In [27]:
```
import graphlab as gl
import numpy as np
import matplotlib.pyplot as plt
```

In [148]:
```
r = gl.SFrame.read_csv('/Users/yijiapan/Desktop/Spr2017-proj5-grp9/data/reviews_Kindle_Store.json', delimiter='\n', header=False)

reviews = r.unpack(unpack_column='X1',column_name_prefix='')
reviews = reviews.unpack(unpack_column='helpful',column_name_prefix='X')
reviews.rename({'X.0':'upvotes','X.1':'downvotes'})
reviews['reviewTime'] = reviews['reviewTime'].str_to_datetime(str_format="%m %d, %Y")
reviews['tfidf'] = gl.text_analytics.tf_idf(reviews['reviewText'])
reviews['tfidf'] = reviews['tfidf'].dict_trim_by_keys(gl.text_analytics.stopwords(), True)

d = gl.SFrame.read_csv('/Users/yijiapan/Desktop/Spr2017-proj5-grp9/data/meta_Kindle_Store.json', delimiter='\n', header=False)

meta = d.unpack(unpack_column='X1',column_name_prefix='')
msf = reviews.join(meta, on='asin', how='inner')
```

```
Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/data/reviews_Kindle_Store.json

Parsing completed. Parsed 100 lines in 1.0601 secs.

------------------------------------------------------
Inferred types from first 100 line(s) of file as
column_type_hints=[dict]
If parsing fails due to incorrect types, you can correct
the inferred type list above and pass it to read_csv in
the column_type_hints argument
------------------------------------------------------

Read 73750 lines. Lines per second: 35263.8

Read 370288 lines. Lines per second: 47279.9

Read 682265 lines. Lines per second: 48145.9

Read 990624 lines. Lines per second: 49016.8

Read 1311842 lines. Lines per second: 49649.1

Read 1635900 lines. Lines per second: 50764.1
```

```
Read 1878365 lines. Lines per second: 49403.4

Read 2184041 lines. Lines per second: 49644.9

Read 2477488 lines. Lines per second: 49899.2

Read 2768812 lines. Lines per second: 50321.1

Read 3050814 lines. Lines per second: 49703

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/reviews_Kindle_Store.json

Parsing completed. Parsed 3205467 lines in 64.317 secs.

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/meta_Kindle_Store.json

Parsing completed. Parsed 100 lines in 1.69598 secs.

------------------------------------------------------
Inferred types from first 100 line(s) of file as
column_type_hints=[dict]
If parsing fails due to incorrect types, you can correct
the inferred type list above and pass it to read_csv in
the column_type_hints argument
------------------------------------------------------

Read 34790 lines. Lines per second: 9416.32

Read 158032 lines. Lines per second: 14540.6

Read 276927 lines. Lines per second: 15224.5

Read 352318 lines. Lines per second: 15167.8

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/meta_Kindle_Store.json

Parsing completed. Parsed 434702 lines in 27.7522 secs.
```

In [147]:
```
msf.head()
```

Out[147]:

asin	brand	categories	description	imUrl
1603420304	None	[[Books, Cookbooks, Food & Wine, Quick & Easy], ...	In less time and for less money than it takes to ...	http://ecx.images-amazon.com/images/I/51IEqP ...

B0002IQ15S	None	[[Kindle Store, Kindle Accessories, Power ...	This universal DC adapter powers/charges portable ...	http://ecx.images-amazon.com/images/I/21QFJM ...
B000F83SZQ	None	[[Books, Literature & Fiction], [Books, ...	None	http://ecx.images-amazon.com/images/I/51yLqHe ...
B000F83TEQ	None	[[Books, Literature & Fiction], [Books, ...	None	http://ecx.images-amazon.com/images/I/2136NB ...
B000F83STC	None	[[Books, Literature & Fiction, Erotica], ...	None	http://g-ecx.images-amazon.com/images/G/01/x ...
B000FA5RE4	None	[[Books, Reference, Dictionaries & ...	Updated 2003 version with corrections ...	http://ecx.images-amazon.com/images/I/21XTM6 ...
B000FA5NSO	None	[[Books, Literature & Fiction], [Books, Sci ...	None	http://ecx.images-amazon.com/images/I/51N45E ...
B000FA5UXC	None	[[Books, Literature & Fiction], [Books, Sci ...	Madoc Tamlin is a man with an unusual problem. ...	http://ecx.images-amazon.com/images/I/51q4iur5
B000FA5T4W	None	[[Books, Business & Money, Accounting], ...	None	http://ecx.images-amazon.com/images/I/51eWyE ...
B000FA5SHK	None	[[Books, Science &	None	http://ecx.images-amazon.

In [3]:
```
msf.column_names()
```

Out[3]:
```
['asin',
 'overall',
 'reviewText',
 'reviewTime',
 'reviewerID',
 'reviewerName',
 'summary',
 'unixReviewTime',
 'upvotes',
 'downvotes',
 'tfidf',
 'brand',
 'categories',
 'description',
 'imUrl',
 'price',
 'related',
 'salesRank',
 'title']
```

Get an SArray of the concatenated text in the `summary`, `reviewText`, and `description` fields.

In [21]:
```
docs = msf.apply(lambda x: str(x['summary']) + ' ' + str(x['reviewText
']) + ' ' + str(x['description']))
```

Create a function to count words from a `docs` SArray that outputs a `docs_sf` SFrame with associated word counts

In [26]:
```
def get_word_frequency(docs):
    """
    Returns the frequency of occurrence of words in an SArray of documents
    Args:
    docs: An SArray (of dtype str) of documents
    Returns:
    An SFrame with the following columns:
     'word'      : Word used
     'count'     : Number of times the word occured in all documents.
     'frequency' : Relative frequency of the word in the set of input documents.
    """

    # Use the count_words function to count the number of words.
    docs_sf = gl.SFrame()
    docs_sf['words'] = gl.text_analytics.count_words(docs)

    # Stack the dictionary into individual word-count pairs.
    docs_sf = docs_sf.stack('words',
                            new_column_name=['word', 'count'])

    # Count the number of unique words (remove None values)
    docs_sf = docs_sf.groupby('word', {'count': gl.aggregate.SUM('count')})
    docs_sf['frequency'] = docs_sf['count'] / docs_sf["count"].sum()
    return docs_sf
```

In [ ]:
```
docs_sf = get_word_frequency(docs)
```

In [ ]:
```
def predict(document_bow, word_topic_counts, topic_counts, vocab,
            alpha=0.1, beta=0.01, num_burnin=5):
    """
    Make predictions for a single document.
    Parameters
    ----------
    document_bow : dict
        Dictionary with words as keys and document frequencies as counts.
    word_topic_counts : numpy array, num_vocab x num_topics
        Number of times a given word has ever been assigned to a topic.
    topic_counts : numpy vector of length num_topics
        Number of times any word has been assigned to a topic.
    vocab : dict
        Words are keys and unique integer is the value.
    alpha : float
        Hyperparameter. See topic_model docs.
```

```
    beta : float
        Hyperparameter. See topic_model docs.
    num_burnin : int
        Number of iterations of Gibbs sampling to perform at predict t
ime.
    Returns
    -------
    out : numpy array of length num_topics
        Probabilities that the document belongs to each topic.
    """
    num_vocab, num_topics = word_topic_counts.shape

    # proportion of each topic in this test doc
    doc_topic_counts = np.zeros(num_topics)
    # Assignment of each unique word
    doc_topic_assignments = []

    # Initialize assignments and counts
    # NB: we are assuming document_bow doesn't change.
    for i, (word, freq) in enumerate(document_bow.iteritems()):
        if word not in vocab:  # skip words not present in training se
t
            continue
        topic = np.random.randint(0, num_topics-1)
        doc_topic_assignments.append(topic)
        doc_topic_counts[topic] += freq

    # Sample topic assignments for the test document
    for burnin in range(num_burnin):
        for i, (word, freq) in enumerate(document_bow.iteritems()):
            if word not in vocab:
                continue
            word_id = vocab[word]

            # Get old topic and decrement counts
            topic = doc_topic_assignments[i]
            doc_topic_counts[topic] -= freq

            # Sample a new topic
            gamma = np.zeros(num_topics)  # store probabilities
            for k in range(num_topics):
                gamma[k] = (doc_topic_counts[k] + alpha) * (word_topic
_counts[word_id, k] + beta) / (topic_counts[k] + num_vocab * beta)
            gamma = gamma / gamma.sum()  # normalize to probabilities
            topic = np.random.choice(num_topics, 1, p=gamma)

            # Use new topic to increment counts
            doc_topic_assignments[i] = topic
            doc_topic_counts[topic] += freq
```

```
    # Create predictions
    predictions = np.zeros(num_topics)
    total_doc_topic_counts = doc_topic_counts.sum()
    for k in range(num_topics):
        predictions[k] = (doc_topic_counts[k] + alpha) / (total_doc_to
pic_counts + num_topics * alpha)
    return predictions / predictions.sum()


    if __name__ == '__main__':
    docs = gl.SFrame({'text': [{'first': 5, 'doc': 1}, {'second': 3, '
doc': 5}]})
    m = gl.topic_model.create(docs)

    # Get test document in bag of words format
    document_bow = docs['text'][0]

    # Input: Global parameters from trained model

    # Number of times each word in the vocabulary has ever been assign
ed to topic k (in any document). You can make an approximate version o
f this by multiplying m['topics'] by some large number (e.g. number of
tokens in corpus) that indicates how strong you "believe" in these top
ics. Make it into counts by flooring it to an integer.
    prior_strength = 1000000
    word_topic_counts = np.array(m['topics']['topic_probabilities'])
    word_topic_counts = np.floor(prior_strength * word_topic_counts)

    # Number of times any word as been assigned to each topic.
    topic_counts = word_topic_counts.sum(0)

    # Get vocabulary lookup
    num_topics = m['num_topics']
    vocab = {}
    for i, w in enumerate(m['topics']['vocabulary']):
        vocab[w] = i
    num_vocab = len(vocab)

    # Make prediction on test document
    probs = predict(document_bow, word_topic_counts, topic_counts, voc
ab)
```

In [16]:
```
print msf[1]['summary']
print msf[1]['reviewText']
print msf[1]['description']
```

```
Okay for true beginners
So, I bought this book a few days ago and have tried three recipes s
o far.  The first was a total flop.  There must be an error, but be
forewarned, do NOT make the Blueberry Coffee Cake as it comes out as
inedible mush--WAY too much water.  The other two recipes (mac and c
heese and grilled cheese with tomato) were decent for quick lunches
or dinners.  They were average in taste, but considering the short a
mount of time it took to make them, I'm okay with that.  All in all,
it's a nice idea book to get creative with everyday ingredients, but
with errors and only average taste, I give it three stars.
In less time and for less money than it takes to order pizza, you ca
n make it yourself!Three harried but heatlh-conscious college studen
ts compiled and tested this collection of more than 200 tasty, heart
y, inexpensive recipes anyone can cook -- yes, anyone!Whether you're
short on cash, fearful of fat, counting your calories, or just miss
home cooking, The Healthy College Cookbook offers everything you nee
d to make good food yourself.
```

In [8]:
```
wc = gl.text_analytics.count_words(docs, to_lower=True)
```

In [13]:
```
trimmer = gl.toolkits.feature_engineering.RareWordTrimmer(threshold=2)

# Fit and transform the data.
transformed_sf = trimmer.fit_transform(wc)
```

```
---------------------------------------------------------------------
-------
ToolkitError                                Traceback (most recent cal
l last)
<ipython-input-13-0457887f7cbe> in <module>()
      2
      3 # Fit and transform the data.
----> 4 transformed_sf = trimmer.fit_transform(wc)

/Users/galen/anaconda/envs/gl-env/lib/python2.7/site-packages/graphl
ab/toolkits/feature_engineering/_doc_utils.pyc in fit_transform(self
, data)
     31
     32 def fit_transform(self, data):
---> 33     return Transformer.fit_transform(self, data)
     34
     35 def republish_docs(cls):

/Users/galen/anaconda/envs/gl-env/lib/python2.7/site-packages/graphl
ab/toolkits/feature_engineering/_feature_engineering.pyc in fit_tran
sform(self, data)
    319         {examples}
    320         """
--> 321         _raise_error_if_not_sframe(data, "data")
    322         _mt._get_metric_tracker().track(self.__class__.__mod
ule__ + '.fit_transform')
    323         return self.__proxy__.fit_transform(data)

/Users/galen/anaconda/envs/gl-env/lib/python2.7/site-packages/graphl
ab/toolkits/_internal_utils.pyc in _raise_error_if_not_sframe(datase
t, variable_name)
    395
    396     if not isinstance(dataset, _SFrame):
--> 397       raise ToolkitError(err_msg % variable_name)
    398
    399 def _raise_error_if_sframe_empty(dataset, variable_name="SFr
ame"):

ToolkitError: Input data is not an SFrame. If it is a Pandas DataFra
me, you may use the to_sframe() function to convert it to an SFrame.
```

