# Assignment:-

## Apply SVM to Amazon Reviews data set

## Amazon Fine Food Reviews Analysis

Data Source: https://www.kaggle.com/snap/amazon-fine-food-reviews (https://www.kaggle.com/snap/amazon-fine-food-reviews)

The Amazon Fine Food Reviews dataset consists of reviews of fine foods from Amazon.

Number of reviews: 568,454
Number of users: 256,059
Number of products: 74,258
Timespan: Oct 1999 - Oct 2012
Number of Attributes/Columns in data: 10

Attribute Information:

1. Id
2. ProductId - unique identifier for the product
3. UserId - unqiue identifier for the user
4. ProfileName
5. HelpfulnessNumerator - number of users who found the review helpful
6. HelpfulnessDenominator - number of users who indicated whether they found the review helpful or not
7. Score - rating between 1 and 5
8. Time - timestamp for the review
9. Summary - brief summary of the review
10. Text - text of the review

# 1. Objective:

Given a review, determine whether the review is positive (Rating of 4 or 5) or negative (rating of 1 or 2). Use BoW, TF-IDF, Avg-Word2Vec,TF-IDF-Word2Vec to vectorise the reviews. Apply RBFSVM Algorithm for Amazon fine food Reviews find right C, gamma(ɣ) where ɣ=1/c by Gridsearch cv,Random search cv

In [1]:

```
# loading required libraries
import warnings
warnings.simplefilter(action='ignore', category=FutureWarning)
warnings.filterwarnings("ignore", category=DeprecationWarning)
warnings.filterwarnings("ignore", category=FutureWarning)
warnings.filterwarnings('ignore')
import numpy as np
import pandas as pd
import matplotlib
import sqlite3
import string
import gensim
import scipy
import nltk
import time
import seaborn as sns
from scipy import stats
from matplotlib import pyplot as plt

from sklearn.feature_extraction.text import TfidfTransformer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.feature_extraction.text import CountVectorizer

from sklearn.model_selection import GridSearchCV
from sklearn.model_selection import RandomizedSearchCV
from sklearn.linear_model import LogisticRegression

from sklearn import metrics
from sklearn.metrics import confusion_matrix
from sklearn.metrics import roc_curve, roc_auc_score, auc
from sklearn.metrics import accuracy_score
from sklearn.metrics import precision_recall_fscore_support as prf1

from sklearn.model_selection import KFold
from sklearn.model_selection import train_test_split
```

## 1.1 Connecting SQL file

In [2]:

```
#Loading the data
con = sqlite3.connect('./final.sqlite')

data = pd.read_sql_query("""
SELECT *
FROM Reviews
""", con)
```

In [3]:

```
print(data.shape)
data.head()
```

(364171, 12)

Out[3]:

| | index | Id | ProductId | UserId | ProfileName | HelpfulnessNumerator | Help |
|---|---|---|---|---|---|---|---|
| **0** | 138706 | 150524 | 0006641040 | ACITT7DI6IDDL | shari zychinski | 0 | |
| **1** | 138688 | 150506 | 0006641040 | A2IW4PEEKO2R0U | Tracy | 1 | |
| **2** | 138689 | 150507 | 0006641040 | A1S4A3IQ2MU7V4 | sally sue "sally sue" | 1 | |
| **3** | 138690 | 150508 | 0006641040 | AZGXZ2UUK6X | Catherine Hallberg " (Kate)" | 1 | |
| **4** | 138691 | 150509 | 0006641040 | A3CMRKGE0P909G | Teresa | 3 | |

# 1.2 Data Preprocessing

In [4]:

```
data.Score.value_counts()
#i had done data preprocessing i had stored in final.sqlite now loaded this file no nee
d to do again data preprocessing
```

Out[4]:

```
positive    307061
negative     57110
Name: Score, dtype: int64
```

# 1.3 Sorting the data

In [5]:

```
# Sorting the data according to the time-stamp
sorted_data = data.sort_values('Time', axis=0, ascending=True, inplace=False, kind='qui
cksort', na_position='last')
sorted_data.head()
```

Out[5]:

| | index | Id | ProductId | UserId | ProfileName | HelpfulnessNumerator |
|---|---|---|---|---|---|---|
| **0** | 138706 | 150524 | 0006641040 | ACITT7DI6IDDL | shari zychinski | 0 |
| **30** | 138683 | 150501 | 0006641040 | AJ46FKXOVC7NR | Nicholas A Mesiano | 2 |
| **424** | 417839 | 451856 | B00004CXX9 | AIUWLEQ1ADEG5 | Elizabeth Medina | 0 |
| **330** | 346055 | 374359 | B00004CI84 | A344SMIA5JECGM | Vincent P. Ross | 1 |
| **423** | 417838 | 451855 | B00004CXX9 | AJH6LUC1UT1ON | The Phantom of the Opera | 0 |

# 1.4 Mapping

In [6]:

```
def partition(x):
    if x == 'positive':
        return 1
    return 0

#Preparing the filtered data
actualScore = sorted_data['Score']
positiveNegative = actualScore.map(partition)
sorted_data['Score'] = positiveNegative
sorted_data.head()
```

Out[6]:

| | index | Id | ProductId | UserId | ProfileName | HelpfulnessNumerator | H |
|---|---|---|---|---|---|---|---|
| **0** | 138706 | 150524 | 0006641040 | ACITT7DI6IDDL | shari zychinski | 0 | |
| **30** | 138683 | 150501 | 0006641040 | AJ46FKXOVC7NR | Nicholas A Mesiano | 2 | |
| **424** | 417839 | 451856 | B00004CXX9 | AIUWLEQ1ADEG5 | Elizabeth Medina | 0 | |
| **330** | 346055 | 374359 | B00004CI84 | A344SMIA5JECGM | Vincent P. Ross | 1 | |
| **423** | 417838 | 451855 | B00004CXX9 | AJH6LUC1UT1ON | The Phantom of the Opera | 0 | |

# 1.5 Taking first 140k rows

In [7]:

```
# We will collect different 140000 rows without repetition from time_sorted_data datafr
ame
my_final = sorted_data[:140000]
print(my_final.shape)
my_final.head()
```

```
(140000, 12)
```

Out[7]:

| | index | Id | ProductId | UserId | ProfileName | HelpfulnessNumerator | H |
|---|---|---|---|---|---|---|---|
| **0** | 138706 | 150524 | 0006641040 | ACITT7DI6IDDL | shari zychinski | 0 | |
| **30** | 138683 | 150501 | 0006641040 | AJ46FKXOVC7NR | Nicholas A Mesiano | 2 | |
| **424** | 417839 | 451856 | B00004CXX9 | AIUWLEQ1ADEG5 | Elizabeth Medina | 0 | |
| **330** | 346055 | 374359 | B00004CI84 | A344SMIA5JECGM | Vincent P. Ross | 1 | |
| **423** | 417838 | 451855 | B00004CXX9 | AJH6LUC1UT1ON | The Phantom of the Opera | 0 | |

# 1.6 Spliting data into train and test based on time (70:30)

In [8]:

```
from sklearn.model_selection import train_test_split
from sklearn.model_selection import cross_validate


x=my_final['CleanedText'].values
y=my_final['Score']

#Splitting data into train test and cross validation
x_train,x_test,y_train,y_test =train_test_split(x,y,test_size =0.3,random_state = 42)

print(x_train.shape)
print(x_test.shape)
print(y_train.shape)
print(y_test.shape)
```

```
(98000,)
(42000,)
(98000,)
(42000,)
```

# 2. Techniques For Vectorization

# Why we have to convert text to vector

By converting text to vector we can use whole power of linear algebra.we can find a plane to seperate

# 2.1 BOW

In [9]:

```
#Bow

from sklearn.feature_extraction.text import CountVectorizer
count_vect = CountVectorizer()
final_counts_Bow_tr= count_vect.fit_transform(x_train)# computing Bow
print("the type of count vectorizer ",type(final_counts_Bow_tr))
print("the shape of out text BOW vectorizer ",final_counts_Bow_tr.get_shape())
print("the number of unique words ", final_counts_Bow_tr.get_shape()[1])
final_counts_Bow_test= count_vect.transform(x_test)# computing Bow
print("the type of count vectorizer ",type(final_counts_Bow_test))
print("the shape of out text BOW vectorizer ",final_counts_Bow_test.get_shape())
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (98000, 36949)
the number of unique words  36949
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text BOW vectorizer  (42000, 36949)
```

# 2.1.1 Normalizing Data

In [10]:

```
# Data-preprocessing: Normalizing Data

from sklearn import preprocessing
standardized_data_train = preprocessing.normalize(final_counts_Bow_tr)
print(standardized_data_train.shape)
standardized_data_test = preprocessing.normalize(final_counts_Bow_test)
print(standardized_data_test.shape)
```

```
(98000, 36949)
(42000, 36949)
```

## 2.2 Applying Support vector Machine Algorithm

## 2.2.1 Applying SGD Classifier by GridSearchCV

In [11]:

```
from sklearn import linear_model
clf=linear_model.SGDClassifier(loss='hinge',max_iter=1000,class_weight='balanced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = GridSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispatch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_tes
t)))
a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=10, average=False, class_weight='b
alanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100
0,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.93
```

In [12]:

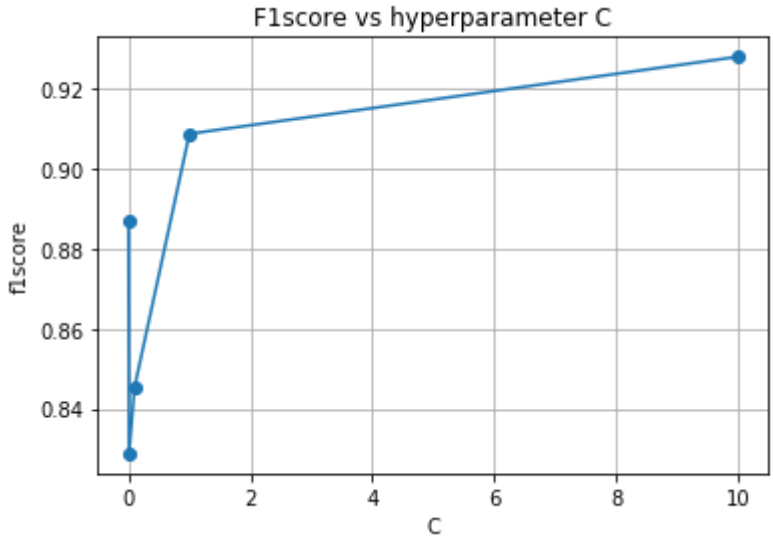
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[12]:

```
array([0.88689402, 0.8288472 , 0.84536848, 0.90860996, 0.92785445])
```

In [13]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```




In [14]:

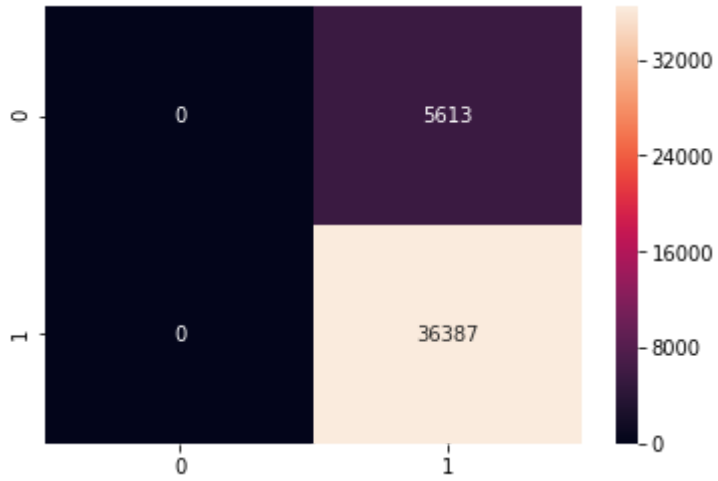
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balance
d')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

## 2.3 Confusion Matrix

In [15]:

```
cm_bow=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_bow, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [16]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_bow.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 0
 false positives are 5613
 false negatives are 0
 true positives are 36387
```

# 2.4 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [17]:

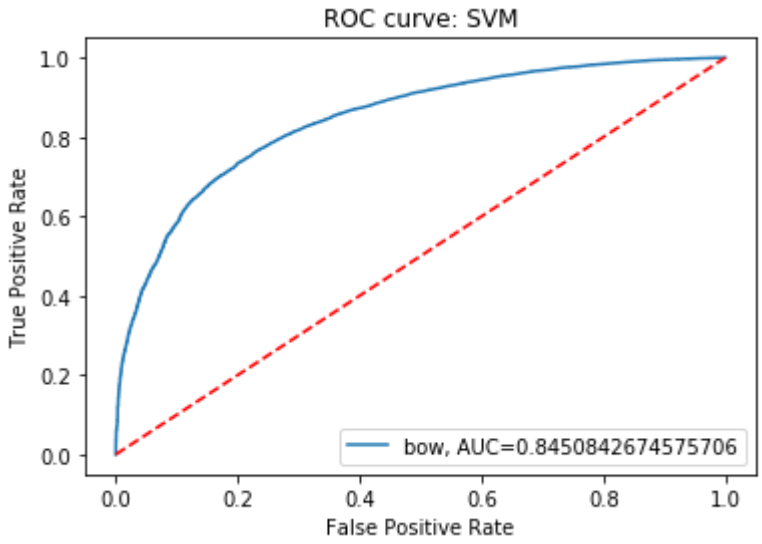
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report
from sklearn.metrics import roc_auc_score

# evaluating accuracy
acc_bow = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for alpha = %.3f is %f%%' % (optimal_alpha, acc_b
ow))

# Error on test data
test_error_bow = 100-acc_bow
print("\nTest Error SVM for alpha  is  %f%%" % (test_error_bow))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the  SVM for alpha  = %.3f is %f' % (optimal_alpha, prec
ision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the  SVM for alpha  = %.3f is %f' % (optimal_alpha, recall_
score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the  SVM for alpha  \n\n ',(classification_r
eport))
```

```
The Test Accuracy of the SVM for alpha = 10.000 is 86.635714%

Test Error SVM for alpha  is  13.364286%

The Test Precision of the  SVM for alpha  = 10.000 is 0.866357

The Test Recall of the  SVM for alpha  = 10.000 is 1.000000

The Test classification report of the  SVM for alpha

                precision    recall  f1-score   support

           0       0.00      0.00      0.00      5613
           1       0.87      1.00      0.93     36387

   micro avg       0.87      0.87      0.87     42000
   macro avg       0.43      0.50      0.46     42000
weighted avg       0.75      0.87      0.80     42000
```

## 2.5 Plotting roc_auc curve

In [18]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="bow, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```




## 2.6 Top 25 words

In [19]:

```
top_n=25
# sorting the weight indices
pos_class_weight_sorted = -clf.coef_.argsort()
neg_class_weight_sorted = clf.coef_.argsort()

# top positive features
print('\nTop '+str(top_n)+' "POSITIVE" Features are:\n')
pos = np.take(count_vect.get_feature_names(), pos_class_weight_sorted[:top_n])
for i in range(top_n):
    print(pos[0][i])

# top negative features
print('\n Top '+str(top_n)+' "NEGATIVE" Features are:\n')
neg = np.take(count_vect.get_feature_names(), neg_class_weight_sorted[:top_n])
for i in range(top_n):
    print(neg[0][i])
```

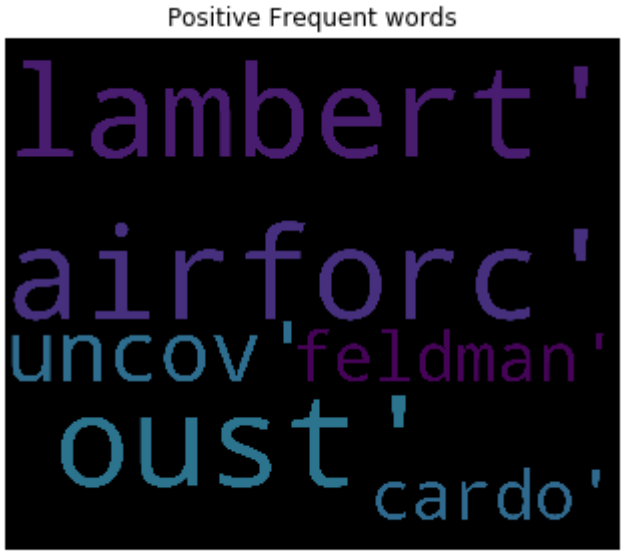
```
Top 25 "POSITIVE" Features are:

cardo
feldman
airforc
salesperson
leukemia
vacumn
tourist
indegst
groundbal
dump
satat
rood
entendr
theoriz
bunchi
methion
racquetbal
vegey
traditon
apper
costom
duplo
lat
extrins
goooooooooo

 Top 25 "NEGATIVE" Features are:

tast
product
would
disappoint
like
bad
box
money
order
review
didnt
dont
receiv
buy
thought
item
even
away
bought
wast
smell
return
look
purchas
packag
```

In [20]:

```
pos=''.join(str(e) for e in pos)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(pos)

plt.title("Positive Frequent words")
plt.figure(1, figsize=(25, 25))
plt.imshow(wordcloud)
plt.tight_layout(pad=0)
plt.axis('off')
```

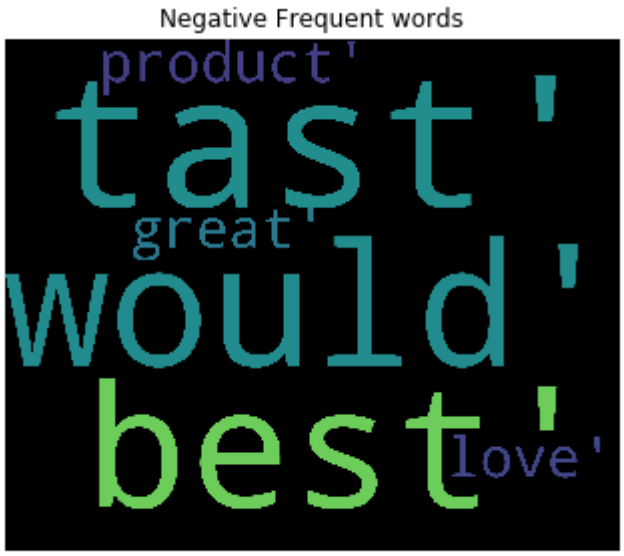
Out[20]:

```
(-0.5, 2999.5, 2499.5, -0.5)
```



In [21]:

```
neg=''.join(str(e) for e in neg)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(neg)

plt.title("Negative Frequent words")
plt.figure(1, figsize=(25, 25))
plt.imshow(wordcloud)
plt.tight_layout(pad=0)
plt.axis('off')
plt.show()
```




## 2.7 Applying SGD Classifier by RandomizedSearchCV

In [22]:

```
from sklearn import linear_model
from sklearn.model_selection import RandomizedSearchCV
clf=linear_model.SGDClassifier(loss='hinge',max_iter=100,class_weight='balanced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = RandomizedSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispa
tch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_tes
t)))
a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=0.1, average=False, class_weight
='balanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.59
```

In [23]:

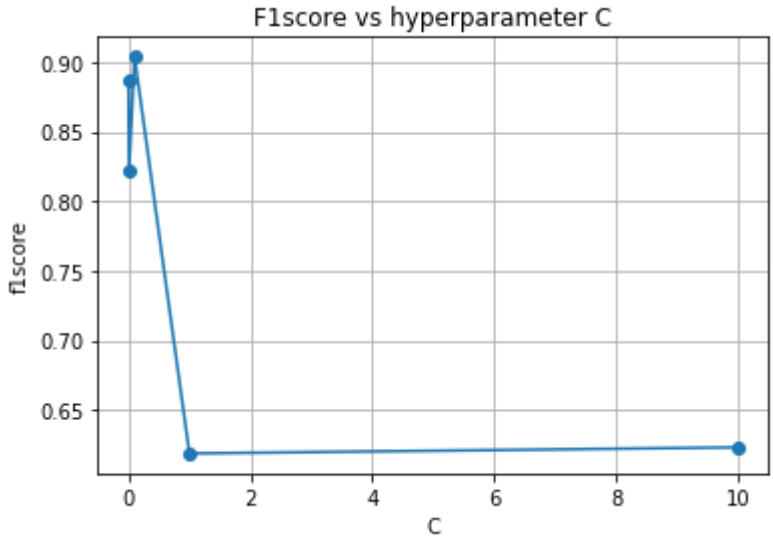
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[23]:

```
array([0.88700749, 0.8221228 , 0.90384401, 0.61870315, 0.62309491])
```

In [24]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```




In [25]:

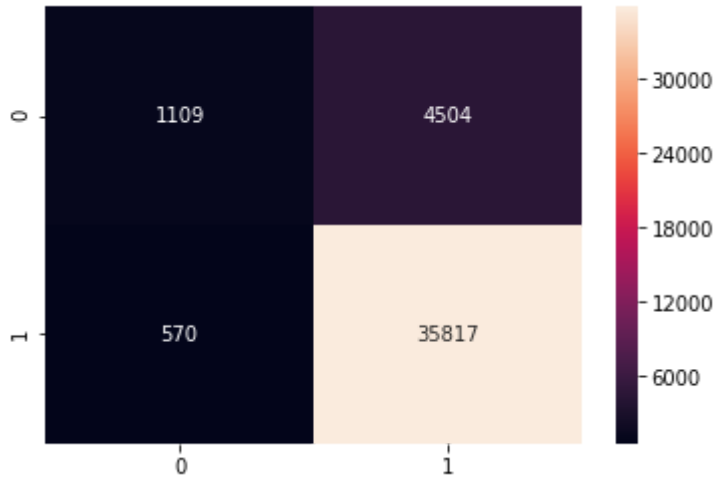
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balance
d')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

## 2.8 Confusion Matrix

In [26]:

```
cm_bow=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_bow, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [27]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_bow.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 1109
 false positives are 4504
 false negatives are 570
 true positives are 35817
```

# 2.9 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [28]:

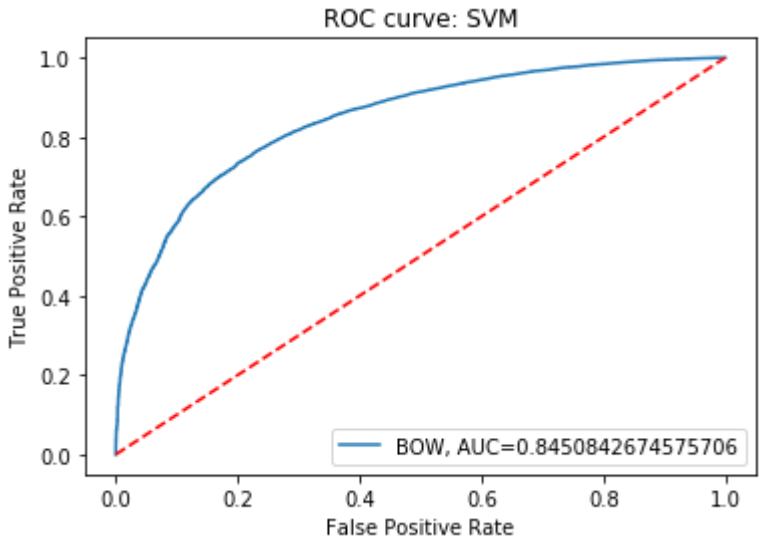
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report
from sklearn.metrics import roc_auc_score

# evaluating accuracy
acc_bow = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for alpha = %.3f is %f%%' % (optimal_alpha, acc_b
ow))

# Error on test data
test_error_bow = 100-acc_bow
print("\nTest Error SVM for alpha  is  %f%%" % (test_error_bow))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the  SVM for alpha  = %.3f is %f' % (optimal_alpha, prec
ision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the  SVM for alpha  = %.3f is %f' % (optimal_alpha, recall_
score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the  SVM for alpha  \n\n ',(classification_r
eport))
```

```
The Test Accuracy of the SVM for alpha = 0.100 is 87.919048%

Test Error SVM for alpha  is  12.080952%

The Test Precision of the  SVM for alpha  = 0.100 is 0.888296

The Test Recall of the  SVM for alpha  = 0.100 is 0.984335

The Test classification report of the  SVM for alpha

                precision    recall  f1-score   support

           0       0.66      0.20      0.30      5613
           1       0.89      0.98      0.93     36387

   micro avg       0.88      0.88      0.88     42000
   macro avg       0.77      0.59      0.62     42000
weighted avg       0.86      0.88      0.85     42000
```

## 2.10 Plotting roc_auc curve

In [29]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="BOW, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```




## 2.11 Top 25 words

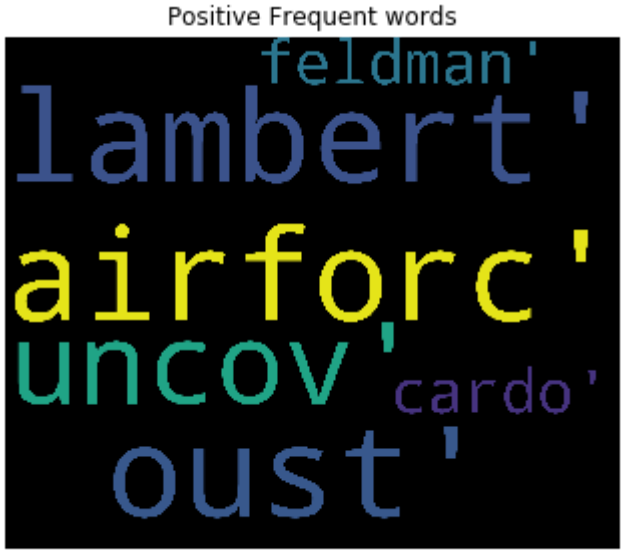
In [30]:

```
top_n=25
# sorting the weight indices
pos_class_weight_sorted = -clf.coef_.argsort()
neg_class_weight_sorted = clf.coef_.argsort()

# top positive features
print('\nTop '+str(top_n)+' "POSITIVE" Features are:\n')
pos = np.take(count_vect.get_feature_names(), pos_class_weight_sorted[:top_n])
for i in range(top_n):
    print(pos[0][i])

# top negative features
print('\nTop '+str(top_n)+' "NEGATIVE" Features are:\n')
neg = np.take(count_vect.get_feature_names(), neg_class_weight_sorted[:top_n])
for i in range(top_n):
    print(neg[0][i])
```

```
Top 25 "POSITIVE" Features are:

cardo
feldman
airforc
salesperson
leukemia
vacumn
tourist
indegst
groundbal
dump
satat
rood
entendr
theoriz
bunchi
methion
racquetbal
vegey
traditon
apper
costom
duplo
lat
extrins
goooooooooo

Top 25 "NEGATIVE" Features are:

tast
product
would
disappoint
like
bad
box
money
order
review
didnt
dont
receiv
buy
thought
item
even
away
bought
wast
smell
return
look
purchas
packag
```

In [31]:

```
pos=''.join(str(e) for e in pos)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(pos)

plt.title("Positive Frequent words")
plt.figure(1, figsize=(25, 25))
plt.tight_layout(pad=0)
plt.imshow(wordcloud)
plt.axis('off')
plt.show()
```



In [32]:

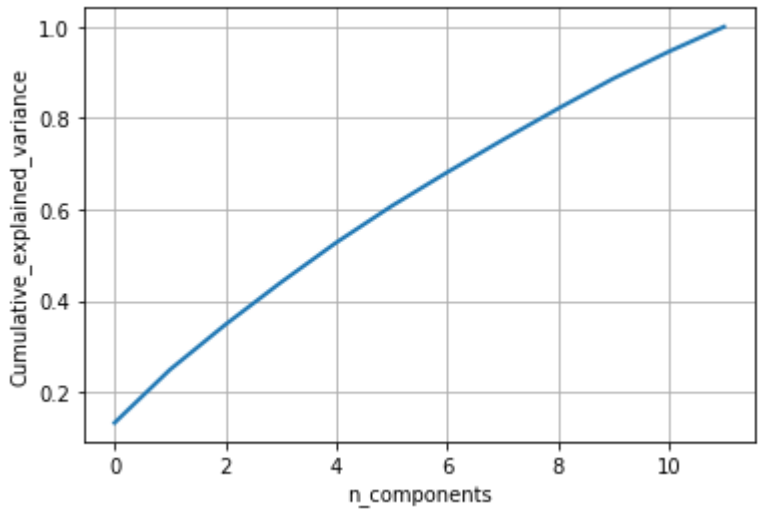
```
neg=''.join(str(e) for e in neg)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(neg)

plt.title("Negative Frequent words")
plt.figure(1, figsize=(25, 25))
plt.tight_layout(pad=0)
plt.imshow(wordcloud)
plt.axis('off')
plt.show()
```


## 3. Applying RBF Kernel for Grid Search

In [33]:

```
# PCA for dimensionality redcution (non-visualization)
# initializing the pca
from scipy.sparse import csr_matrix
from sklearn import decomposition
pca = decomposition.PCA()

standardized_data_train = csr_matrix(standardized_data_train)
standardized_data_train=standardized_data_train.todense()
print(standardized_data_train.shape)

pca.n_components = 12
pca_data = pca.fit_transform(standardized_data_train)

percentage_var_explained = pca.explained_variance_ / np.sum(pca.explained_variance_);

cum_var_explained = np.cumsum(percentage_var_explained)

# Plot the PCA spectrum
plt.figure(1, figsize=(6, 4))

plt.clf()
plt.plot(cum_var_explained, linewidth=2)
plt.axis('tight')
plt.grid()
plt.xlabel('n_components')
plt.ylabel('Cumulative_explained_variance')
plt.show()


# If we take 9-dimensions, approx. 90% of variance is expalined.
```

```
(98000, 36949)
```




In [34]:

```
from sklearn.decomposition import TruncatedSVD
final_counts_Bow_tr_svd = TruncatedSVD(n_components=9).fit_transform(final_counts_Bow_t
r)
final_counts_Bow_tr_svd1 = TruncatedSVD(n_components=9).fit_transform(final_counts_Bow_
test)
```

# 3.1 Normalizing data

In [35]:

```
# Data-preprocessing: Normalizing the data

from sklearn.preprocessing import StandardScaler
scaler = StandardScaler()
standardized_data_train = scaler.fit_transform(final_counts_Bow_tr_svd)
print(standardized_data_train.shape)
standardized_data_test = scaler.fit_transform(final_counts_Bow_tr_svd1)
print(standardized_data_test.shape)
```

```
(98000, 9)
(42000, 9)
```

In [36]:

```
#in RBF SVC hyper parameters are C,gamma

from sklearn.svm import SVC
clf=SVC(kernel='rbf',max_iter=1000,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = GridSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=100, cache_size=200, class_weight='balanced', coef
0=0.0,
  decision_function_shape='ovr', degree=3, gamma=100, kernel='rbf',
  max_iter=1000, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.86
```

In [37]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[37]:

```
array([0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.1349898 , 0.13471429, 0.13539796, 0.13463265, 0.13465306,
       0.13458163, 0.13458163, 0.13458163, 0.23387755, 0.16611224,
       0.18035714, 0.40207143, 0.14154082, 0.37833673, 0.13458163,
       0.13458163, 0.52967347, 0.32055102, 0.32739796, 0.20494898,
       0.85543878, 0.1422551 , 0.37833673, 0.23515306, 0.8247449 ,
       0.78909184, 0.60739796, 0.45688776, 0.39834694, 0.85214286,
       0.1422551 , 0.37833673, 0.85440816, 0.84982653, 0.74642857,
       0.59089796, 0.43712245, 0.41020408, 0.85214286, 0.1422551 ,
       0.37833673])
```

In [38]:

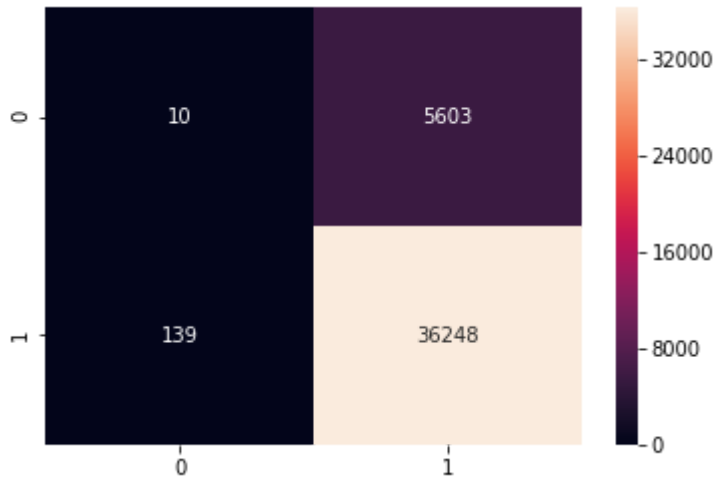
```
y_pred = model.predict(standardized_data_test)
```

## 3.2 Confusion Matrix

In [39]:

```
cm_bow=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_bow, annot=True, fmt='d')
plt.show()
```

Confusion Matrix:



In [40]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_bow.ravel()
( tp, fp, fn, tp)
print(" true negatives are {} \n false positives are {} \n false negatives are {}\n tru
e positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negatives are 10
 false positives are 5603
 false negatives are 139
 true positives are 36248
```

## 3.3 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [41]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report
from sklearn.metrics import roc_auc_score

# evaluating accuracy
acc_bow = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM using RBF kernel  for C and gamma = %.3f ,%.3f is
 %f%%' % (optimal_C,optimal_gamma, acc_bow))

# Error on test data
test_error_bow = 100-acc_bow
print("\nTest Error SVM using RBF for alpha  is  %f%%" % (test_error_bow))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the  SVM using RBF kernel  for C and gamma = %.3f ,%.3f
 is %f' % (optimal_C,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the  SVM using RBF kernel  for C and gamma = %.3f ,%.3f is
%f' % (optimal_C,optimal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the  SVM using RBF kernel  for C and gamma
\n\n ',(classification_report))
```

```
The Test Accuracy of the SVM using RBF kernel  for C and gamma = 100.000 ,
100.000 is 86.328571%

Test Error SVM using RBF for alpha  is  13.671429%

The Test Precision of the  SVM using RBF kernel  for C and gamma = 100.000
,100.000 is 0.866120

The Test Recall of the  SVM using RBF kernel  for C and gamma = 100.000 ,1
00.000 is 0.996180

The Test classification report of the  SVM using RBF kernel  for C and gam
ma

                precision    recall  f1-score   support

           0       0.07      0.00      0.00      5613
           1       0.87      1.00      0.93     36387

   micro avg       0.86      0.86      0.86     42000
   macro avg       0.47      0.50      0.47     42000
weighted avg       0.76      0.86      0.80     42000
```

# 3.5 Applying RBF Kernel for Random Search

In [42]:

```
#in RBF SVC hyper parameters are C,gamma
from sklearn.svm import SVC
from sklearn.model_selection import RandomizedSearchCV
clf=SVC(kernel='rbf',max_iter=100,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = RandomizedSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=100, cache_size=200, class_weight='balanced', coef
0=0.0,
  decision_function_shape='ovr', degree=3, gamma=0.01, kernel='rbf',
  max_iter=100, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.82
```

In [43]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[43]:

```
array([0.3782551 , 0.13458163, 0.13458163, 0.13656122, 0.13458163,
       0.13458163, 0.13459184, 0.61404082, 0.25685714, 0.13458163])
```

In [44]:

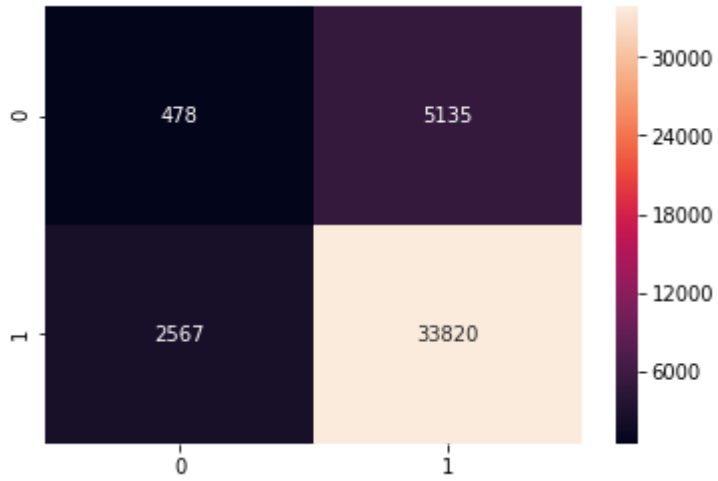
```
y_pred = model.predict(standardized_data_test)
```

# 3.6 Confusion Matrix

In [45]:

```
cm_bow=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_bow, annot=True, fmt='d')
plt.show()

#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_bow.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
Confusion Matrix:
```




```
true negitves are 478
false positives are 5135
false negatives are 2567
true positives are 33820
```

# 3.7 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [46]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report
from sklearn.metrics import roc_auc_score

# evaluating accuracy
acc_bow = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM using RBF kernel  for C and gamma = %.3f ,%.3f is
 %f%%' % (optimal_C,optimal_gamma, acc_bow))

# Error on test data
test_error_bow = 100-acc_bow
print("\nTest Error SVM using RBF  for C and gamma is  %f%%" % (test_error_bow))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the  SVM using RBF kernel  for C and gamma = %.3f ,%.3f
 is %f' % (optimal_C,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the  SVM using RBF kernel  for C and gamma = %.3f ,%.3f is
%f' % (optimal_C,optimal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the  SVM using RBF kernel  for C and gamma
\n\n ',(classification_report))
```

```
The Test Accuracy of the SVM using RBF kernel  for C and gamma = 100.000 ,
0.010 is 81.661905%

Test Error SVM using RBF  for C and gamma is  18.338095%

The Test Precision of the  SVM using RBF kernel  for C and gamma = 100.000
,0.010 is 0.868181

The Test Recall of the  SVM using RBF kernel  for C and gamma = 100.000 ,
0.010 is 0.929453

The Test classification report of the  SVM using RBF kernel  for C and gam
ma

                precision    recall  f1-score   support

           0       0.16      0.09      0.11      5613
           1       0.87      0.93      0.90     36387

   micro avg       0.82      0.82      0.82     42000
   macro avg       0.51      0.51      0.50     42000
weighted avg       0.77      0.82      0.79     42000
```

# 4. TF-IDF

In [47]:

```
#tf-idf
from sklearn.feature_extraction.text import TfidfVectorizer
tf_idf_vect = TfidfVectorizer()

final_counts_tfidf_tr= tf_idf_vect.fit_transform(x_train)
print("the type of count vectorizer ",type(final_counts_tfidf_tr))
print("the shape of out text tfidf vectorizer ",final_counts_tfidf_tr.get_shape())
print("the number of unique words ", final_counts_tfidf_tr.get_shape()[1])
final_counts_tfidf_test= tf_idf_vect.transform(x_test)
print("the type of count vectorizer ",type(final_counts_tfidf_test))
print("the shape of out text tfidf vectorizer ",final_counts_tfidf_test.get_shape())
print("the number of unique words ", final_counts_tfidf_test.get_shape()[1])
```

```
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text tfidf vectorizer  (98000, 36949)
the number of unique words  36949
the type of count vectorizer  <class 'scipy.sparse.csr.csr_matrix'>
the shape of out text tfidf vectorizer  (42000, 36949)
the number of unique words  36949
```

## 4.1 Normalizing Data

In [48]:

```
# Data-preprocessing: Normalizing Data
from sklearn import preprocessing
standardized_data_train = preprocessing.normalize(final_counts_tfidf_tr)
print(standardized_data_train.shape)
standardized_data_test = preprocessing.normalize(final_counts_tfidf_test)
print(standardized_data_test.shape)
```

```
(98000, 36949)
(42000, 36949)
```

## 4.2 Applying SGD Classifier by GridSearchCV

In [49]:

```
from sklearn import linear_model
clf=linear_model.SGDClassifier(loss='hinge',penalty='l2',max_iter=100,class_weight='balanced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = GridSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispatch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_test)))
a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=10, average=False, class_weight='balanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.93
```

In [50]:

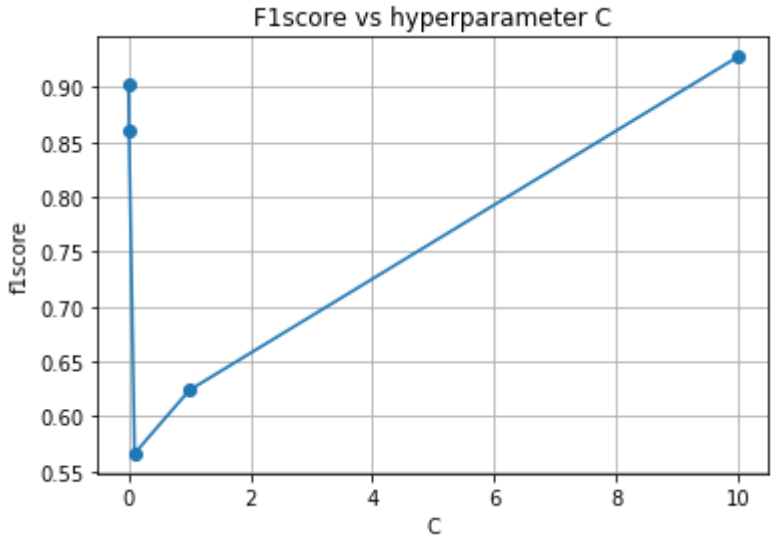
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[50]:

```
array([0.9033876 , 0.85983735, 0.56603207, 0.62378565, 0.92785445])
```

In [51]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```



In [52]:

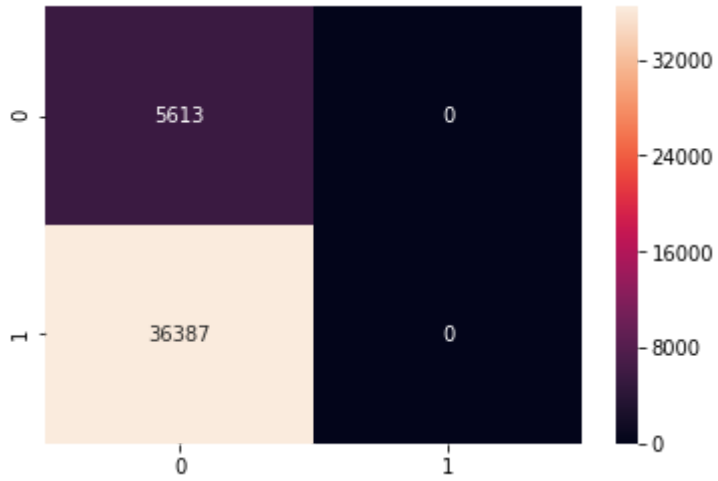
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balance
d')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

## 4.3 Confusion Matrix

In [53]:

```
cm_tfidf=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidf, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [54]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidf.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 5613
 false positives are 0
 false negatives are 36387
 true positives are 0
```

## 4.4 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [55]:

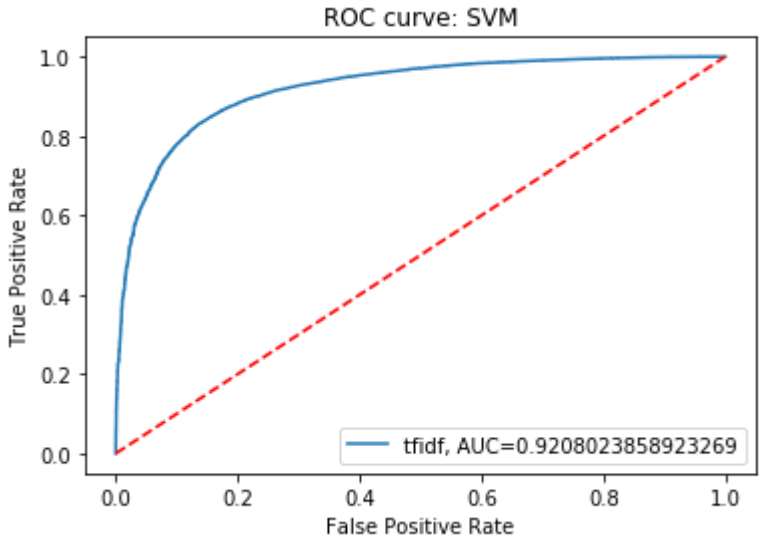
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidf = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for alpha = %.3f is %f%%' % (optimal_alpha, acc_t
fidf))

# Error on test data
test_error_tfidf = 100-acc_tfidf
print("\nTest Error of the SVM for alpha is  %f%%" % (test_error_tfidf))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for alpha is = %.3f is %f' % (optimal_alpha, pre
cision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for alpha is = %.3f is %f' % (optimal_alpha, recall
_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report oof the SVM for alpha is \n\n ',(classification
_report))
```

```
The Test Accuracy of the SVM for alpha = 10.000 is 13.364286%

Test Error of the SVM for alpha is  86.635714%

The Test Precision of the SVM for alpha is = 10.000 is 0.000000

The Test Recall of the SVM for alpha is = 10.000 is 0.000000

The Test classification report oof the SVM for alpha is

                precision    recall  f1-score   support

           0       0.13      1.00      0.24      5613
           1       0.00      0.00      0.00     36387

   micro avg       0.13      0.13      0.13     42000
   macro avg       0.07      0.50      0.12     42000
weighted avg       0.02      0.13      0.03     42000
```

## 4.5 Plotting roc_auc curve

In [56]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="tfidf, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```




## 4.6 Top 25 words

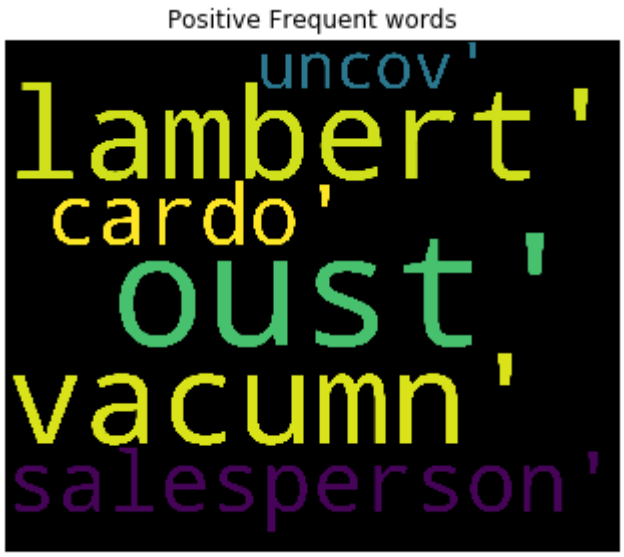
In [57]:

```
top_n=25
# sorting the weight indices
pos_class_weight_sorted = -clf.coef_.argsort()
neg_class_weight_sorted = clf.coef_.argsort()

# top positive features
print('\nTop '+str(top_n)+' "POSITIVE" Features are:\n')
pos = np.take(tf_idf_vect.get_feature_names(), pos_class_weight_sorted[:top_n])
for i in range(top_n):
    print(pos[0][i])

# top negative features
print('Top '+str(top_n)+' "NEGATIVE" Features are:\n')
neg = np.take(tf_idf_vect.get_feature_names(), neg_class_weight_sorted[:top_n])
for i in range(top_n):
    print(neg[0][i])
```

```
Top 25 "POSITIVE" Features are:

salesperson
cardo
vacumn
airforc
indegst
feldman
tourist
satat
apper
duplo
entendr
bunchi
dump
ncieli
leukemia
vegey
methion
caleri
cnat
ajanta
vegitarian
costom
groundbal
bulldog
rood
Top 25 "NEGATIVE" Features are:

disappoint
tast
bad
would
money
product
box
didnt
wast
return
receiv
thought
review
horribl
like
away
item
terribl
stale
worst
aw
smell
order
threw
dont
```

In [58]:

```
pos=''.join(str(e) for e in pos)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(pos)

plt.title("Positive Frequent words")
plt.figure(1, figsize=(25, 25))
plt.imshow(wordcloud)
plt.tight_layout(pad=0)
plt.axis('off')
plt.show()
```



In [59]:

```
neg=''.join(str(e) for e in neg)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(neg)

plt.title("Negative Frequent words")
plt.figure(1, figsize=(25, 25))
plt.imshow(wordcloud)
plt.tight_layout(pad=0)
plt.axis('off')
plt.show()
```


## 4.7 Applying SGD Classifier by RandomizedSearchCV

In [60]:

```
from sklearn import linear_model
from sklearn.model_selection import RandomizedSearchCV
clf=linear_model.SGDClassifier(loss='hinge',penalty='l2',max_iter=100,class_weight='bal
anced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = RandomizedSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispa
tch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_tes
t)))
a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=0.01, average=False, class_weight
='balanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.90
```

In [61]:

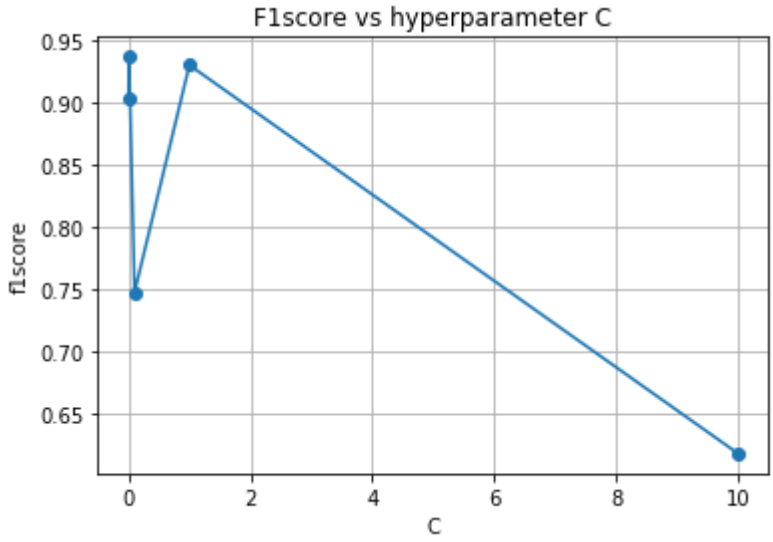
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[61]:

```
array([0.90338307, 0.93630681, 0.74768332, 0.9296187 , 0.61857452])
```

In [62]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```




In [63]:

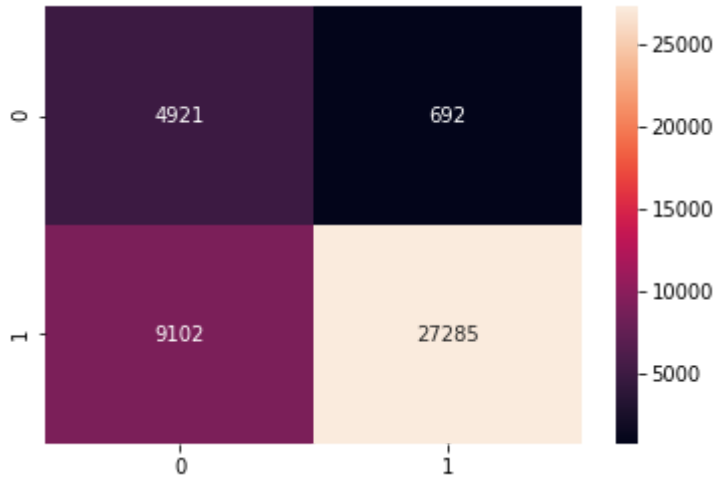
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balanced')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

# 4.8 Confusion Matrix

In [64]:

```
cm_tfidf=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidf, annot=True, fmt='d')
plt.show()

#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidf.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
Confusion Matrix:
```




```
 true negitves are 4921
 false positives are 692
 false negatives are 9102
 true positives are 27285
```

# 4.9 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [65]:

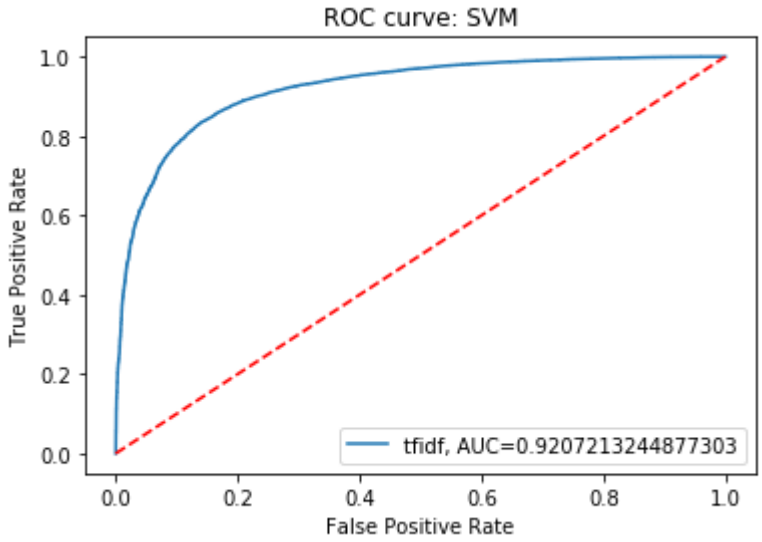
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidf = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for alpha = %.3f is %f%%' % (optimal_alpha, acc_t
fidf))

# Error on test data
test_error_tfidf = 100-acc_tfidf
print("\nTest Error of the SVM for alpha is  %f%%" % (test_error_tfidf))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for alpha is = %.3f is %f' % (optimal_alpha, pre
cision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for alpha is = %.3f is %f' % (optimal_alpha, recall
_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report oof the SVM for alpha is \n\n ',(classification
_report))
```

```
The Test Accuracy of the SVM for alpha = 0.010 is 76.680952%

Test Error of the SVM for alpha is  23.319048%

The Test Precision of the SVM for alpha is = 0.010 is 0.975265

The Test Recall of the SVM for alpha is = 0.010 is 0.749856

The Test classification report oof the SVM for alpha is

                precision    recall  f1-score   support

           0       0.35      0.88      0.50      5613
           1       0.98      0.75      0.85     36387

   micro avg       0.77      0.77      0.77     42000
   macro avg       0.66      0.81      0.67     42000
weighted avg       0.89      0.77      0.80     42000
```

## 4.10 Plotting Roc_auc score

In [66]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="tfidf, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```




## 4.11 Calculating Top25 features

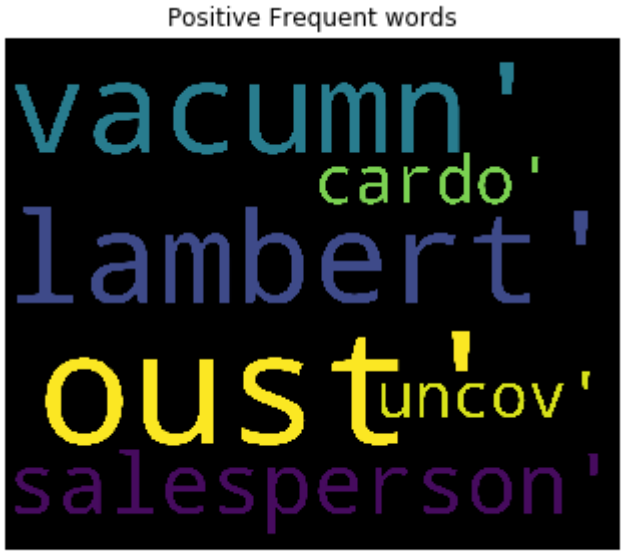
In [67]:

```
top_n=25
# sorting the weight indices
pos_class_weight_sorted = -clf.coef_.argsort()
neg_class_weight_sorted = clf.coef_.argsort()

# top positive features
print('\nTop '+str(top_n)+' "POSITIVE" Features are:\n')
pos = np.take(tf_idf_vect.get_feature_names(), pos_class_weight_sorted[:top_n])
for i in range(top_n):
    print(pos[0][i])

# top negative features
print('Top '+str(top_n)+' "NEGATIVE" Features are:\n')
neg = np.take(tf_idf_vect.get_feature_names(), neg_class_weight_sorted[:top_n])
for i in range(top_n):
    print(neg[0][i])
```

```
Top 25 "POSITIVE" Features are:

salesperson
cardo
vacumn
airforc
indegst
feldman
tourist
satat
apper
duplo
entendr
bunchi
dump
ncieli
leukemia
vegey
methion
caleri
cnat
ajanta
vegitarian
costom
groundbal
bulldog
rood
Top 25 "NEGATIVE" Features are:

disappoint
tast
bad
would
money
product
box
didnt
wast
return
receiv
thought
review
horribl
like
away
item
terribl
stale
worst
aw
smell
order
threw
dont
```

In [68]:

```
pos=''.join(str(e) for e in pos)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(pos)

plt.title("Positive Frequent words")
plt.figure(1, figsize=(25, 25))
plt.imshow(wordcloud)
plt.tight_layout(pad=0)
plt.axis('off')
plt.show()
```



In [69]:

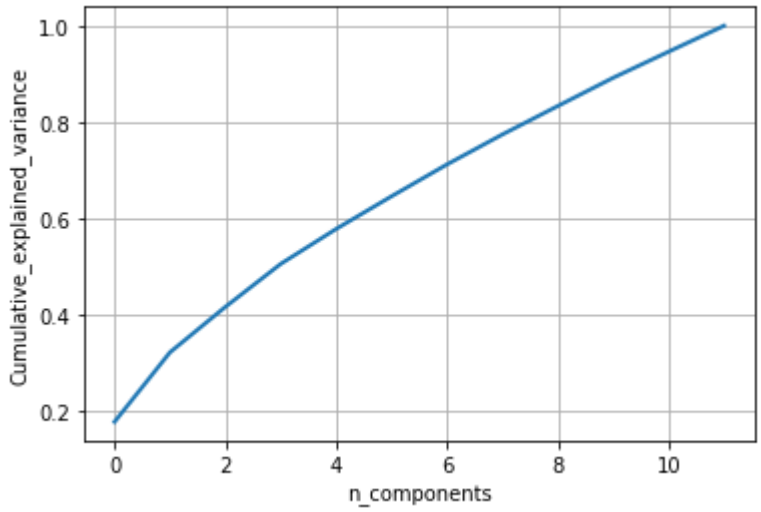
```
neg=''.join(str(e) for e in neg)

from wordcloud import WordCloud

wordcloud = WordCloud(background_color='black',
                      width=3000,
                      height=2500
                     ).generate(neg)

plt.title("Negative Frequent words")
plt.figure(1, figsize=(25, 25))
plt.imshow(wordcloud)
plt.tight_layout(pad=0)
plt.axis('off')
plt.show()
```


## 5. Applying RBF Kernel for GridSearch

In [70]:

```
# PCA for dimensionality redcution (non-visualization)
# initializing the pca
from scipy.sparse import csr_matrix
from sklearn import decomposition
pca = decomposition.PCA()

standardized_data_train = csr_matrix(standardized_data_train)
standardized_data_train=standardized_data_train.todense()
print(standardized_data_train.shape)

pca.n_components = 12
pca_data = pca.fit_transform(standardized_data_train)

percentage_var_explained = pca.explained_variance_ / np.sum(pca.explained_variance_);

cum_var_explained = np.cumsum(percentage_var_explained)

# Plot the PCA spectrum
plt.figure(1, figsize=(6, 4))

plt.clf()
plt.plot(cum_var_explained, linewidth=2)
plt.axis('tight')
plt.grid()
plt.xlabel('n_components')
plt.ylabel('Cumulative_explained_variance')
plt.show()


# If we take 9-dimensions, approx. 90% of variance is expalined.
```

```
(98000, 36949)
```




In [71]:

```
from sklearn.decomposition import TruncatedSVD
final_counts_tfidf_tr_svd = TruncatedSVD(n_components=9).fit_transform(final_counts_tfi
df_tr)
final_counts_tfidf_tr_svd1 = TruncatedSVD(n_components=9).fit_transform(final_counts_tf
idf_test)
```

# 5.1 Normalizing data

In [72]:

```
# Data-preprocessing: Normalizing data

from sklearn import preprocessing
standardized_data_train = preprocessing.normalize(final_counts_tfidf_tr_svd)
print(standardized_data_train.shape)
standardized_data_test = preprocessing.normalize(final_counts_tfidf_tr_svd1)
print(standardized_data_test.shape)
```

```
(98000, 9)
(42000, 9)
```

In [73]:

```
#In RBF SVC hyper parameters are C,gamma
from sklearn.svm import SVC
clf=SVC(kernel='rbf',max_iter=100,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = GridSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=10, cache_size=200, class_weight='balanced', coef0
=0.0,
  decision_function_shape='ovr', degree=3, gamma=1000, kernel='rbf',
  max_iter=100, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.87
```

In [74]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[74]:

```
array([0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13459184,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.14833673,
       0.14679592, 0.38522449, 0.86513265, 0.62186735, 0.13458163,
       0.13458163, 0.13458163, 0.16477551, 0.37640816, 0.38668367,
       0.37715306, 0.86513265, 0.62186735, 0.13458163, 0.13458163,
       0.17866327, 0.57082653, 0.31285714, 0.18407143, 0.37715306,
       0.86513265, 0.62186735, 0.13458163, 0.24285714, 0.46761224,
       0.52660204, 0.31285714, 0.18407143, 0.37715306, 0.86513265,
       0.62186735])
```

In [75]:

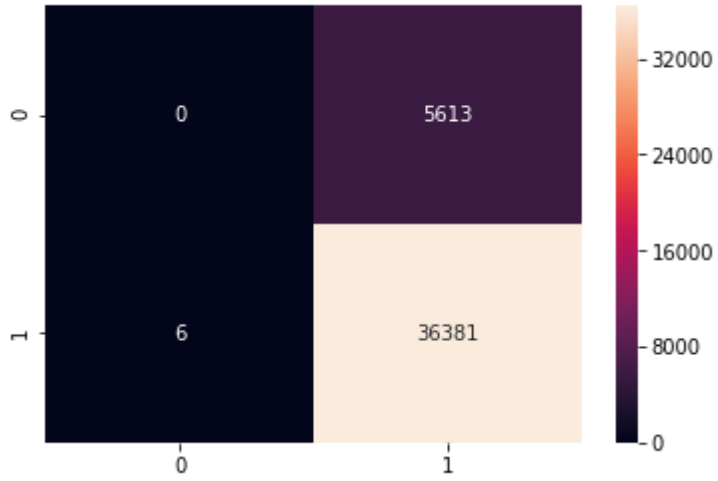
```
y_pred = model.predict(standardized_data_test)
```

## 5.2 Confusion Matrix

In [76]:

```
cm_tfidf=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidf, annot=True, fmt='d')
plt.show()
```

Confusion Matrix:



In [77]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidf.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 0
 false positives are 5613
 false negatives are 6
 true positives are 36381
```

## 5.3 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [78]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidf = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for C and gamma = %.3f ,%.3f is %f%%' % (optimal_
C,optimal_gamma, acc_tfidf))

# Error on test data
test_error_tfidf = 100-acc_tfidf
print("\nTest Error of the SVM for alpha  %f%%" % (test_error_tfidf))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C
,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C,op
timal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for C and gamma \n\n ',(classificati
on_report))
```

```
The Test Accuracy of the SVM for C and gamma = 10.000 ,1000.000 is 86.6214
29%

Test Error of the SVM for alpha  13.378571%

The Test Precision of the SVM for C and gamma = 10.000 ,1000.000 is 0.8663
38

The Test Recall of the SVM for C and gamma = 10.000 ,1000.000 is 0.999835

The Test classification report of the SVM for C and gamma

                precision    recall  f1-score   support

           0       0.00      0.00      0.00      5613
           1       0.87      1.00      0.93     36387

   micro avg       0.87      0.87      0.87     42000
   macro avg       0.43      0.50      0.46     42000
weighted avg       0.75      0.87      0.80     42000
```

## 5.5 Applying RBF Kernel for RandomizedSearchCV

In [79]:

```
#In RBF SVC hyper parameters are C,gamma
from sklearn.svm import SVC
from sklearn.model_selection import RandomizedSearchCV
clf=SVC(kernel='rbf',probability=True,max_iter=100,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = RandomizedSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=10, cache_size=200, class_weight='balanced', coef0
=0.0,
  decision_function_shape='ovr', degree=3, gamma=1000, kernel='rbf',
  max_iter=100, probability=True, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.87
```

In [80]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[80]:

```
array([0.86513265, 0.13458163, 0.31285714, 0.13458163, 0.37715306,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.31285714])
```

In [81]:

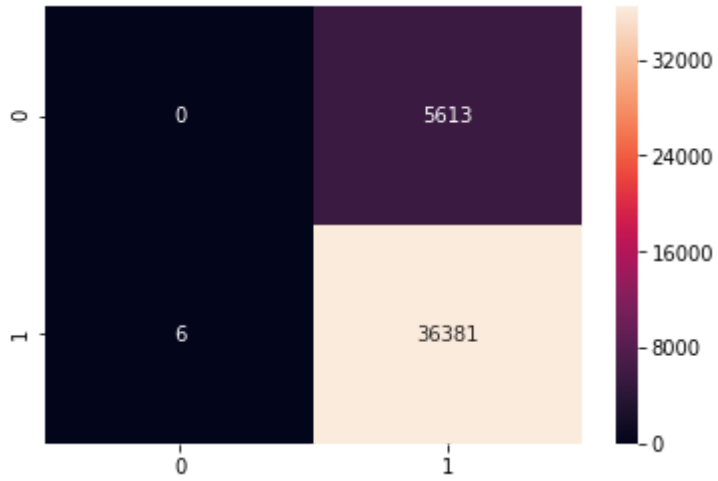
```
y_pred = model.predict(standardized_data_test)
```

# 5.6 Confusion Matrix

In [82]:

```
cm_tfidf=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidf, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [83]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidf.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 0
 false positives are 5613
 false negatives are 6
 true positives are 36381
```

# 5.7 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [84]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidf = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for C and gamma = %.3f ,%.3f is %f%%' % (optimal_
C,optimal_gamma, acc_tfidf))

# Error on test data
test_error_tfidf = 100-acc_tfidf
print("\nTest Error of the SVM for C and gamma %f%%" % (test_error_tfidf))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C
,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C,op
timal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for alpha \n\n ',(classification_rep
ort))
```

```
The Test Accuracy of the SVM for C and gamma = 10.000 ,1000.000 is 86.6214
29%

Test Error of the SVM for C and gamma 13.378571%

The Test Precision of the SVM for C and gamma = 10.000 ,1000.000 is 0.8663
38

The Test Recall of the SVM for C and gamma = 10.000 ,1000.000 is 0.999835

The Test classification report of the SVM for alpha

              precision    recall  f1-score   support

           0       0.00      0.00      0.00      5613
           1       0.87      1.00      0.93     36387

   micro avg       0.87      0.87      0.87     42000
   macro avg       0.43      0.50      0.46     42000
weighted avg       0.75      0.87      0.80     42000
```

# 6. WORD2VEC

In [85]:

```
from gensim.models import Word2Vec
# List of sentence in X_train text
sent_of_train=[]
for sent in x_train:
    sent_of_train.append(sent.split())

# List of sentence in X_est text
sent_of_test=[]
for sent in x_test:
    sent_of_test.append(sent.split())

# Train your own Word2Vec model using your own train text corpus
# min_count = 5 considers only words that occured atleast 5 times
w2v_model=Word2Vec(sent_of_train,min_count=5,size=50, workers=4)

w2v_words = list(w2v_model.wv.vocab)
print("number of words that occured minimum 5 times ",len(w2v_words))
```

```
number of words that occured minimum 5 times  12448
```

# 7. Avg Word2Vec

In [86]:

```
# compute average word2vec for each review for X_train .
train_vectors = [];
for sent in sent_of_train:
    sent_vec = np.zeros(50)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    train_vectors.append(sent_vec)

# compute average word2vec for each review for X_test .
test_vectors = [];
for sent in sent_of_test:
    sent_vec = np.zeros(50)
    cnt_words =0;
    for word in sent: #
        if word in w2v_words:
            vec = w2v_model.wv[word]
            sent_vec += vec
            cnt_words += 1
    if cnt_words != 0:
        sent_vec /= cnt_words
    test_vectors.append(sent_vec)
```

# 7.1 Normalizing data

In [87]:

```
# Data-preprocessing: Normalizing the data

from sklearn import preprocessing
standardized_data_train = preprocessing.normalize(train_vectors)
print(standardized_data_train.shape)
standardized_data_test = preprocessing.normalize(test_vectors)
print(standardized_data_test.shape)
```

```
(98000, 50)
(42000, 50)
```

## 7.2 Applying SGD Classifier by GridSearchCV

In [88]:

```
from sklearn import linear_model
clf=linear_model.SGDClassifier(loss='hinge',max_iter=100,class_weight='balanced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = GridSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispatch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
optimal_alpha = model.best_estimator_.alpha
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_tes
t)))

a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=0.1, average=False, class_weight
='balanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.80
```

In [89]:

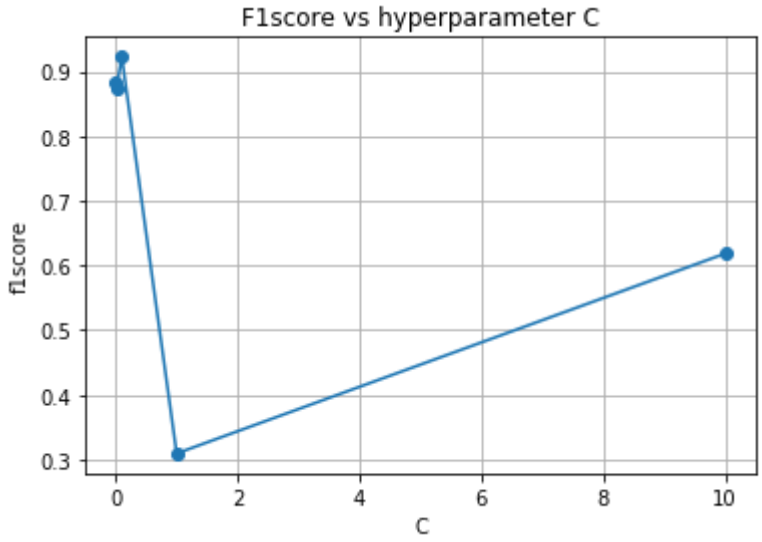
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[89]:

```
array([0.88198769, 0.87344031, 0.92292503, 0.30927993, 0.61855987])
```

In [90]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```




In [91]:

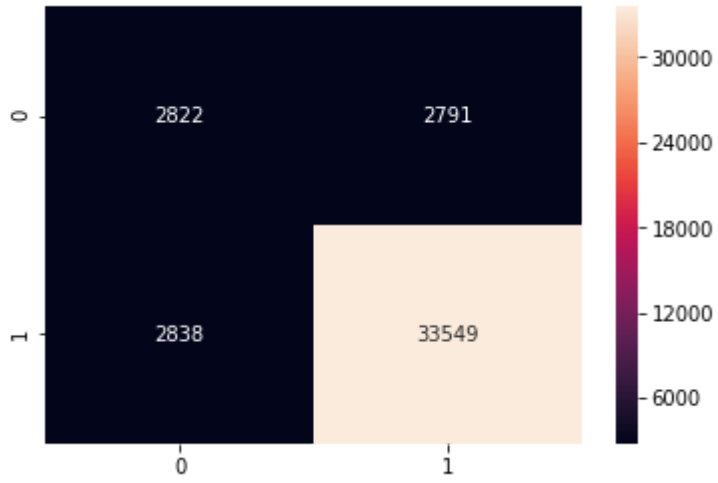
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balance
d')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

## 7.3 Confusion Matrix

In [92]:

```
cm_avgw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_avgw2v, annot=True, fmt='d')
plt.show()
```

Confusion Matrix:




In [93]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_avgw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 2822
 false positives are 2791
 false negatives are 2838
 true positives are 33549
```

# 7.4 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [94]:

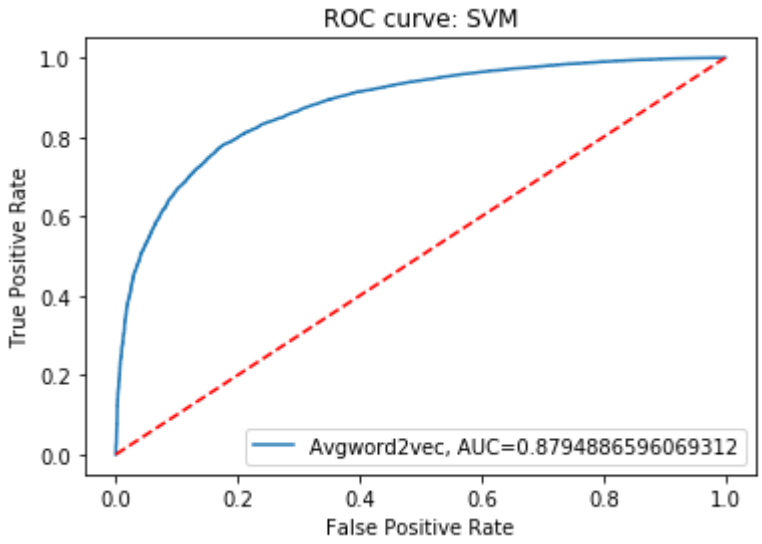
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_avgw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for alpha is = %.3f is %f%%' % (optimal_alpha, ac
c_avgw2v))

# Error on test data
test_error_avgw2v = 100-acc_avgw2v
print("\nTest Error of the SVM for alpha is  %f%%" % (test_error_avgw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for alpha is = %.3f is %f' % (optimal_alpha, pre
cision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for alpha is = %.3f is %f' % (optimal_alpha, recall
_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for alpha is \n\n ',(classification_
report))
```

```
The Test Accuracy of the SVM for alpha is = 0.100 is 86.597619%

Test Error of the SVM for alpha is  13.402381%

The Test Precision of the SVM for alpha is = 0.100 is 0.923198

The Test Recall of the SVM for alpha is = 0.100 is 0.922005

The Test classification report of the SVM for alpha is

                precision    recall  f1-score   support

           0       0.50      0.50      0.50      5613
           1       0.92      0.92      0.92     36387

   micro avg       0.87      0.87      0.87     42000
   macro avg       0.71      0.71      0.71     42000
weighted avg       0.87      0.87      0.87     42000
```

## 7.5 Evaluating roc_auc_score

In [95]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="Avgword2vec, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```




## 7.6 Applying SGD Classifier by RandomizedSearchCV

In [96]:

```
from sklearn import linear_model
from sklearn.model_selection import RandomizedSearchCV
clf=linear_model.SGDClassifier(loss='hinge',max_iter=100,class_weight='balanced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = RandomizedSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispa
tch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
optimal_alpha = model.best_estimator_.alpha
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_tes
t)))

a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=0.001, average=False, class_weight
='balanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.88
```

In [97]:

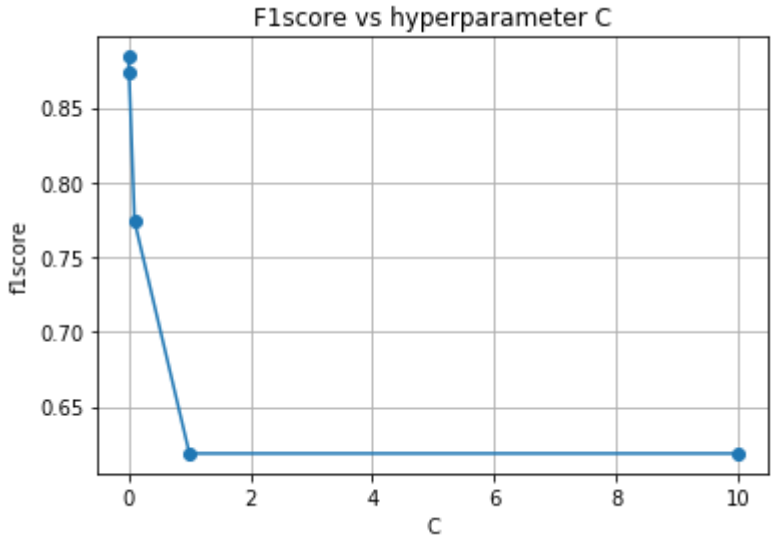
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[97]:

```
array([0.88397563, 0.8735095 , 0.77390256, 0.61857452, 0.61857452])
```

In [98]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```




In [99]:

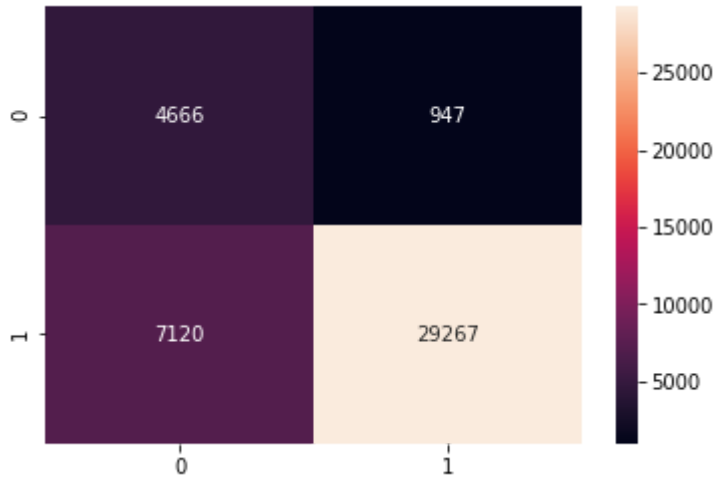
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balanced')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

# 7.7 Confusion Matrix

In [100]:

```
cm_avgw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_avgw2v, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [101]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_avgw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 4666
 false positives are 947
 false negatives are 7120
 true positives are 29267
```

# 7.8 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [102]:

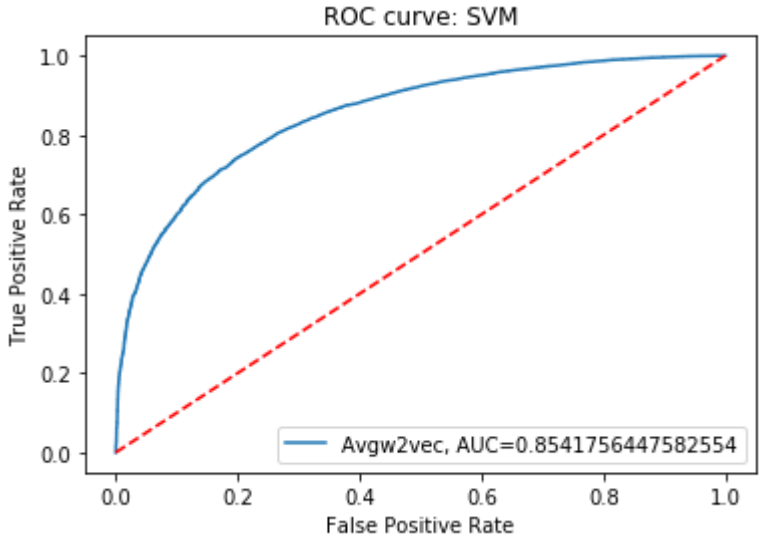
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_avgw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for alpha is = %.3f is %f%%' % (optimal_alpha, ac
c_avgw2v))

# Error on test data
test_error_avgw2v = 100-acc_avgw2v
print("\nTest Error of the SVM for alpha is  %f%%" % (test_error_avgw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for alpha is = %.3f is %f' % (optimal_alpha, pre
cision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for alpha is = %.3f is %f' % (optimal_alpha, recall
_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for alpha is \n\n ',(classification_
report))
```

```
The Test Accuracy of the SVM for alpha is = 0.001 is 80.792857%

Test Error of the SVM for alpha is  19.207143%

The Test Precision of the SVM for alpha is = 0.001 is 0.968657

The Test Recall of the SVM for alpha is = 0.001 is 0.804326

The Test classification report of the SVM for alpha is

                precision    recall  f1-score   support

           0       0.40      0.83      0.54      5613
           1       0.97      0.80      0.88     36387

   micro avg       0.81      0.81      0.81     42000
   macro avg       0.68      0.82      0.71     42000
weighted avg       0.89      0.81      0.83     42000
```

# 7.9 Plotting ROC CURVE

In [103]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="Avgw2vec, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```

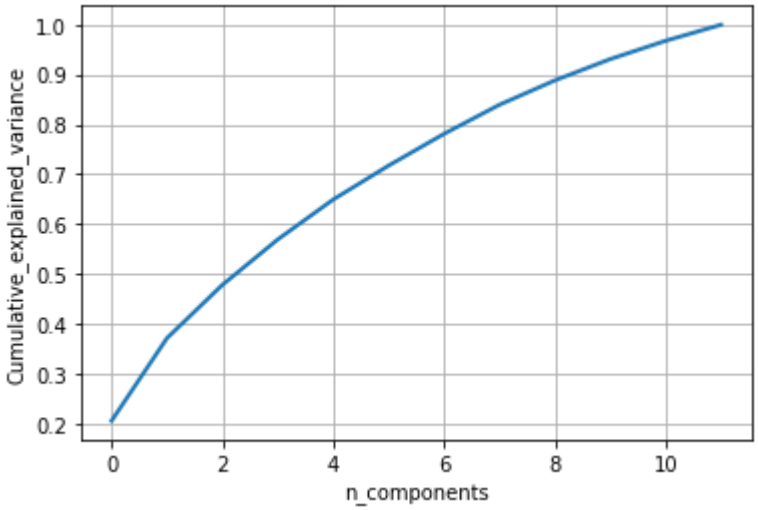



# 8. APPLYING RBF KERNEL BY GRIDSEARCH

In [104]:

```
# PCA for dimensionality redcution (non-visualization)
# initializing the pca
from scipy.sparse import csr_matrix
from sklearn import decomposition
pca = decomposition.PCA()

standardized_data_train = csr_matrix(standardized_data_train)
standardized_data_train=standardized_data_train.todense()
print(standardized_data_train.shape)

pca.n_components = 12
pca_data = pca.fit_transform(standardized_data_train)

percentage_var_explained = pca.explained_variance_ / np.sum(pca.explained_variance_);

cum_var_explained = np.cumsum(percentage_var_explained)

# Plot the PCA spectrum
plt.figure(1, figsize=(6, 4))

plt.clf()
plt.plot(cum_var_explained, linewidth=2)
plt.axis('tight')
plt.grid()
plt.xlabel('n_components')
plt.ylabel('Cumulative_explained_variance')
plt.show()


# If we take 9-dimensions, approx. 90% of variance is expalined.
```

```
(98000, 50)
```




In [105]:

```
from sklearn.decomposition import TruncatedSVD
final_counts_avg_w2v_svd = TruncatedSVD(n_components=9).fit_transform(train_vectors)
final_counts_avg_w2v_svd1 = TruncatedSVD(n_components=9).fit_transform(test_vectors)
```

# 8.2 Normalizing data

In [106]:

```
# Data-preprocessing:Normalizing data

from sklearn import preprocessing
standardized_data_train = preprocessing.normalize(final_counts_avg_w2v_svd)
print(standardized_data_train.shape)
standardized_data_test = preprocessing.normalize(final_counts_avg_w2v_svd1)
print(standardized_data_test.shape)
```

```
(98000, 9)
(42000, 9)
```

In [107]:

```
#In RBF SVC hyper parameters are C,gamma
from sklearn.svm import SVC
clf=SVC(kernel='rbf',max_iter=100,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = GridSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=10, cache_size=200, class_weight='balanced', coef0
=0.0,
  decision_function_shape='ovr', degree=3, gamma=10000, kernel='rbf',
  max_iter=100, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.85
```

In [108]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[108]:

```
array([0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13459184,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13971429,
       0.19752041, 0.14194898, 0.62153061, 0.84621429, 0.13458163,
       0.13458163, 0.13458163, 0.22086735, 0.47533673, 0.30638776,
       0.14194898, 0.62153061, 0.84621429, 0.13458163, 0.13458163,
       0.16184694, 0.47785714, 0.48837755, 0.30638776, 0.14194898,
       0.62153061, 0.84621429, 0.13458163, 0.16944898, 0.52169388,
       0.60069388, 0.48837755, 0.30638776, 0.14194898, 0.62153061,
       0.84621429])
```

In [109]:

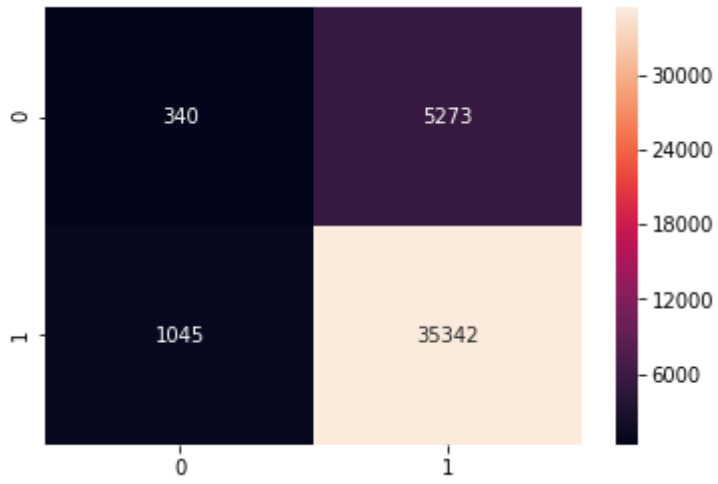
```
y_pred = model.predict(standardized_data_test)
```

## 8.3 Confusion Matrix

In [110]:

```
cm_avgw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_avgw2v, annot=True, fmt='d')
plt.show()
```

Confusion Matrix:



In [111]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_avgw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 340
 false positives are 5273
 false negatives are 1045
 true positives are 35342
```

## 8.4 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [112]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_avgw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for C and gamma = %.3f ,%.3f is %f%%' % (optimal_
C,optimal_gamma, acc_avgw2v))

# Error on test data
test_error_avgw2v = 100-acc_avgw2v
print("\nTest Error of the SVM for C and gamma is  %f%%" % (test_error_avgw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C
,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C,op
timal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for C and gamma  is \n\n ',(classifi
cation_report))
```

```
The Test Accuracy of the SVM for C and gamma = 10.000 ,10000.000 is 84.957
143%

Test Error of the SVM for C and gamma is  15.042857%

The Test Precision of the SVM for C and gamma = 10.000 ,10000.000 is 0.870
171

The Test Recall of the SVM for C and gamma = 10.000 ,10000.000 is 0.971281

The Test classification report of the SVM for C and gamma  is

                precision    recall  f1-score   support

           0       0.25      0.06      0.10      5613
           1       0.87      0.97      0.92     36387

   micro avg       0.85      0.85      0.85     42000
   macro avg       0.56      0.52      0.51     42000
weighted avg       0.79      0.85      0.81     42000
```

# 8.5 APPLYING RBF KERNEL BY RandomizedSearchCV

In [113]:

```
#in RBF SVC hyper parameters are C,gamma
from sklearn.svm import SVC
from sklearn.model_selection import RandomizedSearchCV

clf=SVC(kernel='rbf',max_iter=100,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = RandomizedSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=10, cache_size=200, class_weight='balanced', coef0
=0.0,
  decision_function_shape='ovr', degree=3, gamma=10, kernel='rbf',
  max_iter=100, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.17
```

In [114]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[114]:

```
array([0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.19752041, 0.14194898])
```

In [115]:

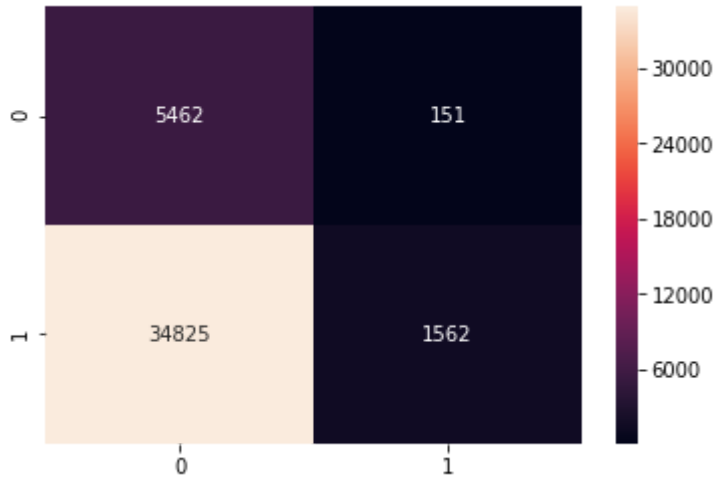
```
y_pred = model.predict(standardized_data_test)
```

# 8.6 Confusion Matrix

In [116]:

```
cm_avgw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_avgw2v, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [117]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_avgw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 5462
 false positives are 151
 false negatives are 34825
 true positives are 1562
```

# 8.7 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [118]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_avgw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for C and gamma = %.3f ,%.3f is %f%%' % (optimal_
C,optimal_gamma, acc_avgw2v))

# Error on test data
test_error_avgw2v = 100-acc_avgw2v
print("\nTest Error of the SVM for C and gamma is  %f%%" % (test_error_avgw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C
,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for C and gamma = %.3f ,%.3f is %f' % (optimal_C,op
timal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for C and gamma \n\n ',(classificati
on_report))
```

```
The Test Accuracy of the SVM for C and gamma = 10.000 ,10.000 is 16.72381
0%

Test Error of the SVM for C and gamma is  83.276190%

The Test Precision of the SVM for C and gamma = 10.000 ,10.000 is 0.911851

The Test Recall of the SVM for C and gamma = 10.000 ,10.000 is 0.042927

The Test classification report of the SVM for C and gamma

                precision    recall  f1-score   support

           0       0.14      0.97      0.24      5613
           1       0.91      0.04      0.08     36387

   micro avg       0.17      0.17      0.17     42000
   macro avg       0.52      0.51      0.16     42000
weighted avg       0.81      0.17      0.10     42000
```

# 9. TFIDF-Word2Vec

In [119]:

```
#tf-idf weighted w2v

from sklearn.feature_extraction.text import TfidfVectorizer

tfidfw2v_vect = TfidfVectorizer()
final_counts_tfidfw2v_train= tfidfw2v_vect.fit_transform(x_train)
print(type(final_counts_tfidfw2v_train))
print(final_counts_tfidfw2v_train.shape)

final_counts_tfidfw2v_test= tfidfw2v_vect.transform(x_test)
print(type(final_counts_tfidfw2v_test))
print(final_counts_tfidfw2v_test.shape)
```

```
<class 'scipy.sparse.csr.csr_matrix'>
(98000, 36949)
<class 'scipy.sparse.csr.csr_matrix'>
(42000, 36949)
```

In [120]:

```
# we are converting a dictionary with word as a key, and the idf as a value
dictionary = dict(zip(tfidfw2v_vect.get_feature_names(), list(tfidfw2v_vect.idf_)))


# TF-IDF weighted Word2Vec
tfidf_feat = tfidfw2v_vect.get_feature_names() # tfidf words/col-names
# final_tf_idf is the sparse matrix with row= sentence, col=word and cell_val = tfidf

tfidf_sent_vectors = []; # the tfidf-w2v for each sentence/review is stored in this lis
t
row=0;
for sent in sent_of_train: # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = w2v_model.wv[word]
#             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
            # to reduce the computation we are
            # dictionary[word] = idf value of word in whole courpus
            # sent.count(word) = tf valeus of word in this review
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors.append(sent_vec)
    row += 1

#Test case

tfidf_sent_vectors1 = []; # the tfidf-w2v for each sentence/review is stored in this li
st
row=0;
for sent in sent_of_test: # for each review/sentence
    sent_vec = np.zeros(50) # as word vectors are of zero length
    weight_sum =0; # num of words with a valid vector in the sentence/review
    for word in sent: # for each word in a review/sentence
        if word in w2v_words:
            vec = w2v_model.wv[word]
#             tf_idf = tf_idf_matrix[row, tfidf_feat.index(word)]
            # to reduce the computation we are
            # dictionary[word] = idf value of word in whole courpus
            # sent.count(word) = tf valeus of word in this review
            tf_idf = dictionary[word]*(sent.count(word)/len(sent))
            sent_vec += (vec * tf_idf)
            weight_sum += tf_idf
    if weight_sum != 0:
        sent_vec /= weight_sum
    tfidf_sent_vectors1.append(sent_vec)
    row += 1
print(len(tfidf_sent_vectors))
print(len(tfidf_sent_vectors1))
```

```
98000
42000
```

# 9.1 Normalizing the data

In [121]:

```
# Data-preprocessing: Normalizing the data

from sklearn import preprocessing
standardized_data_train = preprocessing.normalize(tfidf_sent_vectors)
print(standardized_data_train.shape)
standardized_data_test = preprocessing.normalize(tfidf_sent_vectors1)
print(standardized_data_test.shape)
```

```
(98000, 50)
(42000, 50)
```

# 9.2 Applying SGD Classifier Using GridSearch

In [122]:

```
from sklearn import linear_model
clf=linear_model.SGDClassifier(loss='hinge',penalty='l2',max_iter=100,class_weight='bal
anced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = GridSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispatch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
optimal_alpha = model.best_estimator_.alpha
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_tes
t)))
a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=10, average=False, class_weight='b
alanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.93
```

In [123]:

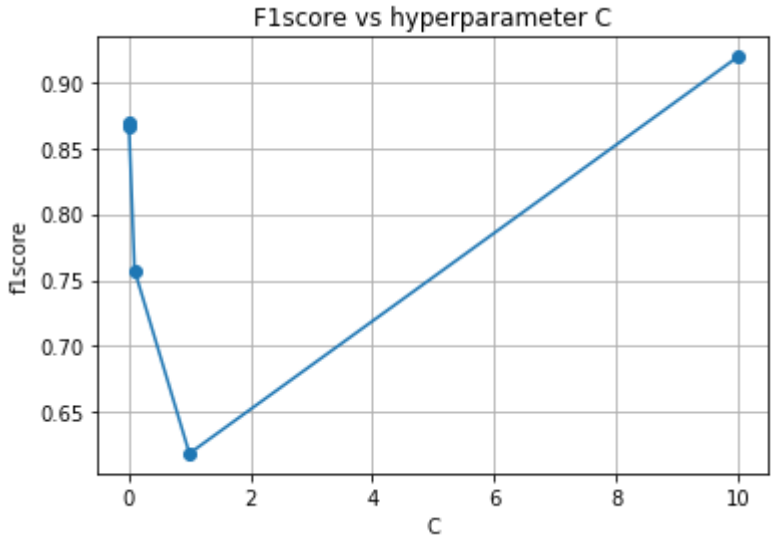
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[123]:

```
array([0.86897213, 0.8656872 , 0.75748986, 0.61855987, 0.91928743])
```

In [124]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```




In [125]:

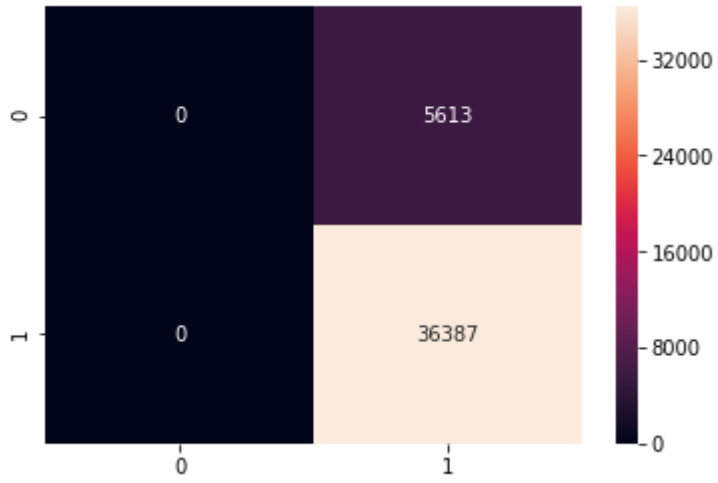
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balance
d')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

## 9.3 Confusion Matrix

In [126]:

```
cm_tfidfw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidfw2v, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [127]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidfw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 0
 false positives are 5613
 false negatives are 0
 true positives are 36387
```

## 9.4 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [128]:

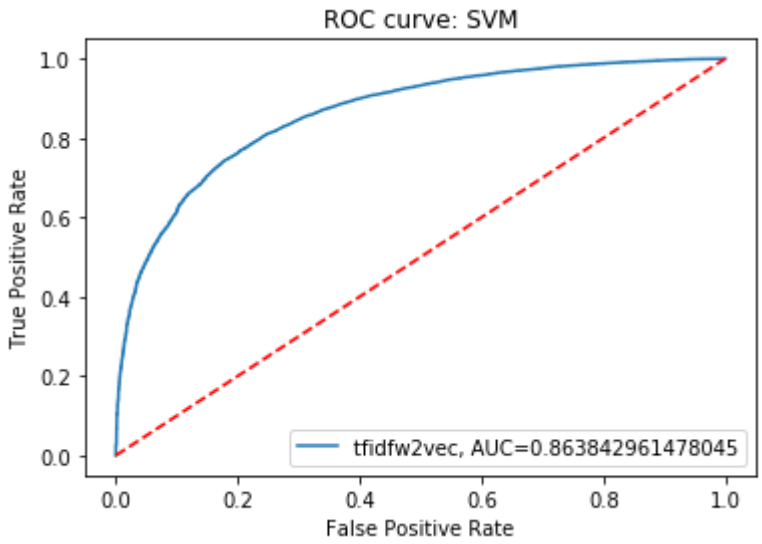
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidfw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM for alpha = %.3f is %f%%' % (optimal_alpha, acc_t
fidfw2v))

# Error on test data
test_error_tfidfw2v = 100-acc_tfidfw2v
print("\nTest Error of the SVM for alpha is  %f%%" % (test_error_tfidfw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for alpha is = %.3f is %f' % (optimal_alpha, pre
cision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for alpha is = %.3f is %f' % (optimal_alpha, recall
_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for alpha is \n\n ',(classification_
report))
```

```
The Test Accuracy of the SVM for alpha = 10.000 is 86.635714%

Test Error of the SVM for alpha is  13.364286%

The Test Precision of the SVM for alpha is = 10.000 is 0.866357

The Test Recall of the SVM for alpha is = 10.000 is 1.000000

The Test classification report of the SVM for alpha is

                precision    recall  f1-score   support

           0       0.00      0.00      0.00      5613
           1       0.87      1.00      0.93     36387

   micro avg       0.87      0.87      0.87     42000
   macro avg       0.43      0.50      0.46     42000
weighted avg       0.75      0.87      0.80     42000
```

# Evaluating roc_auc_score

In [129]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="tfidfw2vec, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```




## 9.5 Applying SGD Classifier Using RandomizedSearchCV

In [130]:

```
from sklearn import linear_model
from sklearn.model_selection import RandomizedSearchCV

clf=linear_model.SGDClassifier(loss='hinge',penalty='l2',max_iter=100,class_weight='bal
anced')
tuned_parameters = {'alpha': [0.001, 0.01, 0.1, 1, 10]}

model = RandomizedSearchCV(clf, tuned_parameters,cv=3,scoring='f1', n_jobs=-1,pre_dispa
tch=2)
model.fit(standardized_data_train, y_train)
print("best alpha value is",model.best_estimator_)
optimal_alpha = model.best_estimator_.alpha
print("Accuracy of the model : {:.2f}".format(model.score(standardized_data_test, y_tes
t)))
a = model.best_params_
optimal_alpha = a.get('alpha')
```

```
best alpha value is SGDClassifier(alpha=0.1, average=False, class_weight
='balanced',
       early_stopping=False, epsilon=0.1, eta0=0.0, fit_intercept=True,
       l1_ratio=0.15, learning_rate='optimal', loss='hinge', max_iter=100,
       n_iter=None, n_iter_no_change=5, n_jobs=None, penalty='l2',
       power_t=0.5, random_state=None, shuffle=True, tol=None,
       validation_fraction=0.1, verbose=0, warm_start=False)
Accuracy of the model : 0.44
```

In [131]:

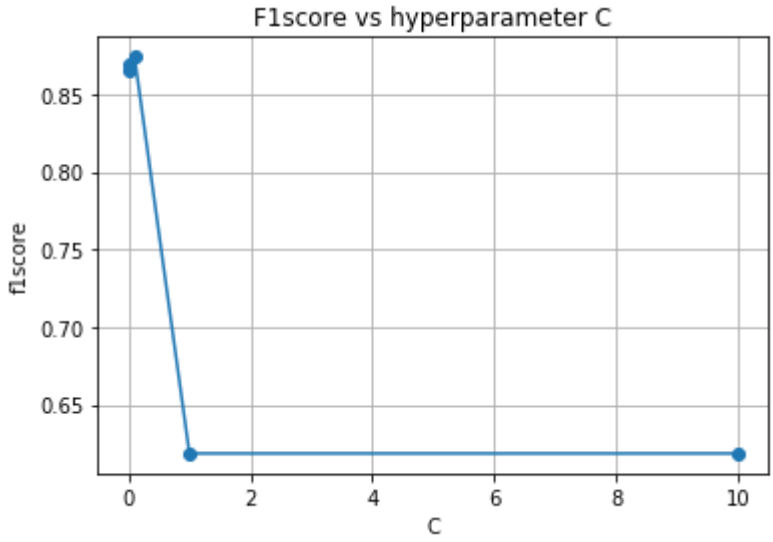
```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[131]:

```
array([0.86976873, 0.8658434 , 0.87406185, 0.61857452, 0.61857452])
```

In [132]:

```
C=0.001, 0.01, 0.1, 1, 10
plt.plot(C,results['mean_test_score'],marker='o')
plt.xlabel('C')
plt.ylabel('f1score')
plt.title("F1score vs hyperparameter C")
plt.grid()
plt.show()
```




In [133]:

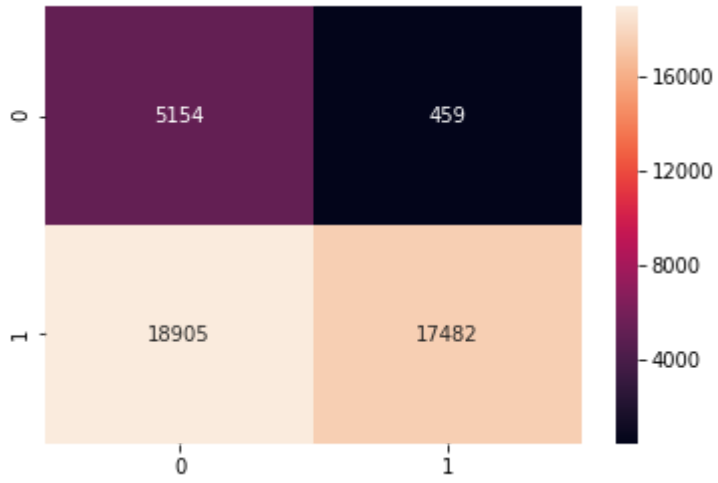
```
clf = linear_model.SGDClassifier(loss='hinge',alpha=optimal_alpha,class_weight='balanced')
clf.fit(standardized_data_train,y_train)
y_pred = clf.predict(standardized_data_test)
```

# 9.6 Confusion Matrix

In [134]:

```
cm_tfidfw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidfw2v, annot=True, fmt='d')
plt.show()
```

Confusion Matrix:




In [135]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidfw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
true negitves are 5154
false positives are 459
false negatives are 18905
true positives are 17482
```

# 9.7 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [136]:

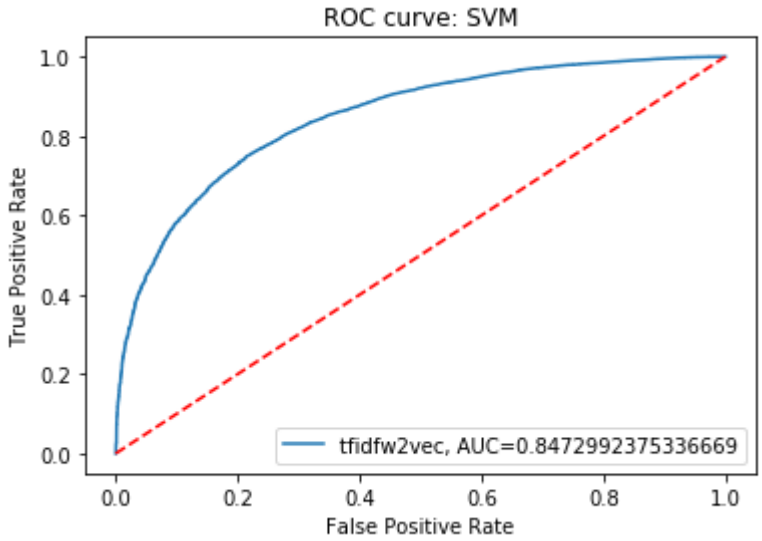
```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidfw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the SVM classifier for alpha = %.3f is %f%%' % (optimal_a
lpha, acc_tfidfw2v))

# Error on test data
test_error_tfidfw2v = 100-acc_tfidfw2v
print("\nTest Error of the SVM for alpha is  %f%%" % (test_error_tfidfw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the SVM for alpha is = %.3f is %f' % (optimal_alpha, pre
cision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the SVM for alpha is = %.3f is %f' % (optimal_alpha, recall
_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the SVM for alpha is \n\n ',(classification_
report))
```

```
The Test Accuracy of the SVM classifier for alpha = 0.100 is 53.895238%

Test Error of the SVM for alpha is  46.104762%

The Test Precision of the SVM for alpha is = 0.100 is 0.974416

The Test Recall of the SVM for alpha is = 0.100 is 0.480446

The Test classification report of the SVM for alpha is

                precision    recall  f1-score   support

           0       0.21      0.92      0.35      5613
           1       0.97      0.48      0.64     36387

   micro avg       0.54      0.54      0.54     42000
   macro avg       0.59      0.70      0.50     42000
weighted avg       0.87      0.54      0.60     42000
```

# Evaluating Roc_auc_score

In [137]:

```
from sklearn.calibration import CalibratedClassifierCV
calibrated = CalibratedClassifierCV(model, method='sigmoid', cv=3)
calibrated.fit(standardized_data_train, y_train)
y_pred_proba = calibrated.predict_proba(standardized_data_test)[::,1]
fpr, tpr, _ = metrics.roc_curve(y_test,  y_pred_proba)
auc = metrics.roc_auc_score(y_test, y_pred_proba)
plt.plot(fpr,tpr,label="tfidfw2vec, AUC="+str(auc))
plt.plot([0,1],[0,1],'r--')
plt.title('ROC curve: SVM')
plt.legend(loc='lower right')
plt.ylabel('True Positive Rate')
plt.xlabel('False Positive Rate')
plt.show()
```



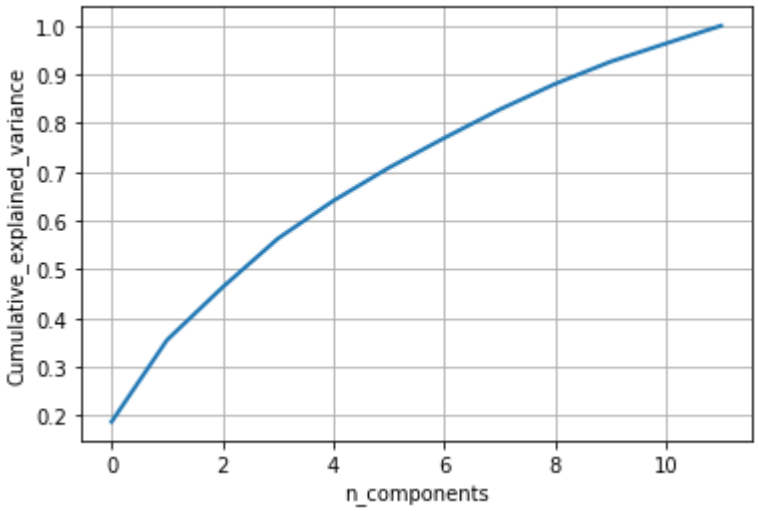

# 10. APPLYING RBF KERNEL BY GRID SEARCH

# 10.1 Gridsearch Cross Validation

In [138]:

```
# PCA for dimensionality redcution (non-visualization)
# initializing the pca
from scipy.sparse import csr_matrix
from sklearn import decomposition
pca = decomposition.PCA()

standardized_data_train = csr_matrix(standardized_data_train)
standardized_data_train=standardized_data_train.todense()
print(standardized_data_train.shape)

pca.n_components = 12
pca_data = pca.fit_transform(standardized_data_train)

percentage_var_explained = pca.explained_variance_ / np.sum(pca.explained_variance_);

cum_var_explained = np.cumsum(percentage_var_explained)

# Plot the PCA spectrum
plt.figure(1, figsize=(6, 4))

plt.clf()
plt.plot(cum_var_explained, linewidth=2)
plt.axis('tight')
plt.grid()
plt.xlabel('n_components')
plt.ylabel('Cumulative_explained_variance')
plt.show()


# If we take 9-dimensions, approx. 90% of variance is expalined.
```

```
(98000, 50)
```




In [139]:

```
from sklearn.decomposition import TruncatedSVD
final_counts_tfidf_w2v_svd = TruncatedSVD(n_components=9).fit_transform(tfidf_sent_vect
ors)
final_counts_tfidf_w2v_svd1 = TruncatedSVD(n_components=9).fit_transform(tfidf_sent_vec
tors1)
```

# 10.2 Normalizing the data

In [140]:

```
# Data-preprocessing: Normalizing the data

from sklearn import preprocessing
standardized_data_train = preprocessing.normalize(final_counts_tfidf_w2v_svd)
print(standardized_data_train.shape)
standardized_data_test = preprocessing.normalize(final_counts_tfidf_w2v_svd1)
print(standardized_data_test.shape)
```

```
(98000, 9)
(42000, 9)
```

In [141]:

```
#in RBF SVC hyper parameters are C,gamma
from sklearn.svm import SVC
clf=SVC(kernel='rbf',max_iter=100,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = GridSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=10, cache_size=200, class_weight='balanced', coef0
=0.0,
  decision_function_shape='ovr', degree=3, gamma=10000, kernel='rbf',
  max_iter=100, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.86
```

In [142]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[142]:

```
array([0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163,
       0.13458163, 0.13458163, 0.13459184, 0.13459184, 0.13459184,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.137     ,
       0.17482653, 0.38171429, 0.38006122, 0.82792857, 0.13458163,
       0.13458163, 0.13458163, 0.14910204, 0.39130612, 0.40759184,
       0.38171429, 0.38006122, 0.82792857, 0.13458163, 0.13458163,
       0.15427551, 0.51593878, 0.35911224, 0.40759184, 0.38171429,
       0.38006122, 0.82792857, 0.13458163, 0.27632653, 0.5332551 ,
       0.54715306, 0.35911224, 0.40759184, 0.38171429, 0.38006122,
       0.82792857])
```

In [143]:

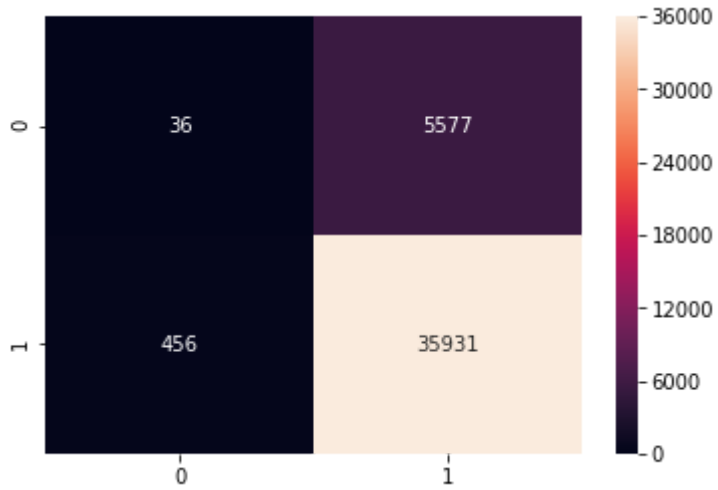
```
y_pred = model.predict(standardized_data_test)
```

## 10.3 Confusion Matrix

In [144]:

```
cm_tfidfw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidfw2v, annot=True, fmt='d')
plt.show()
```

Confusion Matrix:



In [145]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidfw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 36
 false positives are 5577
 false negatives are 456
 true positives are 35931
```

## 10.4 Calculating Accuracy, Error on test data,Precision,Recall,Classification Report

In [146]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidfw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the  SVM using RBF kernel for C and gamma = %.3f ,%.3f is
 %f%%' % (optimal_C,optimal_gamma, acc_tfidfw2v))

# Error on test data
test_error_tfidfw2v = 100-acc_tfidfw2v
print("\nTest Error  of the  SVM using RBF kernel for C and gamma =   %f%%" % (test_err
or_tfidfw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the  SVM using RBF kernel for C and gamma = %.3f ,%.3f i
s %f' % (optimal_C,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the  SVM using RBF kernel for C and gamma = %.3f ,%.3f is %
f' % (optimal_C,optimal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the  SVM using RBF kernel for alpha \n\n ',(
classification_report))
```

```
The Test Accuracy of the  SVM using RBF kernel for C and gamma = 10.000 ,1
0000.000 is 85.635714%

Test Error  of the  SVM using RBF kernel for C and gamma =   14.364286%

The Test Precision of the  SVM using RBF kernel for C and gamma = 10.000 ,
10000.000 is 0.865640

The Test Recall of the  SVM using RBF kernel for C and gamma = 10.000 ,100
00.000 is 0.987468

The Test classification report of the  SVM using RBF kernel for alpha

              precision    recall  f1-score   support

           0       0.07      0.01      0.01      5613
           1       0.87      0.99      0.92     36387

   micro avg       0.86      0.86      0.86     42000
   macro avg       0.47      0.50      0.47     42000
weighted avg       0.76      0.86      0.80     42000
```

# 10.5 APPLYING RBF KERNEL BY RandomizedSearchCV

In [147]:

```
#in RBF SVC hyper parameters are C,gamma
from sklearn.svm import SVC
from sklearn.model_selection import RandomizedSearchCV


clf=SVC(kernel='rbf',max_iter=100,class_weight='balanced')
tuned_parameters = {'C': [10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4],'g
amma':[10**-4,10**-3, 10**-2,10**-1, 1, 10**1,10**2,10**3, 10**4]}
model = RandomizedSearchCV(clf, tuned_parameters,cv=3,n_jobs=-1)
model.fit(standardized_data_train, y_train)
print("tunded parameters",model.best_estimator_)
print("Accuracy of model using SVC classifier by rbf kernel {:.2f}".format(model.score(
standardized_data_test, y_test)))
a = model.best_params_
optimal_C = a.get('C')
optimal_gamma=a.get('gamma')
```

```
tunded parameters SVC(C=100, cache_size=200, class_weight='balanced', coef
0=0.0,
  decision_function_shape='ovr', degree=3, gamma=10, kernel='rbf',
  max_iter=100, probability=False, random_state=None, shrinking=True,
  tol=0.001, verbose=False)
Accuracy of model using SVC classifier by rbf kernel 0.74
```

In [148]:

```
model.best_params_
results = model.cv_results_
results['mean_test_score']
```

Out[148]:

```
array([0.13458163, 0.13458163, 0.40759184, 0.13458163, 0.13459184,
       0.13458163, 0.13458163, 0.13458163, 0.13458163, 0.13458163])
```

In [149]:

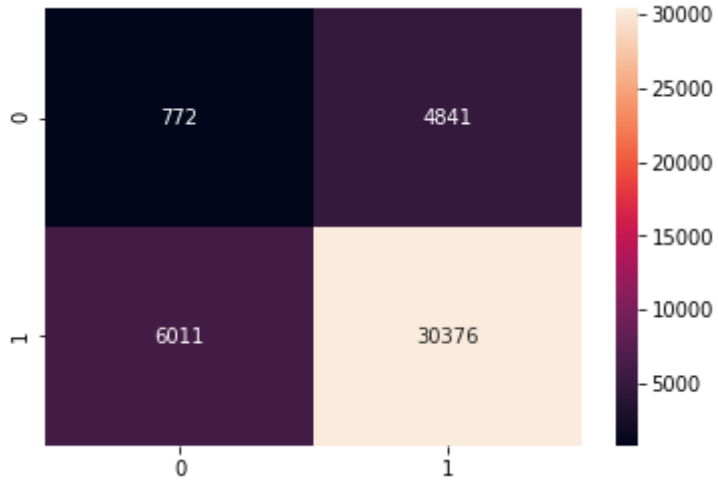
```
y_pred = model.predict(standardized_data_test)
```

# 10.6 Confusion Matrix

In [150]:

```
cm_tfidfw2v=confusion_matrix(y_test,y_pred)
print("Confusion Matrix:")
sns.heatmap(cm_tfidfw2v, annot=True, fmt='d')
plt.show()
```

```
Confusion Matrix:
```




In [151]:

```
#finding out  true negative , false positive , false negative and true positve
tn, fp, fn, tp = cm_tfidfw2v.ravel()
( tp, fp, fn, tp)
print(" true negitves are {} \n false positives are {} \n false negatives are {}\n true
 positives are {} \n ".format(tn,fp,fn,tp))
```

```
 true negitves are 772
 false positives are 4841
 false negatives are 6011
 true positives are 30376
```

# 10.7 Calculating Accuracy,Error on test data,Precision,Recall,Classification Report

In [152]:

```
from sklearn.metrics import recall_score
from sklearn.metrics import precision_score
from sklearn.metrics import classification_report


# evaluating accuracy
acc_tfidfw2v = accuracy_score(y_test, y_pred) * 100
print('\nThe Test Accuracy of the  SVM using RBF kernel for C and gamma = %.3f ,%.3f is
 %f%%' % (optimal_C,optimal_gamma, acc_tfidfw2v))

# Error on test data
test_error_tfidfw2v = 100-acc_tfidfw2v
print("\nTest Error  of the  SVM using RBF kernel for C and gamma  %f%%" % (test_error_
tfidfw2v))

# evaluating precision
precision_score = precision_score(y_test, y_pred)
print('\nThe Test Precision of the  SVM using RBF kernel for C and gamma = %.3f,%.3f is
 %f' % (optimal_C,optimal_gamma, precision_score))

# evaluating recall
recall_score = recall_score(y_test, y_pred)
print('\nThe Test Recall of the  SVM using RBF kernel for C and gamma = %.3f,%.3f is %f
' % (optimal_C,optimal_gamma, recall_score))

# evaluating Classification report
classification_report = classification_report(y_test, y_pred)
print('\nThe Test classification report of the  SVM using RBF kernel for C and gamma \n
\n ',(classification_report))
```

```
The Test Accuracy of the  SVM using RBF kernel for C and gamma = 100.000 ,
10.000 is 74.161905%

Test Error  of the  SVM using RBF kernel for C and gamma  25.838095%

The Test Precision of the  SVM using RBF kernel for C and gamma = 100.000,
10.000 is 0.862538

The Test Recall of the  SVM using RBF kernel for C and gamma = 100.000,10.
000 is 0.834804

The Test classification report of the  SVM using RBF kernel for C and gamm
a

              precision    recall  f1-score   support

           0       0.11      0.14      0.12      5613
           1       0.86      0.83      0.85     36387

   micro avg       0.74      0.74      0.74     42000
   macro avg       0.49      0.49      0.49     42000
weighted avg       0.76      0.74      0.75     42000
```

# 11. CONCLUSIONS:-

# Model performance table

| GRID SEARCH |

| Model | Hyper parameter(alpha) | Test Error | Accuracy |
|---|---|---|---|
| SGD with Bow | 10 | 13.364286 | 86.635714 |
| SGD with Tfidf | 10 | 13.364286 | 86.635714 |
| SGD with Avgw2v | 0.100 | 13.402381 | 86.597619 |
| SGD with Tfidfw2v | 10 | 13.364286 | 86.635714 |

| Model | Hyper parameter(alpha) | gamma | Test Error | Accuracy |
|---|---|---|---|---|
| SVM with Bow | 10 | 1000 | 13.671429 | 86.328571 |
| SVM with Tfidf | 10 | 10000 | 13.378571 | 86.621429 |
| SVM with Avgw2v | 10 | 10000 | 15.042857 | 84.957143 |
| SVM with Tfidfw2v | 10 | 10000 | 14.364286 | 85.635714 |

| RANDOM SEARCH |

| Model | Hyper parameter(alpha) | Test Error | Accuracy |
|---|---|---|---|
| SGD with Bow | 0.100 | 12.080952 | 87.919048 |
| SGD with Tfidf | 0.010 | 23.319048 | 76.680952 |
| SGD with Avgw2v | 0.001 | 19.207143 | 80.792857 |
| SGD with Tfidfw2v | 0.100 | 46.104726 | 53.895238 |

| Model | Hyper parameter(alpha) | gamma | Test Error | Accuracy |
|---|---|---|---|---|
| SVM with Bow | 100 | 0.010 | 18.338095 | 81.661905 |
| SVM with Tfidf | 10 | 1000 | 13.378571 | 86.621429 |
| SVM with Avgw2v | 10 | 10 | 83.276190 | 16.723810 |
| SVM with Tfidfw2v | 100 | 10 | 25.838095 | 74.161905 |

Support Vector Machine (SVM) is a supervised machine learning algorithm which can be used for both classification or regression

challenges.Support Vectors are simply the co-ordinates of individual observation. Support Vector Machine is a frontier which

best segregates the two classes (hyper-plane/ line).

SVM uses a technique called the kernel trick to transform your data and then based on these transformations it finds an optimal

boundary between the possible outputs.

The function of kernel is to take data as input and transform it into the required form. Different SVM algorithms use different

types of kernel functions. These functions can be different types. For example linear, nonlinear, polynomial, radial basis

function (RBF), and sigmoid.

Steps Involved:-

1) Connecting SQL file

2) Data Preprocessing(Already i had done preprocessing no need to do again)

3) Sorting the data based on time

4) Taking 1st 150K Rows (Due to low Ram)

5) Spliting data into train and test based on time (70:30)

6) Techniques For Vectorization Bow,TF-IDF,word2vec,Avgword2vec,tfidfword2vec.

7) Normalizing Data

8) Applying SGD CLASSIFIER For linear kernel using gridsearch and Random search

9) I calculated Accuracy,Error on Test Data, Confusion Matrix,Precision Score,Recall Score,Classification Report,ROC_curve

10) Calculated top 25 Positive and Negative features

10) Applying SVC For RBF Kernel by gridsearch and Random search

11) I calculated Accuracy,Error on Test Data, Confusion Matrix,Precision Score,Recall Score,Classification Report,ROC_curve

In [ ]: