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Sentiment Analysis on Amazon Reviews using Random Forest
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          1. Introduction
          In this project, we are going to perform a sentiment analysis on Amazon Review data. Specifically, we are going to predict whether a product review about
          Amazon Alexa to be classified as negative or positive feedback.
          The dataset is from (www.kaggle.com/sid321axn/amazon-alexa-reviews). Examples of key variables are:
                   - customer reviews: reviews on Amazon Alexa in text format
                   - star ratings: customer's rating which ranges from 1~5
                   - date of review: the date when each review was created
                   - variant: variant of Amazon Alex product, such as Alexa Echo, Echo dots, black, white etc.
                   - feedback: binary value ex) positive or negative
          2. Data & Library
          The dataset includes 3,150 observations and 5 variables ('rating', 'date', 'variation', 'verified_reviews', 'feedback')
In [66]: import pandas as pd
          import numpy as np
          import matplotlib.pyplot as plt
          import seaborn as sns
In [67]: | df = pd.read_csv('amazon_alexa.tsv', sep='\t')
          print(df.shape)
          print(df.head(5))
          print(df.keys())
          (3150, 5)
             rating
                            date
                                          variation \
                 5 31-Jul-18 Charcoal Fabric
                  5 31-Jul-18 Charcoal Fabric
                  4 31-Jul-18 Walnut Finish
                  5 31-Jul-18 Charcoal Fabric
                  5 31-Jul-18 Charcoal Fabric
                                                  verified_reviews feedback
                                                     Love my Echo!
                                                         Loved it!
          2 Sometimes while playing a game, you can answer...
          3 I have had a lot of fun with this thing. My 4 ...
                                                                             1
                                                              Music
          Index(['rating', 'date', 'variation', 'verified_reviews', 'feedback'], dtype='object')
In [68]: df['verified_reviews'].head(10)
Out[68]: 0
                                                       Love my Echo!
               Sometimes while playing a game, you can answer...
               I have had a lot of fun with this thing. My 4 ...
               I received the echo as a gift. I needed anothe...
               Without having a cellphone, I cannot use many ...
               I think this is the 5th one I've purchased. I'...
               Love it! I've listened to songs I haven't hear...
          Name: verified_reviews, dtype: object
          3. Explanatory Analysis & Data Cleaning
          There are 257 negative vs. 2893 positive feedbacks in our dataset
In [69]: df.feedback.value_counts()
Out[69]: 1
               2893
                257
          Name: feedback, dtype: int64
In [70]: sns.countplot(df['feedback'], label = "Count")
Out[70]: <matplotlib.axes._subplots.AxesSubplot at 0x266a56f9c88>
             3000
             2500
             2000
            1500
             1000
              500
                                    feedback
          Consumer Ratings ranges from 1 to 5, just like feedback variable, positive ratings (4, 5) are majority.
In [71]: df['rating'].hist(bins = 5)
Out[71]: <matplotlib.axes._subplots.AxesSubplot at 0x266a5659c08>
           2000
           1500
           1000
            500
                         2.0 2.5 3.0 3.5 4.0
          We found 16 variations, and barcharts below letting us to see that there is no big difference in ratings in terms of variations. Nor the feedback varies based on
          variations.
In [72]: | df.variation.unique()
Out[72]: array(['Charcoal Fabric ', 'Walnut Finish ', 'Heather Gray Fabric ',
                   'Sandstone Fabric ', 'Oak Finish ', 'Black', 'White',
                   'Black Spot', 'White Spot', 'Black Show', 'White Show',
                  'Black Plus', 'White Plus', 'Configuration: Fire TV Stick',
                  'Black Dot', 'White Dot'], dtype=object)
In [73]: plt.figure(figsize = (40,20))
          plt.subplot(2,1,1)
          sns.barplot(x = 'variation', y='feedback', data=df, palette = 'deep')
          sns.barplot(x = 'variation', y='rating', data=df, palette = 'deep')
Out[73]: <matplotlib.axes._subplots.AxesSubplot at 0x266a5832908>
          Our target variable is 'feedback' column, so we do not need 'rating' column which is redundant. Also, date information is less likely to give us additional
          information for sentiment analysis. So we are going to drop date variable as well. Lastly, we saw from above chart that neither feedback nor rating varies by
          product variation, so we are going to drop 'variation' as well.
In [74]: | df = df.drop(['date', 'rating', 'variation'], axis=1)
Out[74]:
                                      verified reviews
                                                   feedback
           0
                                       Love my Echo!
                                                         1
           2 Sometimes while playing a game, you can answer...
           3
                   I have had a lot of fun with this thing. My 4 ...
                                             Music
                                                         1
          we are going to add length of column 'review' hypothesizing that bad review might be longer than positive ones.
In [75]: | df['length'] = df.verified_reviews.apply(len)
          df.head()
Out[75]:
           0
                                       Love my Echo!
           1
                                            Loved it!
             Sometimes while playing a game, you can answer..
                   I have had a lot of fun with this thing. My 4 ...
          In order to feed create dummies, translate into numbers /one hot encoding, avoid dummies trap, we drop first = True we dont want two columns that are
          apposite to each other to avoid multicollinearity lets check withount drop first <> True
          Now let's transform reviews column into code in order to feed them in our classifier. With CountVectorizer, we are counting how many elements (ex - words)
          are included in each review. 3,150 reviews turned into 3,150 rows/4,044 columns. Every single word that was contained within 'review' column now become
          columns.
In [76]: | from sklearn.feature_extraction.text import CountVectorizer
          vectorizer = CountVectorizer()
          review_vectorized = vectorizer.fit_transform(df['verified_reviews'])
In [77]: review_vectorized.shape
Out[77]: (3150, 4044)
          every single word that has been contained wihin our reviews became columns
In [93]: | print(vectorizer.get_feature_names())
          ['00', '000', '07', '10', '100', '100x', '11', '1100sf', '12', '129', '12am', '15', '150', '18', '19', '1964', '199
          0', '1gb', '1rst', '1st', '20', '200', '2000', '2017', '229', '23', '24', '25', '29', '2nd', '2package', '30', '300',
          '30pm', '34', '360', '39', '3rd', '3x', '3xs', '40', '45', '48', '4am', '4ghz', '4k', '4th', '50', '54', '5am', '5gh
          z', '5th', '600', '62', '672', '6th', '70', '75', '79', '80', '80s', '81', '83', '85', '88', '888', '8gb', '90', '9
              '911', '99', '_specifically_', 'a1', 'a19', 'abay', 'abc', 'abd', 'abilities', 'ability', 'able', 'abode', 'abou
              'above', 'absolutely', 'absolutly', 'ac', 'accent', 'acceptable', 'accepting', 'access', 'accessable', 'accessibl
          e', 'accessing', 'accessories', 'accesss', 'accident', 'accidentally', 'accompanying', 'accomplish', 'accomplished',
          'according', 'accordingly', 'account', 'accounts', 'accuracy', 'accurate', 'accurately', 'accustom', 'acknowledge',
          'acoustical', 'across', 'act', 'acting', 'action', 'actions', 'activate', 'activated', 'activates', 'activating', 'ac
          tivation', 'actively', 'activities', 'acts', 'actually', 'ad', 'adapted', 'adapter', 'adapting', 'add', 'added', 'add
          ict', 'addicted', 'addicts', 'adding', 'addition', 'additional', 'additionally', 'addons', 'addressed', 'addresses',
          'adds', 'adept', 'adequate', 'adjacent', 'adjust', 'adjusting', 'adjustment', 'adjusts', 'admit', 'adopters', 'adorab
          le', 'ads', 'adults', 'advance', 'advanced', 'advantage', 'advantages', 'advertise', 'advertised', 'advertisement',
          'advertising', 'advice', 'advise', 'advised', 'aesthetic', 'af', 'affirm', 'affirmations', 'afford', 'affordable', 'a
          fraid', 'after', 'afternoon', 'afterwards', 'again', 'age', 'agent', 'ages', 'ago', 'agree', 'agreement', 'ahead', 'a