In [11]:
```
len(wc)
```

Out[11]: 3205467

In [ ]:
```
# Use the count_words function to count the number of words.
docs_sf = gl.SFrame()
docs_sf['words'] = gl.text_analytics.count_words(docs)

# Stack the dictionary into individual word-count pairs.
docs_sf = docs_sf.stack('words',
                        new_column_name=['word', 'count'])

# Count the number of unique words (remove None values)
docs_sf = docs_sf.groupby('word', {'count': gl.aggregate.SUM('count')}
)
docs_sf['frequency'] = docs_sf['count'] / docs_sf["count"].sum()
```

In [ ]:
```

```

Run CTM with Spark

In [1]:
```
import findspark
findspark.init('/Users/Zoe/spark-2.1.0-bin-hadoop2.7/')
from pyspark.sql import SparkSession

from pyspark.context import SparkContext
sc = SparkContext('local')
spark = SparkSession(sc)
```

Prepare data

In [2]:
```
review_df = spark.read.json("/Users/Zoe/Documents/Spring2017/GR5243/My
Prjs/localData/prj5/reviews_Kindle_Store.json")
#meta_df = spark.read.json("/Users/Zoe/Documents/Spring2017/GR5243/MyP
rjs/localData/prj5/meta_Kindle_Store.json")
```

In [3]:
```
df = review_df.select(review_df.asin,review_df.overall,review_df.revie
werID)
```

In [6]:
```
review_df = 0
meta_df = 0
```

In [5]:
```
df.take(5)
```

Out[5]:
```
[Row(asin=u'1603420304', overall=4.0, reviewerID=u'A2GZ9GFZV1LWB0'),
 Row(asin=u'1603420304', overall=3.0, reviewerID=u'A1K7VSUDCVAPW8'),
 Row(asin=u'1603420304', overall=4.0, reviewerID=u'A35J5XRE5ZT6H2'),
 Row(asin=u'1603420304', overall=4.0, reviewerID=u'A3DGZNFSMNWSX5'),
 Row(asin=u'1603420304', overall=5.0, reviewerID=u'A2CVDQ6H36L4VL')]
```

In [7]:
```
asins_code = df.select('asin').distinct().rdd.zipWithIndex()
users_code = df.select('reviewerID').distinct().rdd.zipWithIndex()
```

In [8]:
```
asins_df = spark.createDataFrame(asins_code.map(lambda r: (r[0][0],r[1
]+1)),['asin','item'])
users_df = spark.createDataFrame(users_code.map(lambda r: (r[0][0],r[1
]+1)),['reviewerID','user'])
```

In [9]:
```
Ratings = df.select(df.asin,df.overall,df.reviewerID).join(asins_df,"a
sin").join(users_df,"reviewerID")
```

In [10]:
```
Ratings = Ratings.select(Ratings.user, Ratings.item, Ratings.overall.a
lias('rating'))
```

In [19]:
```
row1 = Ratings.agg({"user": "max", "item":"max"}).collect()
```

In [20]:
```
row1
```

Out[20]:
```
[Row(max(item)=430529, max(user)=1406889)]
```

In [12]:
```
ItemTopics = spark.read.load('/Users/Zoe/Documents/Spring2017/GR5243/M
yPrjs/localData/prj5/predictions.csv',
                      format='com.databricks.spark.csv',
                      header='true',
                      inferSchema='true')
```

In [13]:
```
ItemTopicsRDD = asins_df.join(ItemTopics,"asin").drop("asin").rdd.map(
lambda r: (r[0],[r[i] for i in range(1,51)]))
```

In [14]:
```
ItemTopics = spark.createDataFrame(ItemTopicsRDD,['item','topic'])
```

In [23]:
```
Full = Ratings.join(ItemTopics, "item")
```

In [24]:
```
subFull = Full.limit(20)
```

In [ ]:
```
subFull.collect()
```

In [ ]:
```

```

Train CTM on Data

In [15]:
```
from pyspark.sql.functions import collect_list
from time import time
import numpy as np
from numpy.random import rand
from numpy import matrix
```

In [22]:
```
def CTM_train(Full,I,J,K,LAMBDA,max_iter=10,n_partition=6):
    '''
    '''

    # define update functions
    def updateU(i,v_ind,R,V,LAMBDA):
        '''
        '''
        r = v_ind.shape[0]
        K = V.shape[1]

        A = V[v_ind,:].T.dot(V[v_ind,:]) + LAMBDA*r*np.eye(K)
        b = V[v_ind,:].T.dot(R).T

        return (np.linalg.solve(A, b)).T

    def updateV(j,u_ind,R,U,LAMBDA,Th):
        '''
        '''
        r = u_ind.shape[0]
        K = U.shape[1]

        A = U[u_ind,:].T.dot(U[u_ind,:]) + LAMBDA*r*np.eye(K)
        b = U[u_ind,:].T.dot(R).T + LAMBDA*r*Th.reshape([K,1])

        return (np.linalg.solve(A, b)).T

    print('pre-compute block information...')
    Full = Full.repartition(n_partition)
    U_map = Full.groupBy("user").agg(collect_list("item").alias('items
'),collect_list("rating").alias('ratings')).sort('user')
    V_map = Full.groupBy("item").agg(collect_list("user").alias('users
'),collect_list("rating").alias('ratings'), first('topic').alias('topi
```

```
c')).sort('item')
    U_map = U_map.repartition(n_partition)
    V_map = V_map.repartition(n_partition)

    print('initialize parameters...')
    U = matrix(rand(I,K))
    V = matrix(rand(J,K))

    Us = sc.broadcast(U)
    Vs = sc.broadcast(V)

    print('update parameters...')
    for i in range(max_iter):


        st = time()
        U = U_map.rdd.map(lambda r: updateU(r[0],np.array(r[1]),np.arr
ay(r[2]),Vs.value,LAMBDA)).reduce(lambda a,b: np.vstack((a,b)))
        Us = sc.broadcast(U)



        V = V_map.rdd.map(lambda r: updateV(r[0],np.array(r[1]),np.arr
ay(r[2]),Us.value,LAMBDA,np.array(r[3]))).reduce(lambda a,b: np.vstack
((a,b)))
        Vs = sc.broadcast(V)
        ed = time()



        print('Finish iteration round: '+str(i)+', use time: '+str(rou
nd(ed-st,4))+'s.\n')

    return (U,V)
```

In [21]:
```
# carefully set number of threads to improve performance
U,V = CTM_train(Full,1406889,430529,50,LAMBDA=0.02,max_iter=10,n_parti
tion=200)
```

```
pre-compute block information...
initialize parameters...
update parameters...

---------------------------------------------------------------------
-------
Py4JJavaError                             Traceback (most recent cal
l last)
<ipython-input-21-89aac2a58056> in <module>()
      1 # carefully set number of threads to improve performance
----> 2 U,V = CTM_train(Ratings,ItemTopics,1406889,430529,50,LAMBDA=
0.02,max_iter=10,U_threads=200,V_threads=200)
```

```
<ipython-input-16-804eb679013b> in CTM_train(R, Th, I, J, K, LAMBDA,
max_iter, U_threads, V_threads)
     44
     45         st = time()
---> 46         U = U_map.rdd.map(lambda r: updateU(r[0],np.array(r[
1]),np.array(r[2]),Vs.value,LAMBDA)).reduce(lambda a,b: np.vstack((a
,b)))
     47         Us = sc.broadcast(U)
     48

/Users/Zoe/spark-2.1.0-bin-hadoop2.7/python/pyspark/rdd.pyc in reduc
e(self, f)
    833             yield reduce(f, iterator, initial)
    834
--> 835         vals = self.mapPartitions(func).collect()
    836         if vals:
    837             return reduce(f, vals)

/Users/Zoe/spark-2.1.0-bin-hadoop2.7/python/pyspark/rdd.pyc in colle
ct(self)
    807         """
    808         with SCCallSiteSync(self.context) as css:
--> 809             port = self.ctx._jvm.PythonRDD.collectAndServe(s
elf._jrdd.rdd())
    810         return list(_load_from_socket(port, self._jrdd_deser
ializer))
    811

/Users/Zoe/spark-2.1.0-bin-hadoop2.7/python/lib/py4j-0.10.4-src.zip/
py4j/java_gateway.py in __call__(self, *args)
   1131         answer = self.gateway_client.send_command(command)
   1132         return_value = get_return_value(
-> 1133             answer, self.gateway_client, self.target_id, sel
f.name)
   1134
   1135         for temp_arg in temp_args:

/Users/Zoe/spark-2.1.0-bin-hadoop2.7/python/pyspark/sql/utils.pyc in
deco(*a, **kw)
     61     def deco(*a, **kw):
     62         try:
---> 63             return f(*a, **kw)
     64         except py4j.protocol.Py4JJavaError as e:
     65             s = e.java_exception.toString()

/Users/Zoe/spark-2.1.0-bin-hadoop2.7/python/lib/py4j-0.10.4-src.zip/
py4j/protocol.py in get_return_value(answer, gateway_client, target_
id, name)
    317                 raise Py4JJavaError(
    318                     "An error occurred while calling {0}{1}{
```

```
2}.\n".
--> 319                     format(target_id, ".", name), value)
    320             else:
    321                 raise Py4JError(

Py4JJavaError: An error occurred while calling z:org.apache.spark.ap
i.python.PythonRDD.collectAndServe.
: org.apache.spark.SparkException: Job aborted due to stage failure:
Task 2 in stage 64.0 failed 1 times, most recent failure: Lost task
2.0 in stage 64.0 (TID 4507, localhost, executor driver): TaskResult
Lost (result lost from block manager)
Driver stacktrace:
        at org.apache.spark.scheduler.DAGScheduler.org$apache$spark$
scheduler$DAGScheduler$$failJobAndIndependentStages(DAGScheduler.sca
la:1435)
        at org.apache.spark.scheduler.DAGScheduler$$anonfun$abortSta
ge$1.apply(DAGScheduler.scala:1423)
        at org.apache.spark.scheduler.DAGScheduler$$anonfun$abortSta
ge$1.apply(DAGScheduler.scala:1422)
        at scala.collection.mutable.ResizableArray$class.foreach(Res
izableArray.scala:59)
        at scala.collection.mutable.ArrayBuffer.foreach(ArrayBuffer.
scala:48)
        at org.apache.spark.scheduler.DAGScheduler.abortStage(DAGSch
eduler.scala:1422)
        at org.apache.spark.scheduler.DAGScheduler$$anonfun$handleTa
skSetFailed$1.apply(DAGScheduler.scala:802)
        at org.apache.spark.scheduler.DAGScheduler$$anonfun$handleTa
skSetFailed$1.apply(DAGScheduler.scala:802)
        at scala.Option.foreach(Option.scala:257)
        at org.apache.spark.scheduler.DAGScheduler.handleTaskSetFail
ed(DAGScheduler.scala:802)
        at org.apache.spark.scheduler.DAGSchedulerEventProcessLoop.d
oOnReceive(DAGScheduler.scala:1650)
        at org.apache.spark.scheduler.DAGSchedulerEventProcessLoop.o
nReceive(DAGScheduler.scala:1605)
        at org.apache.spark.scheduler.DAGSchedulerEventProcessLoop.o
nReceive(DAGScheduler.scala:1594)
        at org.apache.spark.util.EventLoop$$anon$1.run(EventLoop.sca
la:48)
        at org.apache.spark.scheduler.DAGScheduler.runJob(DAGSchedul
er.scala:628)
        at org.apache.spark.SparkContext.runJob(SparkContext.scala:1
918)
        at org.apache.spark.SparkContext.runJob(SparkContext.scala:1
931)
        at org.apache.spark.SparkContext.runJob(SparkContext.scala:1
944)
        at org.apache.spark.SparkContext.runJob(SparkContext.scala:1
958)
```

```
        at org.apache.spark.rdd.RDD$$anonfun$collect$1.apply(RDD.sca
la:935)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOper
ationScope.scala:151)
        at org.apache.spark.rdd.RDDOperationScope$.withScope(RDDOper
ationScope.scala:112)
        at org.apache.spark.rdd.RDD.withScope(RDD.scala:362)
        at org.apache.spark.rdd.RDD.collect(RDD.scala:934)
        at org.apache.spark.api.python.PythonRDD$.collectAndServe(Py
thonRDD.scala:453)
        at org.apache.spark.api.python.PythonRDD.collectAndServe(Pyt
honRDD.scala)
        at sun.reflect.NativeMethodAccessorImpl.invoke0(Native Metho
d)
        at sun.reflect.NativeMethodAccessorImpl.invoke(NativeMethodA
ccessorImpl.java:62)
        at sun.reflect.DelegatingMethodAccessorImpl.invoke(Delegatin
gMethodAccessorImpl.java:43)
        at java.lang.reflect.Method.invoke(Method.java:498)
        at py4j.reflection.MethodInvoker.invoke(MethodInvoker.java:2
44)
        at py4j.reflection.ReflectionEngine.invoke(ReflectionEngine.
java:357)
        at py4j.Gateway.invoke(Gateway.java:280)
        at py4j.commands.AbstractCommand.invokeMethod(AbstractComman
d.java:132)
        at py4j.commands.CallCommand.execute(CallCommand.java:79)
        at py4j.GatewayConnection.run(GatewayConnection.java:214)
        at java.lang.Thread.run(Thread.java:745)
```

Predict on test data

In [ ]:
```
def CTM_predict(test,U,V):
    '''
    '''


    preds = test.rdd.map(lambda r: ((r[0],r[1]),U[r[0],:].dot(V[r[1],:
].T)[0,0]))
    return preds
```

In [ ]:
```
preds = CTM_predict(Ratings,U,V)
```

Evaluation

1. MSE

In [ ]:
```
def evaluate(test,preds,N):
    '''
    '''


    se = test.rdd.map(lambda r: ((r[0],r[1]),r[2])).join(preds).map(la
mbda r: (r[1][0]-r[1][1])**2).reduce(lambda a,b: a+b)
    return se/N
```

In [ ]:
```
N = Ratings.count()
evaluate(test,preds,N)
```

2. Does it works for individual user?

In [149]:
```
to_use = msf[['reviewerID','asin','overall','imUrl','categories']]
```

Step 1: Randomly choose an active user (in order to make sure he has make enough reviews to predict)

In [ ]:
```
import graphlab.aggregate as agg
User = msf.groupby(key_columns='reviewerID',
                           operations={'count': agg.COUNT()})

ActiveUser = User.sort('count', ascending = False)
```

In [ ]:
```
# We will choose one from who was rank 20 to 30 in regard of their num
ber of reviews
ActiveUser[20:30]
```

In [151]:
```
# For example, we will choose 'reviewerID' == 'A2YJ8VP1SSHJ7' and we c
an extract what books has he made reviews
UserBook = to_use.filter_by('A2YJ8VP1SSHJ7','reviewerID')
# We can also choose other users
#UserBook = msf.filter_by('ANSX922QNYA67','reviewerID')
#UserBook = msf.filter_by('A1DA6E4FNRSAWN','reviewerID')
```

Step 2: Find the top 10 books he has given high rates

In [153]:
```
UserRate = UserBook.sort('overall', ascending = False)
UserRate10 = UserRate[1:10]
UserRate10
```

Out[153]:

reviewerID	asin	overall	imUrl	catego
A2YJ8VP1SSHJ7	B0027VXV7Y	5.0	http://ecx.images-amazon.com/images/I/513GN71u...	[[Boo Literat & Fictio [Books
A2YJ8VP1SSHJ7	B002HJ1WS6	5.0	http://ecx.images-amazon.com/images/I/5195xNx8...	[[Boo Literat & Fictio Unite States
A2YJ8VP1SSHJ7	B002R5B0WI	5.0	http://ecx.images-amazon.com/images/I/514jHoot...	[[Boo Literat & Fictio [Bool Sci
A2YJ8VP1SSHJ7	B0030CMJEK	5.0	http://ecx.images-amazon.com/images/I/51gn4USN...	[[Boo Literat & Fictio Erotica
A2YJ8VP1SSHJ7	B0030H269S	5.0	http://ecx.images-amazon.com/images/I/51DTPmD5...	[[Boo Gay Lesbi Literat & Fict ...
A2YJ8VP1SSHJ7	B003370JHG	5.0	http://ecx.images-amazon.com/images/I/51l3GNZX...	[[Boo Literat & Fictio [Books
A2YJ8VP1SSHJ7	B0039NMTFO	5.0	http://ecx.images-amazon	[[Boo Literat

			com/images/I/51M39PxE ...	Literat & Fictio [Books
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A2YJ8VP1SSHJ7	B003RRYC8Y	5.0	http://ecx.images-amazon.	[[Boo Literat

In [154]:
```
# See categories of those books
UserCategory = UserRate10[['categories']]
UserCategory[0]
UserCategory[1]
UserCategory[4]
# It seems that this user's interests are concentrated on the "romance story/fiction story". When we choose other users
# we can also see that large amount of users' interests are concentrated in one or two areas. That's why we can recommend
# books based on their previous reviews.
```

Out[154]:
```
{'categories': [['Books', 'Gay & Lesbian', 'Literature & Fiction', '
Erotica'],
  ['Books',
   'Literature & Fiction',
   'Anthologies & Literary Collections',
   'General'],
  ['Books', 'Literature & Fiction', 'Erotica'],
  ['Books', 'Romance', 'Contemporary'],
  ['Books', 'Romance', 'Lesbian Romance'],
  ['Kindle Store',
   'Kindle eBooks',
   'Literature & Fiction',
   'Anthologies & Literature Collections'],
  ['Kindle Store',
   'Kindle eBooks',
   'Literature & Fiction',
   'Contemporary Fiction',
   'Romance'],
  ['Kindle Store',
   'Kindle eBooks',
   'Literature & Fiction',
   'Erotica',
   'LGBT',
   'Lesbian'],
  ['Kindle Store',
   'Kindle eBooks',
   'Literature & Fiction',
   'Genre Fiction',
   'Gay & Lesbian',
   'Lesbian'],
  ['Kindle Store', 'Kindle eBooks', 'Romance', 'Lesbian Romance']]}
```

In [155]:
```
# We can also show the cover of those books to see them more directly.
def showProductImages(url_sarray):
    image_sarray = url_sarray.apply(lambda x: gl.Image(x))
    gl.canvas.set_target('ipynb')
    image_sarray.show()
showProductImages(UserRate10['imUrl'])
```

```
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04,203,200_PIsitb-sticker-v3-big,TopRight,0,-55_SX278_SY278_PIkin4,B
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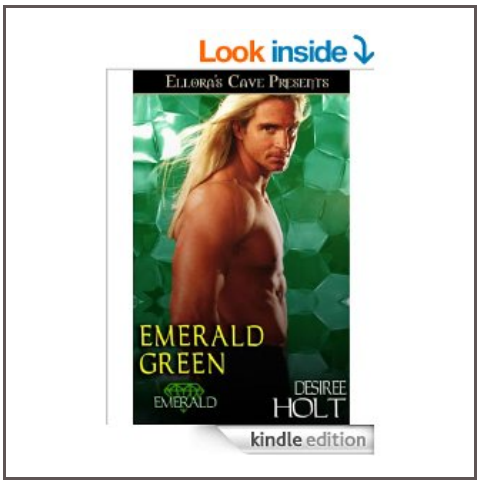
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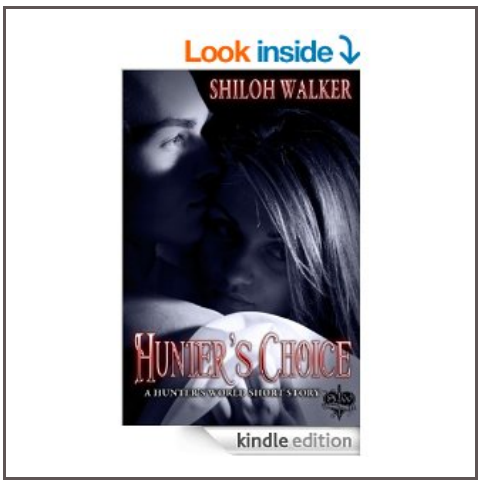

Step 3: Find the books we recommond to him

In [131]:
```
# Load the item and user matrix
ItemMatrix = gl.SFrame.read_csv('/Users/yijiapan/Desktop/Spr2017-proj5
-grp9/data/part-00011', delimiter=',', header=False)
UserMatrix = gl.SFrame.read_csv('/Users/yijiapan/Desktop/Spr2017-proj5
-grp9/data/part-00011', delimiter=',', header=False)
ItemMap = gl.SFrame.read_csv('/Users/yijiapan/Desktop/Spr2017-proj5-gr
p9/data/item_map.csv', delimiter=',', header=True)
UserMap = gl.SFrame.read_csv('/Users/yijiapan/Desktop/Spr2017-proj5-gr
p9/data/user_map.csv', delimiter=',', header=True)
```

```
Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/part-00011

Parsing completed. Parsed 100 lines in 0.624574 secs.
```

```
------------------------------------------------------
Inferred types from first 100 line(s) of file as
column_type_hints=[float,float,float,float,float,float,float,float,f
loat,float,float,float,float,float,float,float,float,float,float,flo
at,float,float,float,float,float,float,float,float,float,float,float
,float,float,float,float,float,float,float,float,float,float,float,f
loat,float,float,float,float,float,float,float,float]
If parsing fails due to incorrect types, you can correct
the inferred type list above and pass it to read_csv in
the column_type_hints argument
------------------------------------------------------

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/part-00011

Parsing completed. Parsed 35840 lines in 0.797602 secs.

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/part-00011

Parsing completed. Parsed 100 lines in 0.529489 secs.

------------------------------------------------------
Inferred types from first 100 line(s) of file as
column_type_hints=[float,float,float,float,float,float,float,float,f
loat,float,float,float,float,float,float,float,float,float,float,flo
at,float,float,float,float,float,float,float,float,float,float,float
,float,float,float,float,float,float,float,float,float,float,float,f
loat,float,float,float,float,float,float,float,float]
If parsing fails due to incorrect types, you can correct
the inferred type list above and pass it to read_csv in
the column_type_hints argument
------------------------------------------------------

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/part-00011

Parsing completed. Parsed 35840 lines in 0.794367 secs.

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/item_map.csv

Parsing completed. Parsed 100 lines in 0.363553 secs.

------------------------------------------------------
Inferred types from first 100 line(s) of file as
column_type_hints=[str,int]
If parsing fails due to incorrect types, you can correct
the inferred type list above and pass it to read_csv in
the column_type_hints argument
------------------------------------------------------
```

```
Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/item_map.csv

Parsing completed. Parsed 430520 lines in 0.324587 secs.

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/user_map.csv

Parsing completed. Parsed 100 lines in 1.73675 secs.

------------------------------------------------------
Inferred types from first 100 line(s) of file as
column_type_hints=[str,int]
If parsing fails due to incorrect types, you can correct
the inferred type list above and pass it to read_csv in
the column_type_hints argument
------------------------------------------------------

Finished parsing file /Users/yijiapan/Desktop/Spr2017-proj5-grp9/dat
a/user_map.csv

Parsing completed. Parsed 1406710 lines in 1.19459 secs.
```

In [158]:
```
# Find u
urow = UserMap.filter_by('A2YJ8VP1SSHJ7','reviewerID')
unum = urow[["user"]]
```

In [159]:
```
unum
```

Out[159]:

user
400529

[1 rows x 1 columns]

In [161]:
```
u = UserMatrix.filter_by(400529.0,'X1')
```

In [105]:
```
# Find the predict rates of this user
ItemMatrix2 = ItemMatrix.to_dataframe().values
UserMatrix2 = u.to_dataframe().values
```

In [109]:
```
PredsRateMatrix = UserMatrix2.dot(ItemMatrix2.T)
```

In [231]:
```
First10_book = np.argsort(PredsRateMatrix.reshape((35840,)))[::-1][:10
]
```

In [228]:
```
#J_pred_bad = np.argsort(PredsRateMatrix.reshape((35840,)))[:10]
```

In [163]:
```
First10_bookmap = ItemMap.filter_by(First10_book,"item")
First10_bookasin = First10_bookmap[['asin']]
```

In [236]:
```
#First10_bookmap_bad = ItemMap.filter_by(J_pred_bad,"item")
#First10_bookasin_bad = First10_bookmap_bad[['asin']]
```

In [166]:
```
PredsRate10 = to_use.join(First10_bookasin,how="inner",on="asin")
```

In [237]:
```
#PredsRate10_bad = to_use.join(First10_bookasin_bad,how="inner",on="as
in")
```

In [245]:
```
# Find the category of those recommend books
PredsRate10.unique()[['categories']][5]
```

Out[245]:
```
{'categories': [['Books', 'Literature & Fiction', 'United States'],
  ['Books', 'Romance', 'Contemporary'],
  ['Kindle Store', 'Kindle eBooks', 'Romance']]}
```

In [238]:
```
# Show the cover of those books to see them more directly.
def showProductImages(url_sarray):
    image_sarray = url_sarray.apply(lambda x: gl.Image(x))
    gl.canvas.set_target('ipynb')
    image_sarray.show()
showProductImages(PredsRate10['imUrl'].unique())
```

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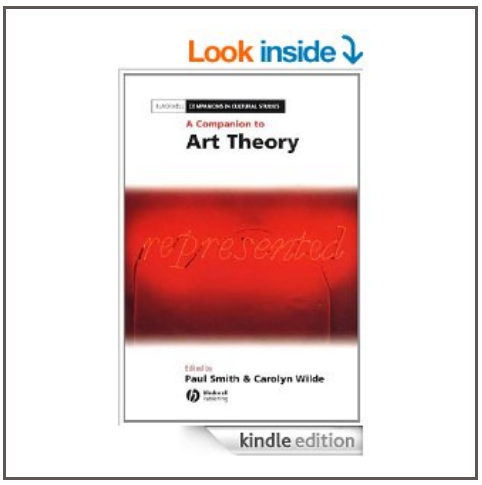
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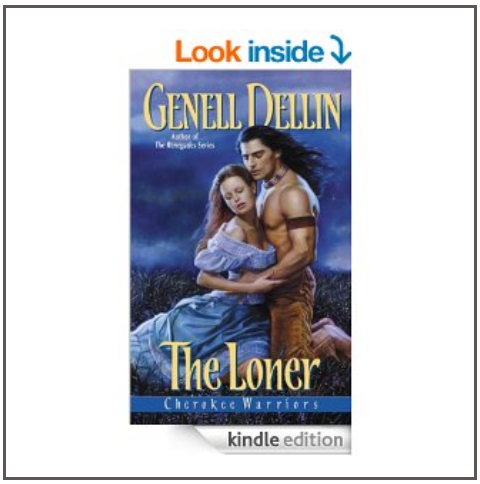
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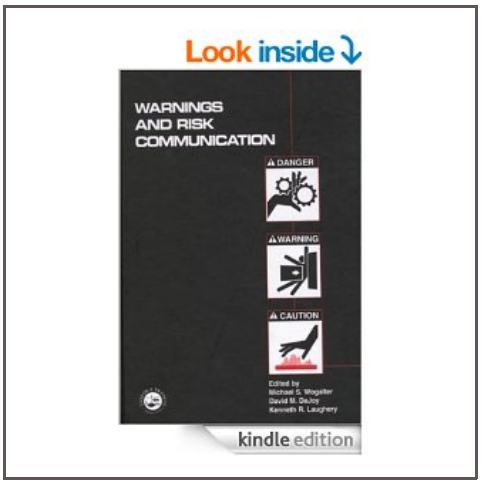
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CAUTION
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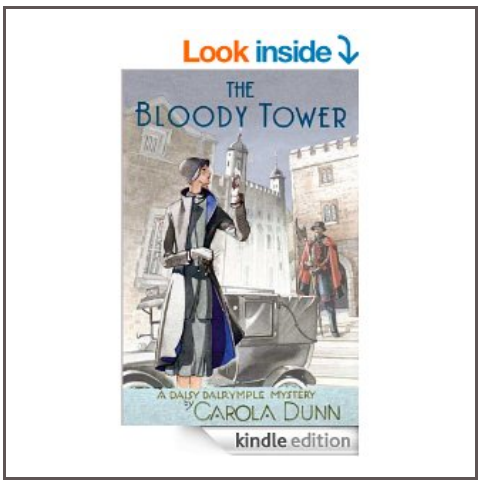
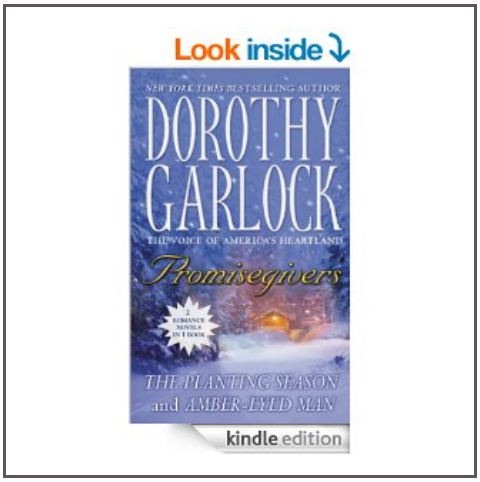
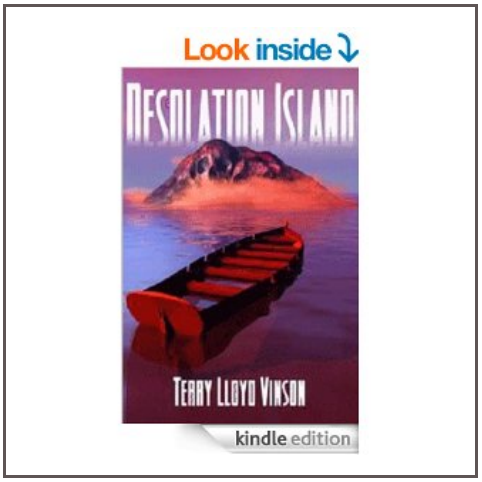






Plot for two dimensions

In [279]:
```
# UserMatrix2
UserMatrix2
Topic2 = np.argsort(UserMatrix2.reshape((51,)))[::-1][:3]
```

In [281]:
```
Topic2
```

Out[281]: array([0, 11, 40])

In [199]:
```
UserRate10.__class__
```

Out[199]: graphlab.data_structures.sframe.SFrame

In [206]:
```
J_real = ItemMap.join(UserRate10,how="inner",on="asin")['item']
```

In [223]:
```
J_real = np.array([17206,32587,62927,69306])
```

In [282]:
```
to_plot = np.hstack((np.vstack((ItemMatrix2[:5,:],ItemMatrix2[-5:,:]))
,np.array([1,1,1,1,1,-1,-1,-1,-1,-1]).reshape((10,1))))
```

In [283]:
```
u = np.hstack((UserMatrix2,np.array((0)).reshape((1,1))))
```

In [285]:
```
to_plot = np.vstack((u,to_plot))
```

In [286]:
```
to_plot = to_plot[:,np.array([11,40,51])]
```

In [224]:
```
ItemMatrix2[J_real,:]
```

```
---------------------------------------------------------------------
-------
IndexError                                Traceback (most recent cal
l last)
<ipython-input-224-b359698da5d4> in <module>()
----> 1 ItemMatrix2[J_real,:]

IndexError: index 62927 is out of bounds for axis 0 with size 35840
```

In [ ]:
```
#vTwo2 = PredsRate10trans.filter_by(Topic2,"item")
```

In [25]:
```
#from mpl_toolkits.axes_grid.axislines import SubplotZero

#if 1:
    #fig = plt.figure(1)
    #ax = SubplotZero(fig, 111)
    #fig.add_subplot(ax)

    #for direction in ["xzero", "yzero"]:
        #ax.axis[direction].set_axisline_style("-|>")
        #ax.axis[direction].set_visible(True)

    #for direction in ["left", "right", "bottom", "top"]:
        #ax.axis[direction].set_visible(False)

    #x = np.linspace(-1.2, 1.2, 2)
    #ax.plot(x,x,'w')

    # The axis texts
    #ax.text(1.5,-0.2,'realistic',fontsize=15)
    #ax.text(-2,-0.2,'unrealistic',fontsize=15)
    #ax.text(-0.2,1.7,'serious',fontsize=15)
    #ax.text(-0.2,-1.7,'funny',fontsize=15)
    #ax.text(-1.23,2.3,'Individual Recommendation', fontsize = 21, fon
tweight = 'bold')
    #ax.plot(vTwo1[0],vTow1[1],'ro')
    #ax.plot(vTwo2[0],vTow2[1],'bs')

    # The vector of books
    #ax.text(v[0][0],v[0][1],'book1',fontsize=12,bbox={'facecolor':'ye
llow','alpha':0.5,'pad':4})
    #ax.text(v[1][0],v[1][1],'book2',fontsize=12,bbox={'facecolor':'ye
llow','alpha':0.5,'pad':4})

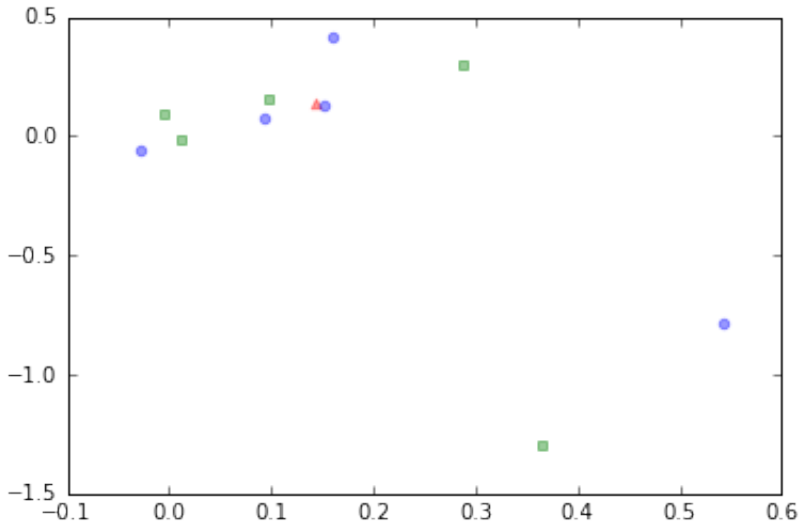
    # The vector of users
    #ax.text(u[0],u[1],'user1',fontsize=12,bbox={'facecolor':'green','
alpha':0.2,'pad':4})
    #ax.text(u[1][0],u[1][1],'user2',fontsize=12,bbox={'facecolor':'gr
een','alpha':0.2,'pad':4})

    #plt.show()
```

```
  File "<ipython-input-25-384576553c35>", line 2
    u1=u.sort(u)
              ^
SyntaxError: invalid syntax
```

In [292]:
```
%matplotlib inline
fig, ax = plt.subplots()
ax.scatter(to_plot[0,0], to_plot[0,1], color='r', marker='^', alpha=.4
)
ax.scatter(to_plot[1:6,0], to_plot[1:6,1], color='b', alpha=.4)
ax.scatter(to_plot[6:,0], to_plot[6:,1], color='g', marker='s', alpha=
.4)
```

Out[292]: <matplotlib.collections.PathCollection at 0x1275c38d0>



In [ ]: