In [ ]:

```
```

In [1]:

```
import pandas as pd
import numpy as np
import nltk
import string
import matplotlib.pyplot as plt
%matplotlib inline
import seaborn as sns
```

In [2]:

```
# Getting data into a dataframe
df = pd.read_csv('Reviews.CSV')
```

In [15]:

```
#!pip install keras
```

In [16]:

```
#!pip install numpy==1.16.1
```

In [3]:

```
# Eliminating neutral reviews i.e. those reviews with Score = 3
data_filtered = df[df['Score'] != 3]

# Converting Score variables to binary class variable (1-positive review and 0-negative
review)
# Give reviews with Score>3 a positive rating (1) , and reviews with a score<3 a negati
ve rating (0).
def polarity(x):
    if x < 3:
        return 0
    return 1

# Applying polarity function on Score column of filtered_data
data_filtered['Score'] = data_filtered['Score'].map(polarity)

print(data_filtered.shape)
data_filtered.head()
```

```
(525814, 10)

C:\Users\IDM LAB-01\Anaconda3\lib\site-packages\ipykernel_launcher.py:12:
SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: http://pandas.pydata.org/pandas-doc
s/stable/indexing.html#indexing-view-versus-copy
  if sys.path[0] == '':
```

Out[3]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	HelpfulnessDen
0	1	B001E4KFG0	A3SGXH7AUHU8GW	delmartian	1	
1	2	B00813GRG4	A1D87F6ZCVE5NK	dll pa	0	
2	3	B000LQOCH0	ABXLMWJIXXAIN	Natalia Corres "Natalia Corres"	1	
3	4	B000UA0QIQ	A395BORC6FGVXV	Karl	3	
4	5	B006K2ZZ7K	A1UQRSCLF8GW1T	Michael D. Bigham "M. Wassir"	0	

Observation: in Score column 1 = positive review and 0 = negative review

Data Cleaning:

Deduplication

In [4]:

```
#Sorting data according to ProductId in ascending order
sorted_data=data_filtered.sort_values('ProductId', axis=0, ascending=True, inplace=Fals
e, kind='quicksort', na_position='last')

#Deduplication of entries
final=sorted_data.drop_duplicates(subset={"UserId","ProfileName","Time","Text"}, keep=
'first', inplace=False)

# Removing rows where HelpfulnessNumerator is greater than HelpfulnessDenominator
final = final[final.HelpfulnessNumerator <= final.HelpfulnessDenominator]

print(final.shape)
final[30:50]
```

```
(364171, 10)
```

Out[4]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfu
150500	150501	0006641040	AJ46FKXOVC7NR	Nicholas A Mesiano	2	
150492	150493	0006641040	AMX0PJKV4PPNJ	E. R. Bird "Ramseelbird"	71	
150499	150500	0006641040	A1IJKK6Q1GTEAY	A Customer	2	
150498	150499	0006641040	A3E7R866M94L0C	L. Barker "simienwolf"	2	
515425	515426	141278509X	AB1A5EGHHVA9M	CHelmic	1	
24750	24751	2734888454	A1C298ITT645B6	Hugh G. Pritchard	0	
24749	24750	2734888454	A13ISQV0U9GZIC	Sandikaye	1	
308076	308077	2841233731	A3QD68O22M2XHQ	LABRNTH	0	
171160	171161	7310172001	AFXMWPNS1BLU4	H. Sandler	0	
171159	171160	7310172001	A74C7IARQEM1R	stucker	0	
171143	171144	7310172001	A1V5MY8V9AWUQB	Cheryl Sapper "champagne girl"	0	

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfu
171142	171143	7310172001	A2SWO60IW01VPX	Sam	0	
171147	171148	7310172001	A3TFTWTG2CC1GA	J. Umphress	0	
171141	171142	7310172001	A2ZO1AYFVQYG44	Cindy Rellie "Rellie"	0	
171140	171141	7310172001	AZ40270J4JBZN	Zhinka Chunmee "gamer from way back in the 70's"	0	
171139	171140	7310172001	ADXXVGRCGQQUO	Richard Pearlstein	0	
171138	171139	7310172001	A13MS1JQG2ADOJ	C. Perrone	0	
171137	171138	7310172001	A13LAE0YTXA11B	Dita Vyslouzilova "dita"	0	
171158	171159	7310172001	A16GY2RCF410DT	LB	0	
171144	171145	7310172001	A1L8DNQYY69L2Z	R. Flores	0	

Observation: Books with ProductId - 0006641040 and 2841233731 are also there so we have to remove all these rows with these ProductIds from the data

In [5]:

```
final = final[final['ProductId'] != '2841233731']
final = final[final['ProductId'] != '0006641040']
final.shape
```

Out[5]:

```
(364136, 10)
```

In [6]:

```
final = final.sample(frac=1).reset_index(drop = True)
```

Text Preprocessing: Stemming, stop-word removal and Lemmatization.

In [7]:

```
from sklearn.feature_extraction.text import CountVectorizer
from nltk.stem.porter import PorterStemmer
import re
import string
from nltk.corpus import stopwords
from nltk.stem import PorterStemmer
from nltk.stem.wordnet import WordNetLemmatizer
```

In [8]:

```
# Downloading stopwords
nltk.download('stopwords')

#set of stopwords in English
from nltk.corpus import stopwords
stop = set(stopwords.words('english'))
words_to_keep = set(('not'))
stop -= words_to_keep
#initialising the snowball stemmer
sno = nltk.stem.SnowballStemmer('english')

 #function to clean the word of any html-tags
def cleanhtml(sentence):
    cleanr = re.compile('<.*?>')
    cleantext = re.sub(cleanr, ' ', sentence)
    return cleantext

#function to clean the word of any punctuation or special characters
def cleanpunc(sentence):
    cleaned = re.sub(r'[?|!|\'|"|#]',r'',sentence)
    cleaned = re.sub(r'[.|,|)|(|\|/]',r' ',cleaned)
    return  cleaned
```

```
[nltk_data] Downloading package stopwords to C:\Users\IDM
[nltk_data]     LAB-01\AppData\Roaming\nltk_data...
[nltk_data]   Unzipping corpora\stopwords.zip.
```

In [9]:

```
#Code for removing HTML tags , punctuations . Code for removing stopwords . Code for ch
ecking if word is not alphanumeric and
# also greater than 2 . Code for stemmimg and also to convert them to lowercase letters
i=0
str1=' '
final_string=[]
all_positive_words=[] # store words from +ve reviews here
all_negative_words=[] # store words from -ve reviews here.
s=''
for sent in final['Text'].values:
    filtered_sentence=[]
    #print(sent);
    sent=cleanhtml(sent) # remove HTML tags
    for w in sent.split():
        for cleaned_words in cleanpunc(w).split():
            if((cleaned_words.isalpha()) & (len(cleaned_words)>2)):
                if(cleaned_words.lower() not in stop):
                    s=(sno.stem(cleaned_words.lower())).encode('utf8')
                    filtered_sentence.append(s)
                    if (final['Score'].values)[i] == 1:
                        all_positive_words.append(s) #list of all words used to describ
e positive reviews
                    if(final['Score'].values)[i] == 0:
                        all_negative_words.append(s) #list of all words used to describ
e negative reviews reviews
                else:
                    continue
            else:
                continue

    str1 = b" ".join(filtered_sentence) #final string of cleaned words


    final_string.append(str1)
    i+=1
```

In [10]:

```
#adding a column of CleanedText which displays the data after pre-processing of the rev
iew
final['CleanedText']=final_string
final['CleanedText']=final['CleanedText'].str.decode("utf-8")
#below the processed review can be seen in the CleanedText Column
print('Shape of final',final.shape)
final.head()
```

```
Shape of final (364136, 11)
```

Out[10]:

	Id	ProductId	UserId	ProfileName	HelpfulnessNumerator	Helpfulne
0	258039	B002HNDYZG	A1AP88KBRBIQNX	Fittzbaron "Fittzbaron"	12	
1	44166	B0007NOWMM	A7XU6G458L769	Roslyn Bowers	0	
2	85240	B0014EOU8E	A28FLGQMEM0HXY	Donna E Cox	1	
3	106263	B000UK3G2Y	A1PRUWNUYO5THO	K. Kostoff	2	
4	2262	B003HG6U3A	A1EZWXGYUD3HYU	PingPing	0	

Converting this data as IMDB dataset

In [11]:

```
from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle
```

In [12]:

```
##Sorting data according to Time in ascending order for Time Based Splitting
time_sorted_data = final.sort_values('Time', axis=0, ascending=True, inplace=False, kin
d='quicksort', na_position='last')

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

# Finding all words in the vocabulary
count_vect = CountVectorizer()
count_vect.fit(x)

vocabulary = count_vect.get_feature_names()
print('No. of words in the Vocabulary : ',len(vocabulary))
```

```
No. of words in the Vocabulary :  71611
```

In [13]:

```
# Storing all words in the dictionary (words as keys and index as values)
corpus = dict()
ind = 0
for sent in x:
  for word in sent.split():
    corpus.setdefault(word,[])
    corpus[word].append(ind)
    ind += 1

# Getting frequency for each word of vocabulary and storing it in a list
freq = []
for w in vocabulary:
  freq.append(len(corpus[w]))
```

In [14]:

```
# Getting Index for each word in the vocabulary
# Sorting frequencies in decreasing order
inc_index =np.argsort(np.array(freq))[::-1]

# Allocating ranks to words of vocabulary in decreasing order of frequency and storing
 words in a dictionary
word_rank = dict()
rank = 1
for i in inc_index:
  word_rank[vocabulary[i]] = rank
  rank +=1
```

In [15]:

```
# Converting full data into imdb format
data = []
for sent in x:
  row = []
  for word in sent.split():
    if(len(word)>1):
      row.append(word_rank[word])
  data.append(row)

# Splitting the data into 70-30 train_data and test_data
from sklearn.model_selection import train_test_split
X_train, X_test, Y_train, Y_test = train_test_split(data, y, test_size=0.5, random_stat
e=42)
```

In [16]:

```
'''from keras.preprocessing.text import Tokenizer
tokenizer = Tokenizer(num_words=5000)
tokenizer.fit_on_texts(X_train)

X_train = tokenizer.texts_to_sequences(X_train)
X_test = tokenizer.texts_to_sequences(X_test)'''
```

Out[16]:

```
'from keras.preprocessing.text import Tokenizer\ntokenizer = Tokenizer(num
_words=5000)\ntokenizer.fit_on_texts(X_train)\n\nX_train = tokenizer.texts
_to_sequences(X_train)\nX_test = tokenizer.texts_to_sequences(X_test)'
```

In [17]:

```
print("No. of datapoints in X_train :",len(X_train))
print("No. of datapoints in X_test :",len(X_test))
print("Shape of Y_train :",Y_train.shape)
print("Shape of Y_test :",Y_test.shape)
```

```
No. of datapoints in X_train : 182068
No. of datapoints in X_test : 182068
Shape of Y_train : (182068,)
Shape of Y_test : (182068,)
```

In [18]:

```
# Importing libraries
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
from keras.layers import Dropout
# fix random seed for reproducibility
np.random.seed(7)
```

```
Using TensorFlow backend.
```

In [19]:

```
# truncate and/or pad input sequences
max_review_length = 100
X_train = sequence.pad_sequences(X_train, maxlen=max_review_length)
X_test = sequence.pad_sequences(X_test, maxlen=max_review_length)

print(X_train.shape)
print(X_train[1])
```

```
(182068, 100)
[    0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0     0     0     0
     0     0     0     0     0     0     0     0     0  7336   349  4915
   395   410  2174  2415  4915   395   371   820  1438    61    35  9687
  1481     6    98  1510   410     2    28    37    91   334   743  1510
   906   410   243    91  1068  1391   231    84    39  2174  2415  4915
   395    40   956   210   580   632   300    65   108     4   465  2703
   238   576   109   643  1635   398   280   297 10364    40  4915   395
   172    21    82    17]
```

In [20]:

```
# this function is used draw Binary Crossentropy Loss VS No. of epochs plot
def plt_dynamic(x, vy, ty):
  plt.figure(figsize=(10,5))
  plt.plot(x, vy, 'b', label="Validation Loss")
  plt.plot(x, ty, 'r', label="Train Loss")
  plt.xlabel('Epochs')
  plt.ylabel('Binary Crossentropy Loss')
  plt.title('\nBinary Crossentropy Loss VS Epochs')
  plt.legend()
  plt.grid()
  plt.show()
```

In [ ]:

```

```

In [ ]:

```

```

Model(1 LSTM Layer)

In [21]:

```
# Credits: https://machinelearningmastery.com/sequence-classification-lstm-recurrent-ne
ural-networks-python-keras/
# LSTM for sequence classification in the IMDB dataset
import numpy
import pandas as pd
#from keras.datasets import imdb
from keras.models import Sequential
from keras.layers import Dense
from keras.layers import LSTM
from keras.layers.embeddings import Embedding
from keras.preprocessing import sequence
# fix random seed for reproducibility
numpy.random.seed(7)
```

In [36]:

```
# create the model
embedding_vecor_length = 32
model1 = Sequential()
model1.add(Embedding(len(vocabulary)+1, embedding_vecor_length, input_length=max_review
_length))
model1.add(LSTM(100))
model1.add(Dense(1, activation='sigmoid'))
model1.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model1.summary())
#Refer: https://datascience.stackexchange.com/questions/10615/number-of-parameters-in-a
n-lstm-model
```

```
WARNING: Logging before flag parsing goes to stderr.
W0625 21:21:33.008895  6576 deprecation_wrapper.py:119] From C:\Users\IDM
LAB-09\Anaconda3\lib\site-packages\keras\backend\tensorflow_backend.py:74:
The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_d
efault_graph instead.

W0625 21:21:33.174904  6576 deprecation_wrapper.py:119] From C:\Users\IDM
LAB-09\Anaconda3\lib\site-packages\keras\backend\tensorflow_backend.py:51
7: The name tf.placeholder is deprecated. Please use tf.compat.v1.placehol
der instead.

W0625 21:21:33.176904  6576 deprecation_wrapper.py:119] From C:\Users\IDM
LAB-09\Anaconda3\lib\site-packages\keras\backend\tensorflow_backend.py:413
8: The name tf.random_uniform is deprecated. Please use tf.random.uniform
instead.

W0625 21:21:33.489922  6576 deprecation_wrapper.py:119] From C:\Users\IDM
LAB-09\Anaconda3\lib\site-packages\keras\optimizers.py:790: The name tf.tr
ain.Optimizer is deprecated. Please use tf.compat.v1.train.Optimizer inste
ad.

W0625 21:21:33.505923  6576 deprecation_wrapper.py:119] From C:\Users\IDM
LAB-09\Anaconda3\lib\site-packages\keras\backend\tensorflow_backend.py:337
6: The name tf.log is deprecated. Please use tf.math.log instead.

W0625 21:21:33.510924  6576 deprecation.py:323] From C:\Users\IDM LAB-09\A
naconda3\lib\site-packages\tensorflow\python\ops\nn_impl.py:180: add_dispa
tch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is dep
recated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where


_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_1 (Embedding)      (None, 100, 32)           2291584
_________________________________________________________________
lstm_1 (LSTM)                (None, 100)               53200
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 101
=================================================================
Total params: 2,344,885
Trainable params: 2,344,885
Non-trainable params: 0
_________________________________________________________________
None
```

In [37]:

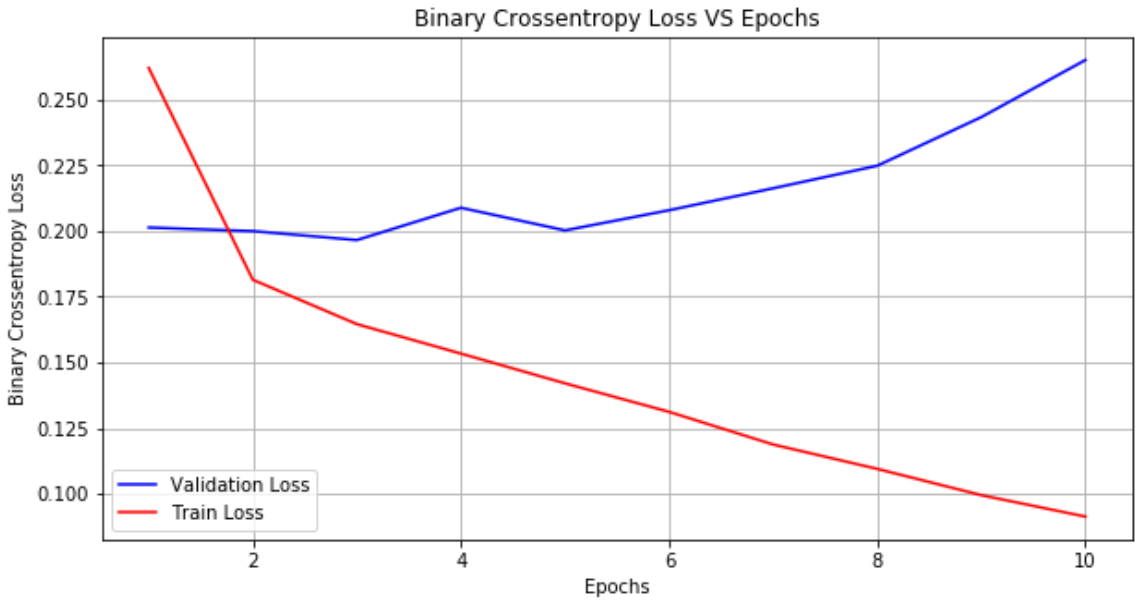
```
# Fitting the data to the model
history1 = model1.fit(X_train, Y_train, nb_epoch=10, batch_size=512 ,verbose=1,validati
on_data=(X_test, Y_test))
```

```
C:\Users\IDM LAB-09\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: U
serWarning: The `nb_epoch` argument in `fit` has been renamed `epochs`.

W0625 21:21:35.405032  6576 deprecation_wrapper.py:119] From C:\Users\IDM
LAB-09\Anaconda3\lib\site-packages\keras\backend\tensorflow_backend.py:98
6: The name tf.assign_add is deprecated. Please use tf.compat.v1.assign_ad
d instead.


Train on 182068 samples, validate on 182068 samples
Epoch 1/10
182068/182068 [==============================] - 210s 1ms/step - loss: 0.2
621 - acc: 0.8985 - val_loss: 0.2013 - val_acc: 0.9211
Epoch 2/10
182068/182068 [==============================] - 282s 2ms/step - loss: 0.1
814 - acc: 0.9298 - val_loss: 0.2000 - val_acc: 0.9213
Epoch 3/10
182068/182068 [==============================] - 284s 2ms/step - loss: 0.1
646 - acc: 0.9367 - val_loss: 0.1965 - val_acc: 0.9227
Epoch 4/10
182068/182068 [==============================] - 210s 1ms/step - loss: 0.1
533 - acc: 0.9416 - val_loss: 0.2088 - val_acc: 0.9218
Epoch 5/10
182068/182068 [==============================] - 207s 1ms/step - loss: 0.1
420 - acc: 0.9459 - val_loss: 0.2002 - val_acc: 0.9218
Epoch 6/10
182068/182068 [==============================] - 207s 1ms/step - loss: 0.1
312 - acc: 0.9508 - val_loss: 0.2079 - val_acc: 0.9196
Epoch 7/10
182068/182068 [==============================] - 204s 1ms/step - loss: 0.1
187 - acc: 0.9557 - val_loss: 0.2163 - val_acc: 0.9179
Epoch 8/10
182068/182068 [==============================] - 201s 1ms/step - loss: 0.1
095 - acc: 0.9593 - val_loss: 0.2248 - val_acc: 0.9193
Epoch 9/10
182068/182068 [==============================] - 187s 1ms/step - loss: 0.0
995 - acc: 0.9636 - val_loss: 0.2433 - val_acc: 0.9173
Epoch 10/10
182068/182068 [==============================] - 200s 1ms/step - loss: 0.0
913 - acc: 0.9664 - val_loss: 0.2651 - val_acc: 0.9156
```

In [38]:

```
# Final evaluation of the model
scores = model1.evaluate(X_test, Y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))

# Test and train accuracy of the model
model1_test = scores[1]
model1_train = max(history1.history['acc'])

# Plotting Train and Test Loss VS no. of epochs
# list of epoch numbers
x = list(range(1,11))

# Validation loss
vy = history1.history['val_loss']
# Training loss
ty = history1.history['loss']

# Calling the function to draw the plot
plt_dynamic(x, vy, ty)
```

```
Accuracy: 91.56%
```



Model (2 Lstm layers with dropout)

In [22]:

```
embedding_vecor_length = 32
model2 = Sequential()
model2.add(Embedding(len(vocabulary)+1, embedding_vecor_length, input_length=max_review
_length))
model2.add(LSTM(100, return_sequences=True,dropout=0.4, recurrent_dropout=0.4))
model2.add(LSTM(100, dropout=0.4, recurrent_dropout=0.4))
model2.add(Dense(1, activation='sigmoid'))
model2.compile(loss='binary_crossentropy', optimizer='adam', metrics=['accuracy'])
print(model2.summary())
```

```
WARNING:tensorflow:From C:\Users\IDM LAB-01\Anaconda3\lib\site-packages\te
nsorflow\python\framework\op_def_library.py:263: colocate_with (from tenso
rflow.python.framework.ops) is deprecated and will be removed in a future
version.
Instructions for updating:
Colocations handled automatically by placer.
WARNING:tensorflow:From C:\Users\IDM LAB-01\Anaconda3\lib\site-packages\ke
ras\backend\tensorflow_backend.py:3445: calling dropout (from tensorflow.p
ython.ops.nn_ops) with keep_prob is deprecated and will be removed in a fu
ture version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1
- keep_prob`.
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
embedding_1 (Embedding)      (None, 100, 32)           2291584
_________________________________________________________________
lstm_1 (LSTM)                (None, 100, 100)          53200
_________________________________________________________________
lstm_2 (LSTM)                (None, 100)               80400
_________________________________________________________________
dense_1 (Dense)              (None, 1)                 101
=================================================================
Total params: 2,425,285
Trainable params: 2,425,285
Non-trainable params: 0
_________________________________________________________________
None
```

In [23]:

```
# Fitting the data to the model
history2 = model2.fit(X_train, Y_train, nb_epoch=10, batch_size=512 ,verbose=1,validati
on_data=(X_test, Y_test))
```

```
WARNING:tensorflow:From C:\Users\IDM LAB-01\Anaconda3\lib\site-packages\te
nsorflow\python\ops\math_ops.py:3066: to_int32 (from tensorflow.python.op
s.math_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.cast instead.

C:\Users\IDM LAB-01\Anaconda3\lib\site-packages\ipykernel_launcher.py:2: U
serWarning: The `nb_epoch` argument in `fit` has been renamed `epochs`.


Train on 182068 samples, validate on 182068 samples
Epoch 1/10
182068/182068 [==============================] - 470s 3ms/step - loss: 0.2
742 - acc: 0.8939 - val_loss: 0.2041 - val_acc: 0.9194
Epoch 2/10
182068/182068 [==============================] - 416s 2ms/step - loss: 0.1
954 - acc: 0.9240 - val_loss: 0.1966 - val_acc: 0.9230
Epoch 3/10
182068/182068 [==============================] - 424s 2ms/step - loss: 0.1
818 - acc: 0.9299 - val_loss: 0.1964 - val_acc: 0.9241
Epoch 4/10
182068/182068 [==============================] - 425s 2ms/step - loss: 0.1
705 - acc: 0.9343 - val_loss: 0.2005 - val_acc: 0.9241
Epoch 5/10
182068/182068 [==============================] - 417s 2ms/step - loss: 0.1
632 - acc: 0.9370 - val_loss: 0.1965 - val_acc: 0.9227
Epoch 6/10
182068/182068 [==============================] - 418s 2ms/step - loss: 0.1
573 - acc: 0.9400 - val_loss: 0.2016 - val_acc: 0.9241
Epoch 7/10
182068/182068 [==============================] - 414s 2ms/step - loss: 0.1
505 - acc: 0.9424 - val_loss: 0.2060 - val_acc: 0.9234
Epoch 8/10
182068/182068 [==============================] - 412s 2ms/step - loss: 0.1
445 - acc: 0.9453 - val_loss: 0.2080 - val_acc: 0.9224
Epoch 9/10
182068/182068 [==============================] - 413s 2ms/step - loss: 0.1
406 - acc: 0.9468 - val_loss: 0.2121 - val_acc: 0.9232
Epoch 10/10
182068/182068 [==============================] - 413s 2ms/step - loss: 0.1
344 - acc: 0.9491 - val_loss: 0.2109 - val_acc: 0.9236
```

In [24]:

```
# Final evaluation of the model
scores = model2.evaluate(X_test, Y_test, verbose=0)
print("Accuracy: %.2f%%" % (scores[1]*100))

# Test and train accuracy of the model
model2_test = scores[1]
model2_train = max(history2.history['acc'])

# Plotting Train and Test Loss VS no. of epochs
# list of epoch numbers
x = list(range(1,11))

# Validation loss
vy = history2.history['val_loss']
# Training loss
ty = history2.history['loss']

# Calling the function to draw the plot
plt_dynamic(x, vy, ty)
```

```
Accuracy: 92.36%
```

In [28]:

```
from prettytable import PrettyTable
x = PrettyTable()
x.field_names = ["Model","Train accuracy","Test accuracy"]
x.add_row(['1 LSTM Layer', '96.64' , '91.5'])
x.add_row(['2 Lstm layers with dropout',model2_train,model2_test])

print(x)
with open('LSTM_IMDB_result.txt', 'w') as w:
    w.write(str(x))
```

```
+---------------------------+--------------------+--------------------+
|           Model           |   Train accuracy   |   Test accuracy    |
+---------------------------+--------------------+--------------------+
|        1 LSTM Layer       |       96.64        |        91.5        |
| 2 Lstm layers with dropout | 0.9491234044671768 | 0.9235944811815453 |
+---------------------------+--------------------+--------------------+
```

Observation:

WE can get more accuracy if run more epochs.

Model 2 is better because having high test accuracy