          i', 'aide', 'aint', 'air', 'aka', 'al', 'alabama', 'alarm', 'alarms', 'albeit', 'alcohol', 'alert', 'alerts', 'alex',
          'alexa', 'alexas', 'alexi', 'alexia', 'alexis', 'alexus', 'algo', 'alive', 'all', 'alleviate', 'allow', 'allowed', 'a
          llowing', 'allows', 'allrecipes', 'almost', 'alone', 'along', 'alongside', 'alot', 'alots', 'aloud', 'alread', 'alrea
          dy', 'alright', 'also', 'altering', 'alternative', 'alternatives', 'although', 'always', 'am', 'amaonmazing', 'amaxin
          g', 'amaze', 'amazed', 'amazin', 'amazing', 'amazingly', 'amazon', 'amazonia', 'amazons', 'ambient', 'american', 'ame
          ricans', 'among', 'amount', 'amounts', 'amozon', 'amplifier', 'amused', 'amusing', 'an', 'analog', 'and', 'android', 'ands', 'angle', 'annoying', 'another', 'answer', 'answered', 'answering', 'answers', 'anti', 'anticipate', 'a
          nticipated', 'any', 'anybody', 'anyhow', 'anylist', 'anymore', 'anyone', 'anypod', 'anything', 'anytime', 'anyway',
          'anyways', 'anywhere', 'apartment', 'app', 'apparent', 'apparently', 'appealing', 'appear', 'appears', 'apple', 'appl
          iance', 'appliances', 'application', 'applications', 'appointments', 'appreciated', 'apprehensive', 'approaching', 'a
          ppropriate', 'approximately', 'apps', 'are', 'area', 'areas', 'aren', 'arent', 'argue', 'argument', 'arguments', 'ari
          ses', 'arlo', 'arm', 'around', 'array', 'arrive', 'arrived', 'arriving', 'articles', 'artist', 'artists', 'as', 'asa
          p', 'ase', 'ask', 'asked', 'askes', 'asking', 'asleep', 'aspect', 'aspects', 'ass', 'assigned', 'assist', 'assistanc
          e', 'assistant', 'assume', 'assumed', 'assuming', 'assumption', 'at', 'atención', 'atmosphere', 'atrás', 'attach', 'a
          ttached', 'attachment', 'attempt', 'attempted', 'attempting', 'attention', 'attractive', 'audible', 'audibles', 'audi
          o', 'audioapple', 'audiobook', 'audiobooks', 'audiophile', 'august', 'aunt', 'auto', 'automatic', 'automatically', 'a
          utomation', 'aux', 'auxiliary', 'av', 'avail', 'availability', 'available', 'avoid', 'awake', 'aware', 'away', 'aweso
          me', 'awful', 'awhile', 'awkward', 'awsome', 'b073sqyxtw', 'baby', 'back', 'background', 'backgrounds', 'backyard',
          'bad', 'baffle', 'baffled', 'ball', 'ban', 'band', 'bandwagon', 'bandwidth', 'bang', 'bar', 'bare', 'barely', 'bargai
          n', 'bark', 'barn', 'barret', 'barry', 'base', 'baseball', 'based', 'basement', 'basic', 'basically', 'bass', 'bathro
          om', 'bathrooms', 'batman', 'batteries', 'battery', 'bc', 'be', 'beam', 'beat', 'beautiful', 'beautifully', 'beauty',
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          'beefy', 'been', 'before', 'begin', 'beginners', 'beginning', 'begun', 'behaved', 'behind', 'being', 'believe', 'beli
          ever', 'bells', 'belong', 'below', 'benefit', 'benefits', 'beside', 'besides', 'best', 'bet', 'beta', 'better', 'bett
          ter', 'between', 'beyond', 'bezel', 'bezos', 'bf', 'bff', 'bible', 'big', 'bigger', 'biggest', 'bill', 'billboard',
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          g', 'board', 'boat', 'bob', 'body', 'bolt', 'bonkers', 'bonus', 'book', 'books', 'boom', 'boombox', 'booming', 'boos
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          h', 'bought', 'box', 'boyfriend', 'brainer', 'brand', 'brandnew', 'brands', 'bread', 'break', 'breakfast', 'breeze',
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          ay', 'broke', 'broken', 'brought', 'bt', 'bucks', 'buddies', 'budget', 'buffer', 'buffering', 'buffet', 'bug', 'buggi
          ng', 'bugs', 'build', 'building', 'built', 'bulb', 'bulbs', 'buld', 'bulky', 'bummed', 'bunch', 'bundle', 'bundled',
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          g', 'by', 'bye', 'cable', 'calendar', 'calendars', 'call', 'called', 'calling', 'calls', 'calm', 'calmer', 'cam', 'ca
          mbiar', 'came', 'camelot', 'camera', 'cameras', 'campus', 'cams', 'can', 'canary', 'cancel', 'canceling', 'cancelle
          d', 'cancels', 'cannot', 'cant', 'capabilities', 'capability', 'capable', 'capacity', 'capasity', 'car', 'card', 'car
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          l', 'channels', 'characteristics', 'charge', 'chargeable', 'charger', 'charging', 'charlotte', 'charm', 'charmed', 'c
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          ldren', 'chocolate', 'choice', 'choices', 'choose', 'choosing', 'choppy', 'chores', 'chose', 'chosen', 'christmas',
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          lassroom', 'clean', 'cleaner', 'cleaning', 'clear', 'clearer', 'clearly', 'click', 'clients', 'clips', 'clock', 'cloc
          khome', 'clocking', 'clocks', 'clone', 'close', 'closed', 'closer', 'clothes', 'cloud', 'clue', 'cm_cr_ryp_prd_ttl_so
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          ort', 'comfortable', 'comforting', 'coming', 'command', 'commanded', 'commands', 'comment', 'comments', 'commercial
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          sion', 'connect', 'connected', 'connecting', 'connection', 'connectivity', 'connects', 'cons', 'conscious', 'conside
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          nue', 'continues', 'continuous', 'continuously', 'control', 'controll', 'controllable', 'controlled', 'controller',
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          t', 'corrected', 'correctly', 'corresponds', 'cortna', 'cost', 'costs', 'cotton', 'couch', 'could', 'couldn', 'counte
          r', 'counters', 'countless', 'countries', 'country', 'county', 'couple', 'course', 'cousin', 'cousins', 'cover', 'cov
          ered', 'covers', 'cozi', 'cpr', 'cracked', 'crackle', 'crackling', 'crap', 'crappy', 'crashed', 'crashes', 'crashin
          g', 'crazy', 'creapy', 'create', 'created', 'credited', 'creepy', 'crib', 'crisp', 'critically', 'cropping', 'cross',
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          ycled', 'cycles', 'cylinder', 'cylindercal', 'dad', 'daily', 'damage', 'dance', 'dancing', 'dare', 'dark', 'darn', 'd
          ash', 'data', 'date', 'dated', 'dates', 'daughter', 'day', 'days', 'de', 'deactivate', 'dead', 'deaf', 'deal', 'deal
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          e', 'dedicated', 'deep', 'deeper', 'default', 'defeats', 'defective', 'defence', 'defently', 'definately', 'define',
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          pers', 'development', 'device', 'deviceoverall', 'devices', 'devise', 'devises', 'dhiw', 'diagnostics', 'dial', 'dict
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          lity', 'disable', 'disabled', 'disagree', 'disappoint', 'disappointed', 'disappointing', 'disappointment', 'disappoin
          tments', 'disarm', 'disaster', 'disconcerting', 'disconnect', 'disconnected', 'disconnecting', 'disconnections', 'dis
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          able', 'dissatisfaction', 'distance', 'distorted', 'distracting', 'distraction', 'disturbing', 'ditch', 'ditched', 'd
          iversity', 'divertido', 'dj', 'do', 'docking', 'doctor', 'documentation', 'dodging', 'does', 'doesn', 'doesnt', 'do
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          airs', 'dp', 'drag', 'draw', 'drawback', 'drawing', 'dressed', 'drive', 'driven', 'drivers', 'drives', 'driving', 'dr
          op', 'dropped', 'dropping', 'drops', 'dryer', 'due', 'dumb', 'dumber', 'dunce', 'dunno', 'during', 'dust', 'duty', 'd
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          l', 'eeaanh', 'effected', 'effective', 'effects', 'efficiency', 'efficient', 'effort', 'effortless', 'efforts', 'eg'
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          ctronics', 'elegant', 'element', 'eliminate', 'else', 'elsewhere', 'em', 'email', 'embarrassed', 'emergency', 'emoj
          i', 'employees', 'en', 'enable', 'enabled', 'enables', 'encyclopedias', 'end', 'ended', 'endless', 'ends', 'engage',
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          nment', 'entire', 'entirely', 'entry', 'eq', 'equal', 'equalized', 'equalizer', 'equipment', 'equipo', 'error', 'erro
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          e', 'evrything', 'ex', 'exact', 'exactly', 'example', 'examples', 'exasperation', 'exceeded', 'exceeds', 'excelente'
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          g', 'excited', 'excitement', 'excuses', 'exho', 'existence', 'existent', 'existing', 'expanded', 'expanding', 'expec
          t', 'expectation', 'expectations', 'expected', 'expecting', 'expensive', 'experience', 'experienced', 'experiences',
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          s', 'fabric', 'fabulous', 'face', 'facebook', 'faces', 'facetime', 'fact', 'factor', 'factory', 'facts', 'fail', 'fai
          led', 'failing', 'fails', 'fair', 'fairly', 'fairness', 'fall', 'falling', 'falls', 'false', 'familiar', 'family', 'f
          an', 'fanatic', 'fans', 'fantastic', 'far', 'farther', 'fascinating', 'fashioned', 'fast', 'faster', 'fat', 'father',
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          irst', 'fit', 'fits', 'five', 'fix', 'fixed', 'fixes', 'fixing', 'fixture', 'fixtures', 'flash', 'flashes', 'flat',
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          orecast', 'forecasts', 'forever', 'forget', 'forgot', 'forgotten', 'forjust', 'form', 'forth', 'fortunately', 'forum
          s', 'forward', 'found', 'four', 'fourth', 'free', 'freeze', 'freezes', 'frequently', 'fri', 'friday', 'friend', 'frie
          ndly', 'friends', 'from', 'front', 'frustrated', 'frustrating', 'frustration', 'full', 'fuller', 'fully', 'fumble',
          'fun', 'funciona', 'funcionamiento', 'funciones', 'function', 'functionalities', 'functionality', 'functions', 'funn
          y', 'further', 'furthermore', 'fussing', 'fussy', 'future', 'fw', 'gadget', 'gadgets', 'gain', 'galaxy', 'game', 'gam
          es', 'gameshow', 'gaming', 'gap', 'garage', 'garbage', 'gateway', 'gather', 'gatherings', 'gave', 'gazebo', 'gb', 'g
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          res', 'geo', 'get', 'gets', 'getting', 'gf', 'ghost', 'gift', 'gifts', 'girlfriend', 'girls', 'give', 'given', 'give
          s', 'giving', 'gizmo', 'glad', 'glaring', 'glasses', 'glitch', 'glitches', 'glitching', 'glorified', 'glow', 'go', 'g
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          e', 'theater', 'theecho', 'their', 'theirs', 'them', 'themes', 'themselves', 'then', 'theories', 'there', 'therefor
          e', 'thermostat', 'these', 'thestand', 'thete', 'they', 'thick', 'thing', 'things', 'think', 'thinking', 'third', 'th
          is', 'thongs', 'thorough', 'thoroughly', 'those', 'thou', 'though', 'thought', 'thoughts', 'thousands', 'three', 'thr
          illed', 'through', 'throughout', 'throw', 'thrown', 'thru', 'thu', 'thumb', 'thumbs', 'thunderstorm', 'thursday', 't
          i', 'tickled', 'tiempo', 'tiene', 'ties', 'til', 'till', 'time', 'timer', 'timers', 'times', 'timing', 'tin', 'ting',
          'tinker', 'tinkering', 'tinny', 'tiny', 'tipping', 'tips', 'tired', 'title', 'tivo', 'to', 'toda', 'today', 'toddle
          r', 'together', 'toilet', 'told', 'tomorrow', 'tomy', 'ton', 'tones', 'tons', 'tony', 'too', 'took', 'tool', 'tools',
          'tooth', 'top', 'topic', 'tosca', 'total', 'totallly', 'totally', 'tou', 'touch', 'touching', 'touted', 'toward', 'to
          wards', 'tower', 'town', 'toy', 'tp', 'track', 'traditional', 'traffic', 'trailer', 'trailers', 'trained', 'trainee
          s', 'training', 'transferring', 'travel', 'traveling', 'travelling', 'través', 'treadmill', 'treat', 'treble', 'tre
          k', 'tremendous', 'trending', 'trial', 'tricks', 'tricky', 'tried', 'tries', 'trigger', 'trip', 'trivia', 'trouble',
          'troubleshooting', 'troublesome', 'troubling', 'true', 'truly', 'trust', 'try', 'trying', 'tube', 'tubi', 'tune', 'tu
          nein', 'tunes', 'turn', 'turned', 'turning', 'turns', 'tv', 'tvs', 'tweeter', 'tweeters', 'twice', 'twist', 'twitte
          r', 'two', 'ty', 'type', 'typed', 'types', 'typical', 'typically', 'typing', 'títulos', 'udefulness', 'ugly', 'uhyou
          r', 'ummm', 'un', 'unable', 'unacceptable', 'unavailable', 'unbelievable', 'uncle', 'under', 'underestimated', 'under
          stand', 'understanding', 'understands', 'understood', 'unexpected', 'unfortunately', 'unhappy', 'unhelpful', 'unico', 'unimportant', 'uninstall', 'unique', 'unit', 'units', 'universal', 'unless', 'unlike', 'unlimited', 'unlocking', 'un
          nannounced', 'unnecessary', 'unobtrusive', 'unplug', 'unplugged', 'unresponsive', 'unsettling', 'untapped', 'until',
          'unusable', 'unused', 'unwitty', 'unwrapped', 'up', 'upcoming', 'update', 'updated', 'updates', 'updating', 'upgrad
          e', 'upgraded', 'upgrades', 'upgrading', 'upload', 'upon', 'upset', 'upsetting', 'upstairs', 'urge', 'us', 'usa', 'us
          able', 'usage', 'usb', 'usde', 'use', 'used', 'useful', 'useless', 'user', 'users', 'uses', 'using', 'usual', 'usuall
          y', 'utility', 'utilización', 'utilize', 'utilizing', 'vacation', 'vacations', 'vacuum', 'value', 'variant', 'variet
          y', 'various', 'vast', 've', 'vehicle', 'verbal', 'verbalize', 'verbally', 'versa', 'versatile', 'versatility', 'vers
          e', 'verses', 'version', 'versions', 'versus', 'very', 'vetted', 'vez', 'via', 'vibrating', 'vice', 'viceo', 'video',
          'videos', 'view', 'viewed', 'viewing', 'views', 'vintage', 'viola', 'virtual', 'virtually', 'visa', 'visible', 'visio
          n', 'visiting', 'visits', 'visual', 'visuals', 'vlan', 'voice', 'voices', 'voiceview', 'voila', 'voltage', 'voltson',
          'volume', 'vs', 'vudu', 'wait', 'waited', 'waiting', 'waits', 'wake', 'wakes', 'waking', 'walk', 'walked', 'walking',
          'walks', 'wall', 'walls', 'want', 'wanted', 'wanting', 'warehouse', 'warning', 'warns', 'warranty', 'was', 'wasconcer
          ned', 'wasn', 'wasnt', 'waste', 'wasted', 'watch', 'watched', 'watching', 'water', 'wattage', 'wave', 'way', 'ways',
          'we', 'weak', 'wealth', 'wear', 'weary', 'weather', 'web', 'website', 'websites', 'wedding', 'week', 'weekday', 'week
          days', 'weekend', 'weekly', 'weeks', 'weight', 'weird', 'welcome', 'well', 'wellfour', 'went', 'were', 'weren', 'wha
          t', 'whatever', 'whats', 'whatsoever', 'whe', 'when', 'whenever', 'where', 'wherever', 'whether', 'which', 'while',
          'whisper', 'whistles', 'white', 'who', 'whole', 'whom', 'whos', 'whose', 'why', 'wi', 'wide', 'widespread', 'wife',
           'wifi', 'wikipedia', 'will', 'willing', 'wind', 'window', 'winds', 'wink', 'wireless', 'wish', 'wished', 'wishing',
          'with', 'within', 'without', 'woke', 'woken', 'won', 'wonder', 'wonderful', 'wonderfully', 'wonders', 'wont', 'woofe
          r', 'woofers', 'woohoo', 'word', 'words', 'work', 'workarounds', 'worked', 'worker', 'working', 'workout', 'workrea
          t', 'works', 'world', 'worried', 'worry', 'worse', 'worst', 'worth', 'worthless', 'worthy', 'would', 'wouldn', 'wow',
          'writes', 'writing', 'wrong', 'www', 'xbox', 'xfinity', 'xm', 'yale', 'yard', 'yards', 'yeah', 'year', 'years', 'yel
          l', 'yelling', 'yellow', 'yep', 'yes', 'yesterday', 'yet', 'yhe', 'york', 'you', 'young', 'younger', 'youngest', 'you
          r', 'yourself', 'youtube', 'yr', 'yrs', 'yup', 'zero', 'zigbee', 'zonked', 'zzzz', 'zzzzzzz', 'útil']
          Now, we need to transform above object into 0/1 encoding to feed our algorithm, and merge with our data(df)
In [79]: | reviews = pd.DataFrame(review_vectorized.toarray())
          reviews.head()
Out[79]:
           4 0 0 0 0 0 0 0 0 0 0 ...
          5 rows × 4044 columns
In [80]: |df.drop(['verified_reviews'], axis=1, inplace=True)
          df = pd.concat([df, reviews], axis=1)
          df.head(5)
Out[80]:
                                                   4034 4035 4036 4037 4038 4039 4040 4041 4042 4043
                         5 rows × 4046 columns
          4. Random Forest - Training
In [81]: y = df['feedback']
In [82]: X = df.drop(['feedback'], axis=1)
In [83]: from sklearn.model_selection import train_test_split
          X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.30, random_state=5)
In [84]: print("X_train", X_train.shape)
          print("X_test", X_test.shape)
          print("y_train", y_train.shape)
          print("y_test", y_test.shape)
          X_train (2205, 4045)
          X_test (945, 4045)
          y_train (2205,)
          y_test (945,)
          By setting n estimators = 100 for RandomForestClassifier, we are training 100 trees with 100 random training data subsets.
In [85]: from sklearn.metrics import classification_report, confusion_matrix
          from sklearn.ensemble import RandomForestClassifier
          randomforest_classifier = RandomForestClassifier(n_estimators = 100, criterion = 'entropy')
          randomforest_classifier.fit(X_train, y_train)
Out[85]: RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                                   criterion='entropy', max_depth=None, max_features='auto',
                                    max_leaf_nodes=None, max_samples=None,
                                   min_impurity_decrease=0.0, min_impurity_split=None,
                                   min_samples_leaf=1, min_samples_split=2,
                                   min_weight_fraction_leaf=0.0, n_estimators=100,
                                   n jobs=None, oob score=False, random state=None,
                                   verbose=0, warm_start=False)
          Now let's make predictions on our random forest classifier object with our training data. From the result, we can see that only 14 points are misclassified. The
          f1 score is 99%.
In [86]: y_predict_train = randomforest_classifier.predict(X_train)
          cm = confusion_matrix(y_train, y_predict_train)
In [87]: | sns.heatmap(cm, annot=True)
Out[87]: <matplotlib.axes._subplots.AxesSubplot at 0x266a59db588>
                                                     - 2000
                                                     1750
           0
                   1.6e+02
                                                     1500
                                                     1250
                                                     1000
                                                     750
                                      2e+03
                                                     - 500
                                                     250
In [88]: print(classification_report(y_train, y_predict_train))
                         precision
                                       recall f1-score support
                               1.00
                                          0.92
                                                     0.96
                                                                 171
                                                                2034
                               0.99
                                          1.00
                                                     1.00
                                                     0.99
                                                                2205
               accuracy
              macro avq
                               1.00
                                          0.96
                                                     0.98
                                                                2205
          weighted avg
                                                     0.99
                                                                2205
                               0.99
                                          0.99
          5. Random Forest - Evaluating
          When we apply our classifier into testing data, the result is f1-score 90%. We correctly classified 874 cases and misclassified 71 cases.
In [89]: y_predict_test = randomforest_classifier.predict(X_test)
          cm = confusion_matrix(y_test, y_predict_test)
In [90]: sns.heatmap(cm, annot=True)
Out[90]: <matplotlib.axes._subplots.AxesSubplot at 0x266b9cfa248>
                                                     800
                                                     700
           0
                                       71
                                                     600
                                                     500
                                                     400
                                                     300
                                     8.6e+02
                                                     - 200
                                                     - 100
```

In [91]: | print(classification_report(y_test, y_predict_test))

1.00

0.92

0.96

0.93

recall f1-score support

0.30

0.96

0.92

0.63

0.90

0.17

1.00

0.59

0.92

86

859

945

945

945

precision

accuracy

macro avg

weighted avg