', 'americans', 'america', 'would']
```

```

[375]: # Pipeline with CountVectorizer and RandomForest
rf_pipe1_a = Pipeline([
    ('cvec', CountVectorizer(stop_words=common_stopwords)),
    ('rf', RandomForestClassifier())
])

# Pipeline with TfidfVectorizer and RandomForest
rf_pipe2_a = Pipeline([
    ('tvec', TfidfVectorizer(stop_words=common_stopwords)),
    ('rf', RandomForestClassifier())
])

# Parameter grids for RandomForest
rf_params1_a = {
    'cvec__max_features': list(np.arange(5000, 10000, 1000)),
    'cvec__ngram_range': [(1, 1), (1, 2)],
    'cvec__min_df': [0.00005, 0.0001],
    'cvec__max_df': [0.6, 0.65, 0.7],
    'rf__n_estimators': [10, 50, 100],
    'rf__max_depth': [None, 10, 20],

```

```

        'rf__min_samples_split': [2, 5, 10],
    }

    rf_params2_a = {
        'tvec__max_features': list(np.arange(5000, 10000, 1000)),
        'tvec__ngram_range': [(1, 1), (1, 2)],
        'tvec__min_df': [0.00005, 0.0001],
        'tvec__max_df': [0.6, 0.65, 0.7],
        'rf__n_estimators': [10, 50, 100],
        'rf__max_depth': [None, 10, 20],
        'rf__min_samples_split': [2, 5, 10],
    }

    # Instantiate GridSearchCV for RandomForest
    gs_rf1_a = GridSearchCV(rf_pipe1_a,
                           param_grid=rf_params1_a,
                           cv=5,
                           n_jobs=-1,
                           scoring=custom_scorer)

    gs_rf2_a = GridSearchCV(rf_pipe2_a,
                           param_grid=rf_params2_a,
                           cv=5,
                           n_jobs=-1,
                           scoring=custom_scorer)

    # Measure the time taken for the parameter search
    start_time = time.time()
    gs_rf1_a.fit(clean_train_total, y_train)
    end_time = time.time()
    print(f"Time taken for GridSearchCV with RandomForest and CountVectorizer:␣
    ↳{end_time - start_time:.2f} seconds")

    start_time = time.time()
    gs_rf2_a.fit(clean_train_total, y_train)
    end_time = time.time()
    print(f"Time taken for GridSearchCV with RandomForest and TfidfVectorizer:␣
    ↳{end_time - start_time:.2f} seconds")

```

Time taken for GridSearchCV with RandomForest and CountVectorizer: 4920.75 seconds

Time taken for GridSearchCV with RandomForest and TfidfVectorizer: 5741.91 seconds

[376]: gs_rf1_a.best_params_


```
[376]: {'cvec__max_df': 0.7,
        'cvec__max_features': 9000,
        'cvec__min_df': 0.0001,
        'cvec__ngram_range': (1, 1),
        'rf__max_depth': None,
        'rf__min_samples_split': 2,
        'rf__n_estimators': 100}
```

```
[377]: gs_rf2_a.best_params_
```

```
[377]: {'rf__max_depth': None,
        'rf__min_samples_split': 5,
        'rf__n_estimators': 100,
        'tvec__max_df': 0.6,
        'tvec__max_features': 9000,
        'tvec__min_df': 5e-05,
        'tvec__ngram_range': (1, 1)}
```

```
[378]: print(f"Train Accuracy Score CVec Random Forest Stopwords| {round(gs_rf1_a.
        ↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score CVec Random Forest Stopwords| {round(gs_rf1_a.
        ↪score(clean_test_total, y_test),3)}")
```

Train Accuracy Score CVec Random Forest Stopwords| 1.0
 Test Accuracy Score CVec Random Forest Stopwords| 0.694

```
[379]: print(f"Train Accuracy Score TVec Random Forest Stopwords| {round(gs_rf2_a.
        ↪score(clean_train_total, y_train),3)}")
print(f"Test Accuracy Score TVec Random Forest Stopwords| {round(gs_rf2_a.
        ↪score(clean_test_total, y_test),3)}")
```

Train Accuracy Score TVec Random Forest Stopwords| 0.998
 Test Accuracy Score TVec Random Forest Stopwords| 0.732

```
[380]: # Get predictions from optimal KNN model
preds_rf1_a = gs_rf1_a.predict(clean_test_total)
# Save confusion matrix values
tn_rf1_a, fp_rf1_a, fn_rf1_a, tp_rf1_a = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

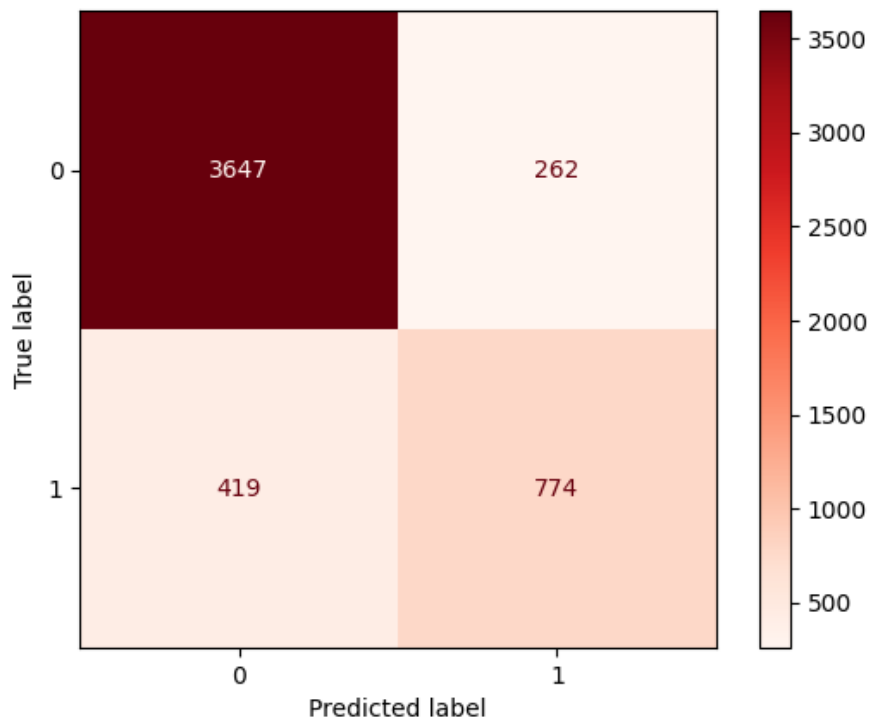
# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_rf1_a, clean_test_total, y_test,
        ↪cmap='Reds');
```

```
plt.title('Confusion Matrix for the Random Forest TVec_
↳Predictions',fontsize=16, loc='center');

print(find_cm(y_test, preds_rf1_a))
```

TN: 3647
 FP: 262
 FN: 419
 TP: 774

Confusion Matrix for the Random Forest TVec Predictions



```
[381]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp_rf1_a/(tp_rf1_a+fn_rf1_a),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn_rf1_a/(tn_rf1_a+fp_rf1_a),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp_rf1_a+tn_rf1_a)/
↳(tp_rf1_a+fp_rf1_a+tn_rf1_a+fn_rf1_a),3)}")
# Calculate Precision
print(f"Precision | {round(tp_rf1_a/(tp_rf1_a+fp_rf1_a),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp_rf1_a+fn_rf1_a)/
↳(tp_rf1_a+fp_rf1_a+tn_rf1_a+fn_rf1_a),3)}")
```

Sensitivity | 0.746
Specificity | 0.928
Accuracy | 0.886
Precision | 0.76
Miscalculation Rate | 0.114

```
[383]: # Get predictions from optimal KNN model
preds_rf2_a = gs_rf2_a.predict(clean_test_total)
# Save confusion matrix values
tn_rf2_a, fp_rf2_a, fn_rf2_a, tp_rf2_a = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

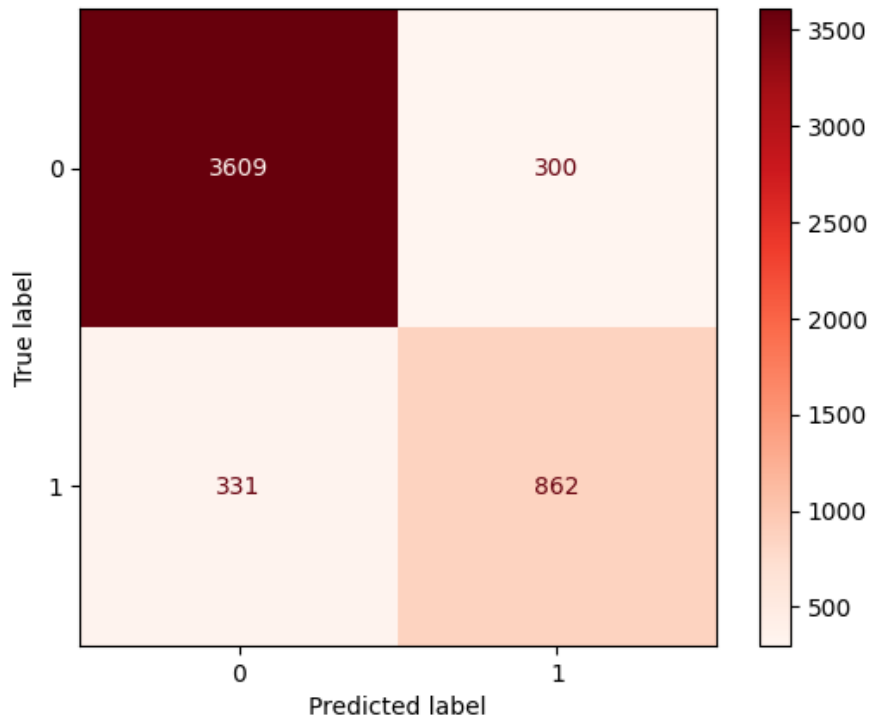
    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_rf2_a, clean_test_total, y_test, cmap='Reds');
plt.title('Confusion Matrix for the Random Forest TVec Predictions', fontsize=16, loc='center');

print(find_cm(y_test, preds_rf2_a))
```

TN: 3609
FP: 300
FN: 331
TP: 862

Confusion Matrix for the Random Forest TVec Predictions



```
[385]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp_rf2_a/(tp_rf2_a+fn_rf2_a),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn_rf2_a/(tn_rf2_a+fp_rf2_a),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp_rf2_a+tn_rf2_a)/
    ↳(tp_rf2_a+fp_rf2_a+tn_rf2_a+fn_rf2_a),3)}")
# Calculate Precision
print(f"Precision | {round(tp_rf2_a/(tp_rf2_a+fp_rf2_a),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp_rf2_a+fn_rf2_a)/
    ↳(tp_rf2_a+fp_rf2_a+tn_rf2_a+fn_rf2_a),3)}")
```

```
Sensitivity | 0.746
Specificity | 0.928
Accuracy | 0.886
Precision | 0.76
Miscalculation Rate | 0.114
```

```
[384]: print(f1_score(y_test, preds_rf2_a))
```

```
0.7320594479830149
```

4.4 Support Vector Machine - Linear SVC

```
[264]: pipe17 = Pipeline([
    ('cvec', CountVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('svc', LinearSVC())
])

pipe18 = Pipeline([
    ('tvec', TfidfVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('svc', SVC())
])

pipe_params17 = {'cvec__max_features': list(np.arange(5000, 10000, 1000)),
    'cvec__ngram_range': [(1,1), (1,2)],
    'cvec__min_df': [0.00005, 0.0001],
    'cvec__max_df': [0.6,0.65,0.7],
    'svc__C': [0.1, 1, 10]
}

pipe_params18 = {'tvec__max_features' : list(np.arange(5000, 10000, 1000)),
    'tvec__ngram_range' : [(1, 1), (1, 2)],
    'tvec__min_df': [0.00005, 0.0001],
    'tvec__max_df': [0.6,0.65,0.7],
    'svc__C': [0.1, 1, 10]
}

# Instantiate GridSearchCV.

gs17 = GridSearchCV(pipe17, # what object are we optimizing?
    param_grid=pipe_params17, # what parameters values are we
    ↪searching?
    cv=5,
    n_jobs=-1) # 5-fold cross-validation.

gs18 = GridSearchCV(pipe18, # what object are we optimizing?
    param_grid=pipe_params18, # what parameters values are we
    ↪searching?
    cv=5,
    n_jobs=-1) # 5-fold cross-validation.

# Start the timer
start_time = time.time()
```

```

gs17.fit(clean_train_total, y_train)

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Cvec: {elapsed_time:.4f} seconds")

```

```

/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/svm/_classes.py:32:
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```

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/Users/ben/miniforge3/lib/python3.10/site-packages/sklearn/svm/_classes.py:32:

```



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```

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ConvergenceWarning: Liblinear failed to converge, increase the number of
iterations.
    warnings.warn(
Computation Time Cvec: 267.2620 seconds

```

```

-----
KeyboardInterrupt                                Traceback (most recent call last)
Cell In[264], line 59
     56 # Start the timer
     57 start_time = time.time()
--> 59 gs18.fit(clean_train_total, y_train)
     61 # Stop the timer
     62 end_time = time.time()

File ~/miniforge3/lib/python3.10/site-packages/sklearn/base.py:1151, in _
fit_context.<locals>.decorator.<locals>.wrapper(estimator, *args, **kwargs)
    1144 estimator._validate_params()
    1146 with config_context(
    1147     skip_parameter_validation=(
    1148         prefer_skip_nested_validation or global_skip_validation
    1149     )
    1150 ):
-> 1151     return fit_method(estimator, *args, **kwargs)

File ~/miniforge3/lib/python3.10/site-packages/sklearn/model_selection/_search.
py:898, in BaseSearchCV.fit(self, X, y, groups, **fit_params)
    892 results = self._format_results(
    893     all_candidate_params, n_splits, all_out, all_more_results
    894 )
    896 return results
--> 898 self._run_search(evaluate_candidates)
    900 # multimetric is determined here because in the case of a callable
    901 # self.scoring the return type is only known after calling
    902 first_test_score = all_out[0]["test_scores"]

File ~/miniforge3/lib/python3.10/site-packages/sklearn/model_selection/_search.
py:1419, in GridSearchCV._run_search(self, evaluate_candidates)
    1417 def _run_search(self, evaluate_candidates):
    1418     """Search all candidates in param_grid"""

```

```
-> 1419 evaluate_candidates(ParameterGrid(self.param_grid))
```

File ~/miniforge3/lib/python3.10/site-packages/sklearn/model_selection/_search.

```
py:845, in BaseSearchCV.fit.<locals>.evaluate_candidates(candidate_params, cv,
more_results)
```

```
837 if self.verbose > 0:
838     print(
839         "Fitting {0} folds for each of {1} candidates,"
840         " totalling {2} fits".format(
841             n_splits, n_candidates, n_candidates * n_splits
842         )
843     )
--> 845 out = parallel(
846     delayed(_fit_and_score)(
847         clone(base_estimator),
848         X,
849         y,
850         train=train,
851         test=test,
852         parameters=parameters,
853         split_progress=(split_idx, n_splits),
854         candidate_progress=(cand_idx, n_candidates),
855         **fit_and_score_kwargs,
856     )
857     for (cand_idx, parameters), (split_idx, (train, test)) in product(
858         enumerate(candidate_params), enumerate(cv.split(X, y, groups))
859     )
860 )
862 if len(out) < 1:
863     raise ValueError(
864         "No fits were performed. "
865         "Was the CV iterator empty? "
866         "Were there no candidates?"
867     )
```

File ~/miniforge3/lib/python3.10/site-packages/sklearn/utils/parallel.py:65, in

```
Parallel.__call__(self, iterable)
60 config = get_config()
61 iterable_with_config = (
62     _with_config(delayed_func, config), args, kwargs)
63     for delayed_func, args, kwargs in iterable
64 )
---> 65 return super().__call__(iterable_with_config)
```

File ~/miniforge3/lib/python3.10/site-packages/joblib/parallel.py:1098, in

```
Parallel.__call__(self, iterable)
1095     self._iterating = False
1097 with self._backend.retrieval_context():
```

```

-> 1098     self.retrieve()
    1099 # Make sure that we get a last message telling us we are done
    1100 elapsed_time = time.time() - self._start_time

File ~/miniforge3/lib/python3.10/site-packages/joblib/parallel.py:975, in
↳Parallel.retrieve(self)
    973 try:
    974     if getattr(self._backend, 'supports_timeout', False):
-> 975         self._output.extend(job.get(timeout=self.timeout))
    976     else:
    977         self._output.extend(job.get())

File ~/miniforge3/lib/python3.10/site-packages/joblib/_parallel_backends.py:567
↳in LokyBackend.wrap_future_result(future, timeout)
    564 """Wrapper for Future.result to implement the same behaviour as
    565 AsyncResults.get from multiprocessing."""
    566 try:
-> 567     return future.result(timeout=timeout)
    568 except CfTimeoutError as e:
    569     raise TimeoutError from e

File ~/miniforge3/lib/python3.10/concurrent/futures/_base.py:453, in Future.
↳result(self, timeout)
    450 elif self._state == FINISHED:
    451     return self.__get_result()
-> 453 self._condition.wait(timeout)
    455 if self._state in [CANCELLED, CANCELLED_AND_NOTIFIED]:
    456     raise CancelledError()

File ~/miniforge3/lib/python3.10/threading.py:320, in Condition.wait(self,
↳timeout)
    318 try:     # restore state no matter what (e.g., KeyboardInterrupt)
    319     if timeout is None:
-> 320         waiter.acquire()
    321         gotit = True
    322     else:

KeyboardInterrupt:

```

```
[265]: gs17.best_params_
```

```
[265]: {'cvec__max_df': 0.6,
        'cvec__max_features': 8000,
        'cvec__min_df': 5e-05,
        'cvec__ngram_range': (1, 1),
        'svc__C': 0.1}
```

```
[386]: # Start the timer
start_time = time.time()

gs18.fit(clean_train_total, y_train)

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Tvec: {elapsed_time:.4f} seconds")
```

Computation Time Tvec: 11219.7218 seconds

```
[388]: gs18.best_params_
```

```
[388]: {'svc__C': 10,
      'tvec__max_df': 0.6,
      'tvec__max_features': 6000,
      'tvec__min_df': 0.0001,
      'tvec__ngram_range': (1, 2)}
```

```
[267]: print(f"Train Accuracy Score CVec SVC | {round(gs17.score(clean_train_total,
↪y_train),5)}")
print(f"Test Accuracy Score CVec SVC | {round(gs17.score(clean_test_total,
↪y_test),5)}")
```

Train Accuracy Score CVec SVC | 0.97276

Test Accuracy Score CVec SVC | 0.88985

```
[389]: print(f"Train Accuracy Score TVec SVC | {round(gs18.score(clean_train_total,
↪y_train),5)}")
print(f"Test Accuracy Score TVec SVC | {round(gs18.score(clean_test_total,
↪y_test),5)}")
```

Train Accuracy Score TVec SVC | 1.0

Test Accuracy Score TVec SVC | 0.88064

```
[305]: # Get predictions from optimal KNN model
preds = gs17.predict(clean_test_total)
# Save confusion matrix values
tn17, fp17, fn17, tp17 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()
```

```

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

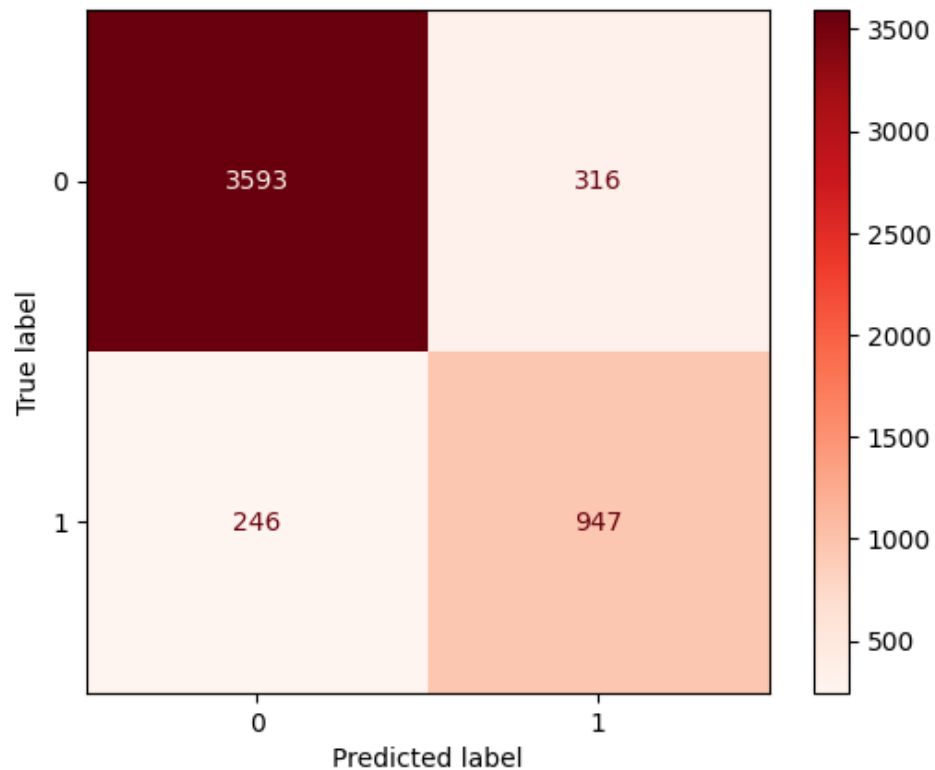
# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs17, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Linear SVC CVec Predictions',fontsize=16,
    loc='center');

print(find_cm(y_test, preds))

```

TN: 3593
 FP: 316
 FN: 246
 TP: 947

Confusion Matrix for the Linear SVC CVec Predictions



```

[306]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp17/(tp17+fn17),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn17/(tn17+fp17),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp17+tn17)/(tp17+fp17+tn17+fn17),3)}")

```

```

# Calculate Precision
print(f"Precision | {round(tp17/(tp17+fp17),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp17+fn17)/(tp17+fp17+tn17+fn17),3)}")

```

```

Sensitivity | 0.794
Specificity | 0.919
Accuracy | 0.89
Precision | 0.75
Miscalculation Rate | 0.11

```

```

[405]: # Get predictions from optimal KNN model
preds = gs18.predict(clean_test_total)
# Save confusion matrix values
tn18, fp18, fn18, tp18 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs18, clean_test_total, y_test,
    cmap='Reds');
plt.title('Confusion Matrix for the Linear SVC TVec Predictions',fontsize=16,
    loc='center');

print(find_cm(y_test, preds))

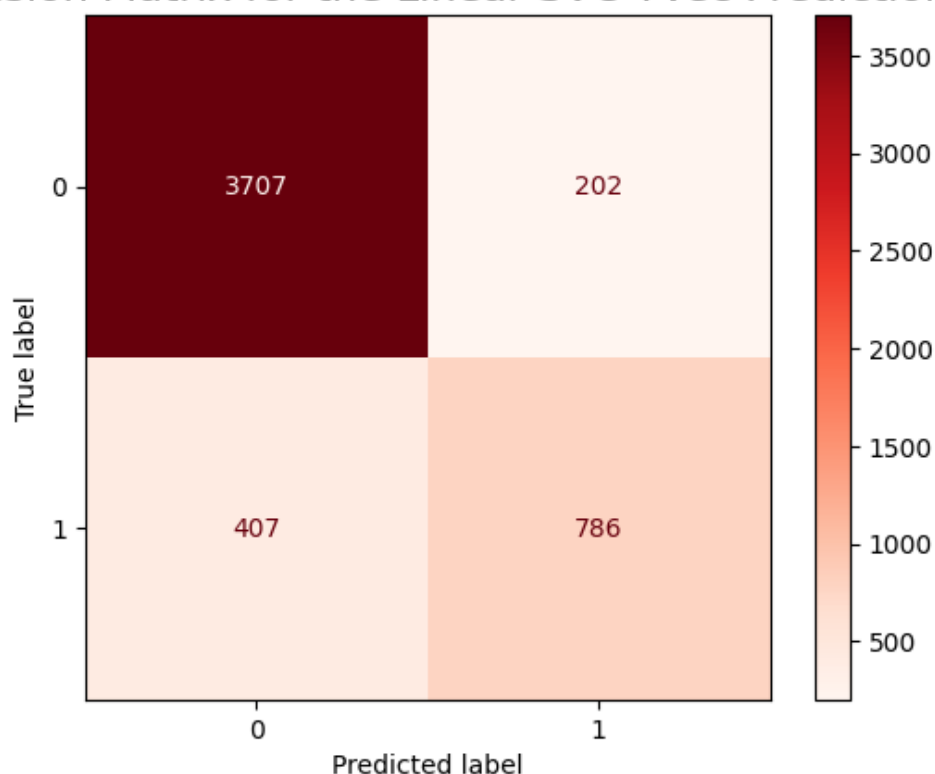
```

```

TN: 3707
FP: 202
FN: 407
TP: 786

```

Confusion Matrix for the Linear SVC TVec Predictions



```
[406]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp18/(tp18+fn18),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn18/(tn18+fp18),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp18+tn18)/(tp18+fp18+tn18+fn18),3)}")
# Calculate Precision
print(f"Precision | {round(tp18/(tp18+fp18),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp18+fn18)/(tp18+fp18+tn18+fn18),3)}")
```

```
Sensitivity | 0.659
Specificity | 0.948
Accuracy | 0.881
Precision | 0.796
Miscalculation Rate | 0.119
```

```
[408]: print(f"F1 Score | {round(f1_score(y_test, preds),3)}")
```

```
F1 Score | 0.721
```

Optimizing the best performing bagging, forest, and ADA


```

[270]: pipe_bgc = Pipeline([
    ('cvec', CountVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('bg', BaggingClassifier())
])

pipe_bgt = Pipeline([
    ('tvec', TfidfVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('bg', BaggingClassifier())
])

pipe_params_bgc = {'cvec__max_features': list(np.arange(5000, 10000, 1000)),
    'cvec__ngram_range': [(1,1), (1,2)],
    'cvec__min_df': [0.00005, 0.0001],
    'cvec__max_df': [0.6,0.65,0.7],
    'bg__n_estimators': [10, 15, 25],
    'bg__max_samples': [0.5, 0.7, 1.0],
    'bg__max_features': [0.5, 0.7, 1.0],
    'bg__verbose': [1]

    }

pipe_params_bgt = {'tvec__max_features' : list(np.arange(5000, 10000, 1000)),
    'tvec__ngram_range' : [(1, 1), (1, 2)],
    'tvec__min_df': [0.00005, 0.0001],
    'tvec__max_df': [0.6,0.65,0.7],
    'bg__n_estimators': [10, 15, 25],
    'bg__max_samples': [0.5, 0.7, 1.0],
    'bg__max_features': [0.5, 0.7, 1.0],
    'bg__verbose': [1]
    }

# Instantiate GridSearchCV.

gs_bgc = GridSearchCV(pipe_bgc, # what object are we optimizing?
    param_grid=pipe_params_bgc, # what parameters values are we
    ↪searching?
    cv=3,
    n_jobs=-1) # 5-fold cross-validation.

gs_bgt = GridSearchCV(pipe_bgt, # what object are we optimizing?
    param_grid=pipe_params_bgt, # what parameters values are we
    ↪searching?
    cv=3,
    n_jobs=-1) # 5-fold cross-validation.

```

```

# Start the timer
start_time = time.time()

gs_bgc.fit(clean_train_total, y_train)

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Cvec: {elapsed_time:.4f} seconds")

# Start the timer
start_time = time.time()

gs_bgt.fit(clean_train_total, y_train)

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Tvec: {elapsed_time:.4f} seconds")

```

```

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
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[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 8.9s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 9.0s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 8.9s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 9.1s finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 9.2s finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished

```

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[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.3min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.5min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.5min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.3s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.3min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.5min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.1min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.1min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.0min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 2.0min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 1.7min finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished
[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.

```

Computation Time Tvec: 33967.4037 seconds

```

[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 1.4min finished

```

```

[387]: pipe_adac = Pipeline([
    ('cvec', CountVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('ada', AdaBoostClassifier())
])

pipe_adat = Pipeline([
    ('tvec', TfidfVectorizer()),
    # ('ss', StandardScaler(with_mean=False)),
    ('ada', AdaBoostClassifier())
])

```

```

])

pipe_params_adac = {'cvec__max_features': list(np.arange(5000, 10000, 1000)),
                    'cvec__ngram_range': [(1,1), (1,2)],
                    'cvec__min_df': [0.00005, 0.0001],
                    'cvec__max_df': [0.6,0.65,0.7],
                    'ada__n_estimators': [50, 100, 200],
                    'ada__learning_rate': [0.01, 0.1, 1.0]
                    }

pipe_params_adat = {'tvec__max_features' : list(np.arange(5000, 10000, 1000)),
                    'tvec__ngram_range' : [(1, 1), (1, 2)],
                    'tvec__min_df': [0.00005, 0.0001],
                    'tvec__max_df': [0.6,0.65,0.7],
                    'ada__n_estimators': [50, 100, 200],
                    'ada__learning_rate': [0.01, 0.1, 1.0]
                    }

# Instantiate GridSearchCV.

gs_adac = GridSearchCV(pipe_adac, # what object are we optimizing?
                       param_grid=pipe_params_adac, # what parameters values are we
↳searching?
                       cv=5,
                       n_jobs=-1) # 5-fold cross-validation.

gs_adat = GridSearchCV(pipe_adat, # what object are we optimizing?
                       param_grid=pipe_params_adat, # what parameters values are we
↳searching?
                       cv=5,
                       n_jobs=-1) # 5-fold cross-validation.

# Start the timer
start_time = time.time()

gs_adac.fit(clean_train_total, y_train)

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Cvec: {elapsed_time:.4f} seconds")

```

```

# Start the timer
start_time = time.time()

gs_adat.fit(clean_train_total, y_train)

# Stop the timer
end_time = time.time()

# Calculate the elapsed time
elapsed_time = end_time - start_time

# Print the computation time
print(f"Computation Time Tvec: {elapsed_time:.4f} seconds")

```

Computation Time Cvec: 2021.2501 seconds

Computation Time Tvec: 3703.5591 seconds

4.5 Metrics Section

4.5.1 Bagging Classifier

```
[271]: gs_bgc.best_params_
```

```

[271]: {'bg__max_features': 0.5,
       'bg__max_samples': 1.0,
       'bg__n_estimators': 25,
       'bg__verbose': 1,
       'cvec__max_df': 0.7,
       'cvec__max_features': 9000,
       'cvec__min_df': 5e-05,
       'cvec__ngram_range': (1, 2)}

```

```
[273]: gs_bgt.best_params_
```

```

[273]: {'bg__max_features': 0.5,
       'bg__max_samples': 0.7,
       'bg__n_estimators': 25,
       'bg__verbose': 1,
       'tvec__max_df': 0.65,
       'tvec__max_features': 9000,
       'tvec__min_df': 0.0001,
       'tvec__ngram_range': (1, 1)}

```

```

[274]: print(f"Train Accuracy Score CVec Bagging Tree | {round(gs_bgc.
      ↪score(clean_train_total, y_train),5)}")

```

```
print(f"Test Accuracy Score CVec Bagging Tree | {round(gs_bgc.
↪score(clean_test_total, y_test),5)}")
```

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
 [Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.4s finished
 [Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.

Train Accuracy Score CVec Bagging Tree | 0.99907

Test Accuracy Score CVec Bagging Tree | 0.86652

[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished

```
[275]: print(f"Train Accuracy Score TVec Bagging Tree | {round(gs_bgt.
↪score(clean_train_total, y_train),5)}")
print(f"Test Accuracy Score TVec Bagging Tree | {round(gs_bgt.
↪score(clean_test_total, y_test),5)}")
```

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.

Train Accuracy Score TVec Bagging Tree | 0.9926

Test Accuracy Score TVec Bagging Tree | 0.87475

[Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.6s finished
 [Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
 [Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished

```
[276]: # Get predictions from optimal KNN model
preds = gs_bgc.predict(clean_test_total)
# Save confusion matrix values
tn18, fp18, fn18, tp18 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_bgc, clean_test_total, y_test,
↪cmap='Purples');
plt.title('Confusion Matrix for the Bagging Classifier CVec
↪Predictions',fontsize=16, loc='center');

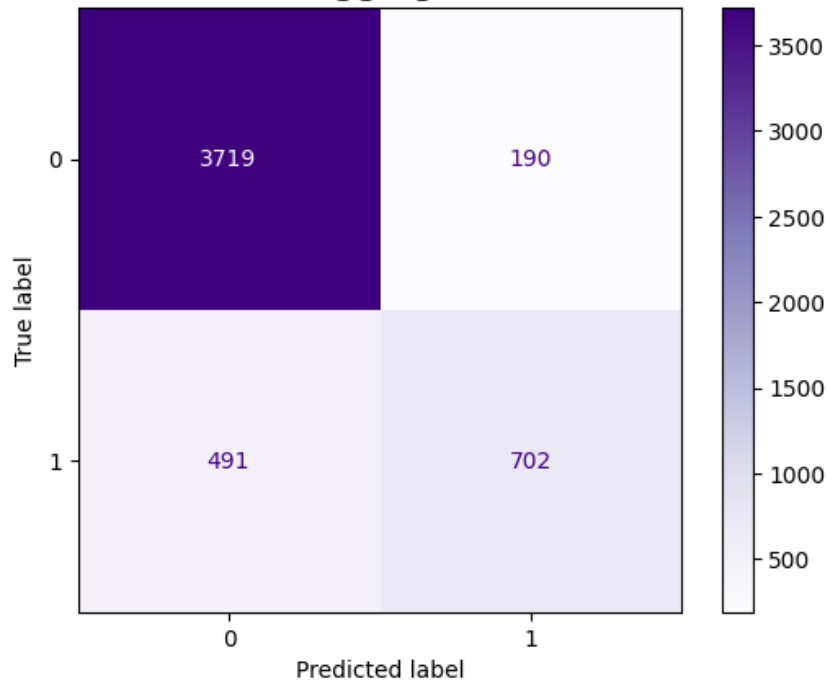
print(find_cm(y_test, preds))
```

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
 [Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished
 [Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
 [Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.1s finished

TN: 3719

FP: 190
FN: 491
TP: 702

Confusion Matrix for the Bagging Classifier CVec Predictions



```
[277]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp18/(tp18+fn18),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn18/(tn18+fp18),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp18+tn18)/(tp18+fp18+tn18+fn18),3)}")
# Calculate Precision
print(f"Precision | {round(tp18/(tp18+fp18),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp18+fn18)/(tp18+fp18+tn18+fn18),3)}")
```

Sensitivity | 0.588
Specificity | 0.951
Accuracy | 0.867
Precision | 0.787
Miscalculation Rate | 0.133

```
[282]: # Get predictions from optimal KNN model
preds = gs_bgt.predict(clean_test_total)
# Save confusion matrix values
```



```

tn19, fp19, fn19, tp19 = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_bgt, clean_test_total, y_test,
    cmap='Purples');
plt.title('Confusion Matrix for the Bagging Classifier TVec
    Predictions', fontsize=16, loc='center');

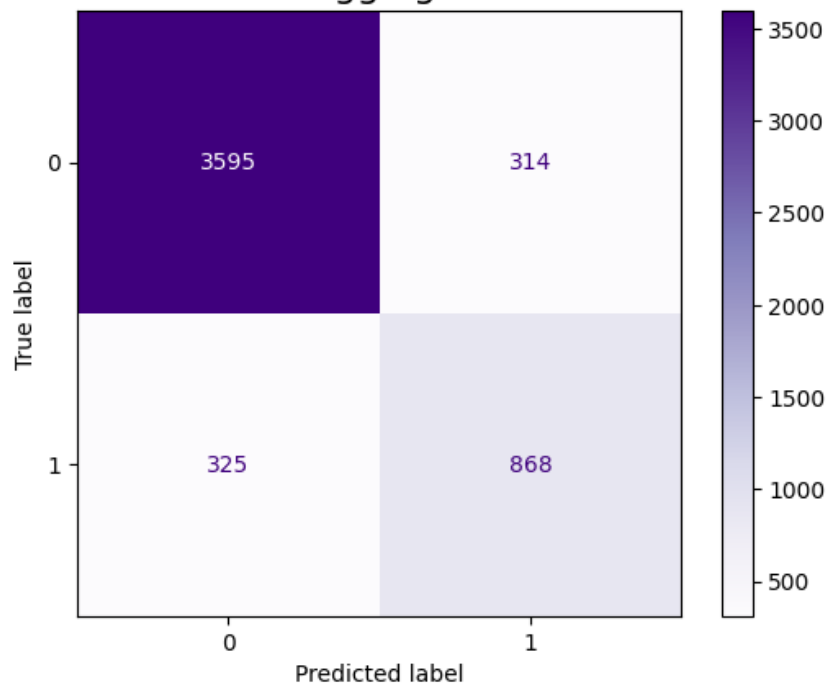
print(find_cm(y_test, preds))

```

[Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
 [Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished
 [Parallel(n_jobs=1)]: Using backend SequentialBackend with 1 concurrent workers.
 [Parallel(n_jobs=1)]: Done 1 out of 1 | elapsed: 0.2s finished

TN: 3595
 FP: 314
 FN: 325
 TP: 868

Confusion Matrix for the Bagging Classifier TVec Predictions



```
[283]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp19/(tp19+fn19),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn19/(tn19+fp19),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp19+tn19)/(tp19+fp19+tn19+fn19),3)}")
# Calculate Precision
print(f"Precision | {round(tp19/(tp19+fp19),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp19+fn19)/(tp19+fp19+tn19+fn19),3)}")
```

```
Sensitivity | 0.728
Specificity | 0.92
Accuracy | 0.875
Precision | 0.734
Miscalculation Rate | 0.125
```

```
[390]: gs_adac.best_params_
```

```
[390]: {'ada__learning_rate': 1.0,
      'ada__n_estimators': 200,
      'cvec__max_df': 0.6,
      'cvec__max_features': 8000,
      'cvec__min_df': 5e-05,
      'cvec__ngram_range': (1, 1)}
```

```
[391]: gs_adat.best_params_
```

```
[391]: {'ada__learning_rate': 1.0,
      'ada__n_estimators': 200,
      'tvec__max_df': 0.6,
      'tvec__max_features': 9000,
      'tvec__min_df': 5e-05,
      'tvec__ngram_range': (1, 1)}
```

```
[392]: print(f"Train Accuracy Score CVec ADA Boost | {round(gs_adac.
      ↪score(clean_train_total, y_train),5)}")
print(f"Test Accuracy Score CVec ADA Boost | {round(gs_adac.
      ↪score(clean_test_total, y_test),5)}")
```

```
Train Accuracy Score CVec ADA Boost | 0.85305
Test Accuracy Score CVec ADA Boost | 0.84379
```

```
[393]: print(f"Train Accuracy Score TVec ADA Boost | {round(gs_adat.
      ↪score(clean_train_total, y_train),5)}")
print(f"Test Accuracy Score TVec ADA Boost | {round(gs_adat.
      ↪score(clean_test_total, y_test),5)}")
```

Train Accuracy Score TVec ADA Boost | 0.87304

Test Accuracy Score TVec ADA Boost | 0.86535

```
[399]: # Get predictions from optimal KNN model
preds = gs_adac.predict(clean_test_total)
# Save confusion matrix values
tn_adac, fp_adac, fn_adac, tp_adac = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_adac, clean_test_total, y_test, cmap='Purples');
plt.title('Confusion Matrix for the ADA CVec Predictions', fontsize=16, loc='center');

print(find_cm(y_test, preds))
```

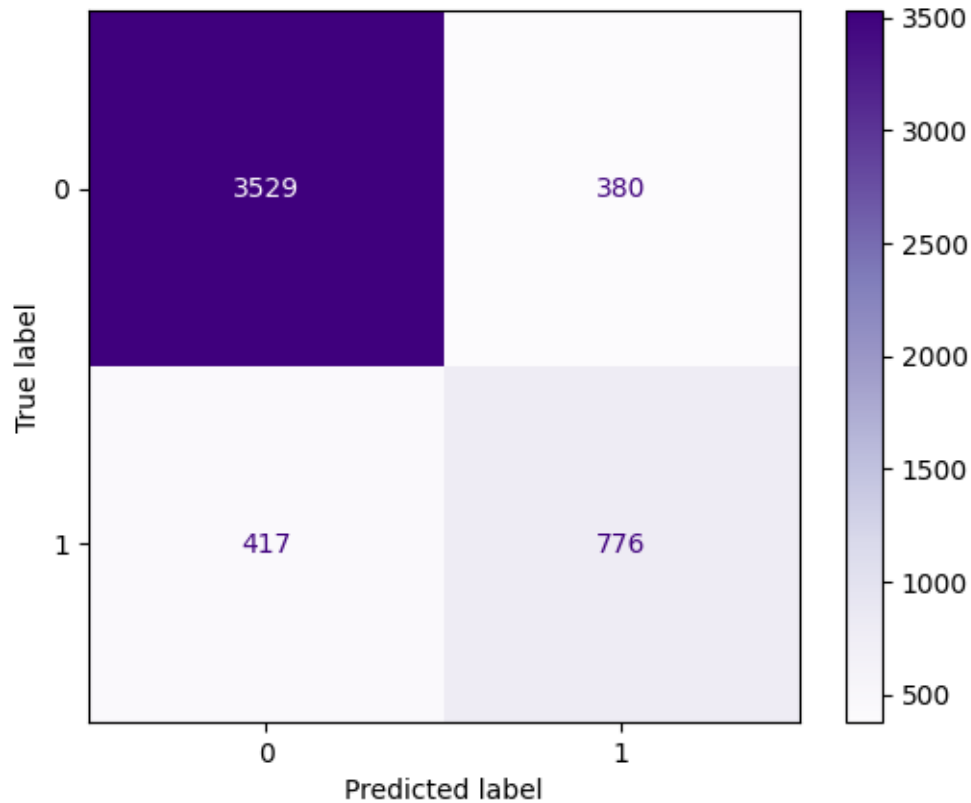
TN: 3529

FP: 380

FN: 417

TP: 776

Confusion Matrix for the ADA CVec Predictions



```
[400]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp_adac/(tp_adac+fn_adac),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn_adac/(tn_adac+fp_adac),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp_adac+tn_adac)/
    ↳(tp_adac+fp_adac+tn_adac+fn_adac),3)}")
# Calculate Precision
print(f"Precision | {round(tp_adac/(tp_adac+fp_adac),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp_adac+fn_adac)/
    ↳(tp_adac+fp_adac+tn_adac+fn_adac),3)}")
```

```
Sensitivity | 0.65
Specificity | 0.903
Accuracy | 0.844
Precision | 0.671
Miscalculation Rate | 0.156
```

```
[402]: # Get predictions from optimal KNN model
preds = gs_adat.predict(clean_test_total)
# Save confusion matrix values
tn_adat, fp_adat, fn_adat, tp_adat = confusion_matrix(y_test, preds).ravel()

# Generate values of confusion matrix for reference
def find_cm(y_test, preds):
    tn, fp, fn, tp = confusion_matrix(y_test, preds).ravel()

    return f"TN: {tn}\nFP: {fp}\nFN: {fn}\nTP: {tp}"

# View confusion matrix
ConfusionMatrixDisplay.from_estimator(gs_adat, clean_test_total, y_test,
    cmap='Purples');
plt.title('Confusion Matrix for the ADA TVec Predictions',fontsize=16,
    loc='center');

print(find_cm(y_test, preds))
```

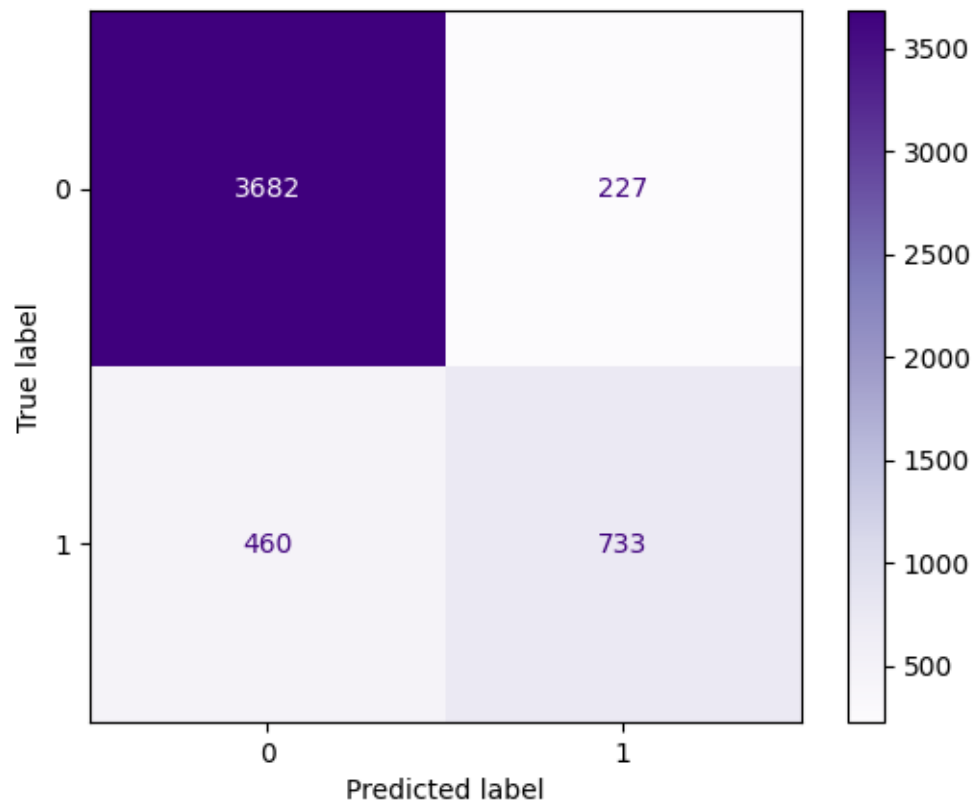
TN: 3682

FP: 227

FN: 460

TP: 733

Confusion Matrix for the ADA TVec Predictions



```
[409]: # Calculate Sensitivity
print(f"Sensitivity | {round(tp_adat/(tp_adat+fn_adat),3)}")
# Calculate the Specificity
print(f"Specificity | {round(tn_adat/(tn_adat+fp_adat),3)}")
# Calculate Accuracy
print(f"Accuracy | {round((tp_adat+tn_adat)/
    ↳(tp_adat+fp_adat+tn_adat+fn_adat),3)}")
# Calculate Precision
print(f"Precision | {round(tp_adat/(tp_adat+fp_adat),3)}")
# Calculate Miscalculation Rate
print(f"Miscalculation Rate | {round((fp_adat+fn_adat)/
    ↳(tp_adat+fp_adat+tn_adat+fn_adat),3)}")
```

```
Sensitivity | 0.614
Specificity | 0.942
Accuracy | 0.865
Precision | 0.764
Miscalculation Rate | 0.135
```

```
[404]: f1_score(y_test, preds)
```

[404] : 0.6809103576405016

4.5.2 Summary

Linear SVC TVec performed very well in specificity and accuracy and F1 score was also acceptable:

Sensitivity | 0.659

Specificity | 0.948

Accuracy | 0.881

Precision | 0.796

Miscalculation Rate | 0.119

F1 Score | 0.721.

ADA Boost was the closest fit model in terms of accuracy scores with

Train Accuracy Score CVec ADA Boost | 0.85305

Test Accuracy Score CVec ADA Boost | 0.84379

and

Train Accuracy Score TVec ADA Boost | 0.87304

Test Accuracy Score TVec ADA Boost | 0.86535.

4.5.3 Therefore, our LSTM neural network will have to surpass these values and we will also perform sentiment analysis after labeling data from the non-Opinion section identified in these models to evaluate whether or not our models are efficient at identifying bias in abstracts and headlines. This begins the second portion of this project.