In [1]:

```python

import os
import time
from PIL import Image
import pandas as pd

import pyspark
import os as os
from pyspark.sql import SparkSession

from sklearn.manifold import TSNE
import time
import seaborn as sns

#customised functions
def set_up_working_directory(str_dir_path):
    os.chdir(str_dir_path)
    print("Working direcotry changed to " + os.getcwd())

def data_basic_details(image_folder_path):

    df = pd.DataFrame(columns = ['FileName', 'width', 'height'])
    print(df)
    start_time = time.time()
    #iterate through every file
    for r, d, f in os.walk(image_folder_path):
        for file in f:
            if file.endswith(".jpg"):
                width, height = Image.open(os.path.join(r, file)).size
                df = df.append({'FileName' :  file , 'width' :width  , 'height' :
    #total time taken
    print('Time Taken:', time.strftime("%H:%M:%S",time.gmtime(time.time() - start

def spark_spin_up_session(session_name):
    spark = SparkSession.builder.appName(session_name).getOrCreate()
    return spark

def spark_read_csv(sparkobj, file_path):
    spark = sparkobj
    readobj= spark.read.option('header','true').csv(file_path)
    return readobj

def spark_read_images_from_path(sparkobj, file_path):
    spark = sparkobj
    image_df = spark.read.format("image").load(file_path, inferschema=True)
    return image_df

def spark_return_image_attribute(image_obj):
    image_obj.select("image.origin", "image.width", "image.height","image.nChanne

```

In [2]:
```
spark= spark_spin_up_session("session1")
spark
```

Out[2]:

SparkSession - in-memory

SparkContext

Spark UI (http://Narayan-PC:4040)

Version

`v3.2.0`

Master

`local[*]`

AppName

`session1`

In [3]:
```
image_df= spark_read_images_from_path(spark, "e:/dev/Kaggle/fashion/sample/1164.j
spark_return_image_attribute(image_df)
```

```
+--------------------------------------------+-----+------+---------+----+
|origin                                      |width|height|nChannels|mode|
+--------------------------------------------+-----+------+---------+----+
|file:///e:/dev/Kaggle/fashion/sample/1164.jpg|60   |80    |3        |16  |
+--------------------------------------------+-----+------+---------+----+
```

In [4]:
```
image_df = spark_read_images_from_path(spark, "e:/dev/Kaggle/fashion/sample/")
spark_return_image_attribute(image_df)
```

```
+--------------------------------------------+-----+------+---------+----+
|origin                                      |width|height|nChannels|mode|
+--------------------------------------------+-----+------+---------+----+
|file:///e:/dev/Kaggle/fashion/sample/1611.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1619.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1755.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1752.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1533.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1689.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1982.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1570.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1531.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1617.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1981.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1613.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1164.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1603.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1625.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1798.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1536.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1528.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1539.jpg|60   |80    |3        |16  |
|file:///e:/dev/Kaggle/fashion/sample/1636.jpg|60   |80    |3        |16  |
+--------------------------------------------+-----+------+---------+----+
only showing top 20 rows
```

In [5]:

```
image_df.printSchema()
```

```
root
 |-- image: struct (nullable = true)
 |    |-- origin: string (nullable = true)
 |    |-- height: integer (nullable = true)
 |    |-- width: integer (nullable = true)
 |    |-- nChannels: integer (nullable = true)
 |    |-- mode: integer (nullable = true)
 |    |-- data: binary (nullable = true)
```

In [6]:

```
display(image_df)
```

```
DataFrame[image: struct<origin:string,height:int,width:int,nChannels:int,mode:i
nt,data:binary>]
```

In [7]:

```
from mpl_toolkits.mplot3d import Axes3D
from sklearn.preprocessing import StandardScaler
import matplotlib.pyplot as plt # plotting
import matplotlib.image as mpimg
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import os # accessing directory structure
```

In [8]:

```
DATASET_PATH = "e:/dev/Kaggle/fashion/"
print(os.listdir(DATASET_PATH))
```

```
['df_embs.txt', 'embed.txt', 'images', 'myntradataset', 'my_model.h5', 'projec
t', 'sample', 'styles.csv']
```

In [9]:
```
df = pd.read_csv(DATASET_PATH + "styles.csv", nrows=5000, error_bad_lines=False)
df['image'] = df.apply(lambda row: str(row['id']) + ".jpg", axis=1)
df = df.reset_index(drop=True)
df.head(10)
```

Out[9]:

	id	gender	masterCategory	subCategory	articleType	baseColour	season	year	usage
0	15970	Men	Apparel	Topwear	Shirts	Navy Blue	Fall	2011	Casual
1	39386	Men	Apparel	Bottomwear	Jeans	Blue	Summer	2012	Casual
2	59263	Women	Accessories	Watches	Watches	Silver	Winter	2016	Casual
3	21379	Men	Apparel	Bottomwear	Track Pants	Black	Fall	2011	Casual
4	53759	Men	Apparel	Topwear	Tshirts	Grey	Summer	2012	Casual
5	1855	Men	Apparel	Topwear	Tshirts	Grey	Summer	2011	Casual
6	30805	Men	Apparel	Topwear	Shirts	Green	Summer	2012	Ethnic
7	26960	Women	Apparel	Topwear	Shirts	Purple	Summer	2012	Casual
8	29114	Men	Accessories	Socks	Socks	Navy Blue	Summer	2012	Casual
9	30039	Men	Accessories	Watches	Watches	Black	Winter	2016	Casual

In [10]:

```
import cv2
def plot_figures(figures, nrows = 1, ncols=1,figsize=(8, 8)):
    """Plot a dictionary of figures.

    Parameters
    ----------
    figures : <title, figure> dictionary
    ncols : number of columns of subplots wanted in the display
    nrows : number of rows of subplots wanted in the figure
    """

    fig, axeslist = plt.subplots(ncols=ncols, nrows=nrows,figsize=figsize)
    for ind,title in enumerate(figures):
        axeslist.ravel()[ind].imshow(cv2.cvtColor(figures[title], cv2.COLOR_BGR2R
        axeslist.ravel()[ind].set_title(title)
        axeslist.ravel()[ind].set_axis_off()
    plt.tight_layout() # optional

def img_path(img):
    return DATASET_PATH+"images/"+img

def load_image(img):
    return cv2.imread(img_path(img))
```

```
In [33]: import matplotlib.pyplot as plt
         import numpy as np

         # generation of a dictionary of (title, images)
         figures = {'image '+str(i): load_image(row.image) for i, row in df.sample(6).iter
         # plot of the images in a figure, with 2 rows and 3 columns
         plot_figures(figures, 2, 3)
```

image 2746 image 884 image 2495

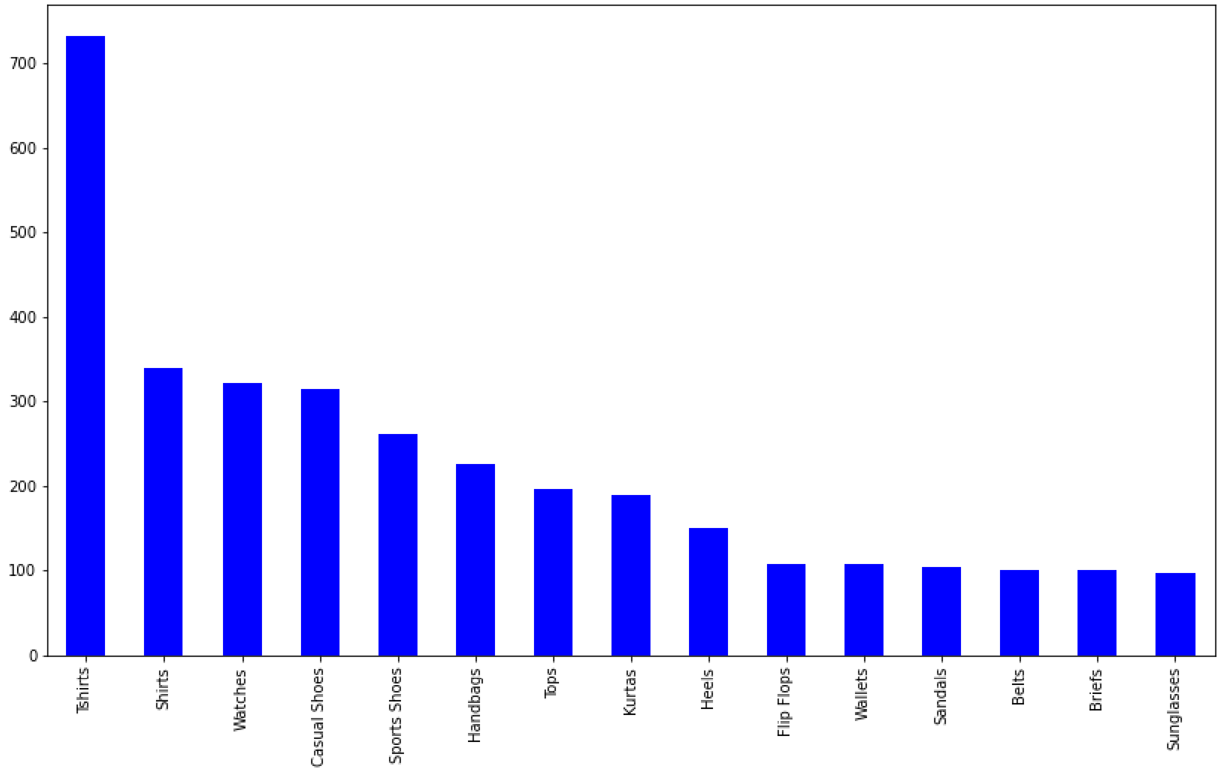
image 1829 image 3923 image 4319

In [46]:

```
plt.figure(figsize=(14,8))
df.articleType.value_counts().nlargest(15).plot(kind='bar', color="blue")
```

Out[46]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x596d1d60>
```



In [13]:

```
import tensorflow as tf
from tensorflow.keras import Model
from tensorflow.keras.applications.resnet50 import ResNet50
from tensorflow.keras.preprocessing import image
from tensorflow.keras.applications.resnet50 import preprocess_input, decode_predi
from tensorflow.keras.layers import GlobalMaxPooling2D
tf.__version__
```

Out[13]:

```
'2.4.0'
```

In [14]:
```
# Input Shape
img_width, img_height, _ = load_image(df.iloc[0].image).shape

# Pre-Trained Model
base_model = ResNet50(weights='imagenet',
                      include_top=False,
                      input_shape = (img_width, img_height, 3))
base_model.trainable = False

# Add Layer Embedding
model = tf.keras.Sequential([
    base_model,
    GlobalMaxPooling2D()
])

model.summary()
```

```
Model: "sequential"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
resnet50 (Functional)        (None, 3, 2, 2048)        23587712
_________________________________________________________________
global_max_pooling2d (Global (None, 2048)              0
=================================================================
Total params: 23,587,712
Trainable params: 0
Non-trainable params: 23,587,712
_________________________________________________________________
```

In [15]:
```
def get_embedding(model, img_name):
    # Reshape
    img = image.load_img(img_path(img_name), target_size=(img_width, img_height)
    # img to Array
    x   = image.img_to_array(img)
    # Expand Dim (1, w, h)
    x   = np.expand_dims(x, axis=0)
    # Pre process Input
    x   = preprocess_input(x)
    return model.predict(x).reshape(-1)
```

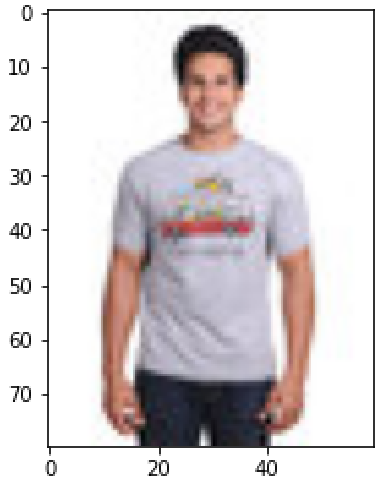
In [ ]:
```
def get_embedding(DATASET_PATH, model, img_name, img_width, img_height):
    # Reshape
    img = image.load_img(img_path(DATASET_PATH,img_name), target_size=(img_width,
    # img to Array
    x   = image.img_to_array(img)
    # Expand Dim (1, w, h)
    x   = np.expand_dims(x, axis=0)
    # Pre process Input
    x   = preprocess_input(x)
    return model.predict(x).reshape(-1)
```

In [16]:
```
emb = get_embedding(DATASET_PATH, model, df.iloc[1].image)
emb.shape
```

Out[16]:
```
(2048,)
```

In [29]:
```
plt.imshow(cv2.cvtColor(load_image(df.iloc[1].image), cv2.COLOR_BGR2RGB))
print(emb)
```

```
[1.8793364  1.6008836  0.09203261 ... 3.2688963  2.2717304  5.4333878 ]
```



In [18]:
```
%%time
import swifter

# Parallel apply
map_embeddings = df['image'].swifter.apply(lambda img: get_embedding(model, img))
df_embs        = map_embeddings.apply(pd.Series)

print(df_embs.shape)
df_embs.head()
```

```
Pandas Apply: 100%                                    5000/5000 [07:16<00:00, 11.45it/s]


(5000, 2048)
Wall time: 7min 56s
```

Out[18]:

	0	1	2	3	4	5	6	7	8	9
0	0.000000	3.539255	0.000000	1.094599	0.000000	0.000000	4.458534	2.446015	2.678130	0.0
1	1.879336	1.600884	0.092033	4.433075	0.000000	0.000000	3.030769	8.530592	5.498659	0.0
2	0.000000	0.311199	0.000000	3.808681	0.437031	7.112498	0.000000	0.000000	0.000000	0.0
3	0.588018	9.894616	0.000000	6.295309	1.783727	1.913123	0.000000	13.309944	7.805779	0.0
4	0.000000	1.882976	0.000000	5.122097	0.000000	0.000000	2.950291	6.626864	1.606633	0.0

5 rows × 2048 columns

In [19]:
```python
# Load distance metrics
from sklearn.metrics.pairwise import pairwise_distances

#find distance metrics
cosine_sim = 1-pairwise_distances(df_embs, metric='cosine')
cosine_sim[:4, :4]
```

Out[19]:
```
array([[0.99999934, 0.5813052 , 0.23863798, 0.49294078],
       [0.5813052 , 0.99999905, 0.23951322, 0.72273475],
       [0.23863798, 0.23951322, 0.9999998 , 0.22011638],
       [0.49294078, 0.72273475, 0.22011638, 1.        ]], dtype=float32)
```

In [52]:
```python
indices = pd.Series(range(len(df)), index=df.index)
indices

# Function that get movie recommendations based on the cosine similarity score of
def get_recommender(idx, df, max_rec = 5):
    sim_idx    = indices[idx]
    sim_scores = list(enumerate(cosine_sim[sim_idx]))
    sim_scores = sorted(sim_scores, key=lambda x: x[1], reverse=True)
    sim_scores = sim_scores[1:max_rec+1]
    idx_rec    = [i[0] for i in sim_scores]
    idx_sim    = [i[1] for i in sim_scores]

    return indices.iloc[idx_rec].index, idx_sim

get_recommender(2993, df, max_rec = 3)
```

Out[52]:
```
(Int64Index([259, 4305, 0], dtype='int64'), [0.9040973, 0.8925514, 0.89175576])
```

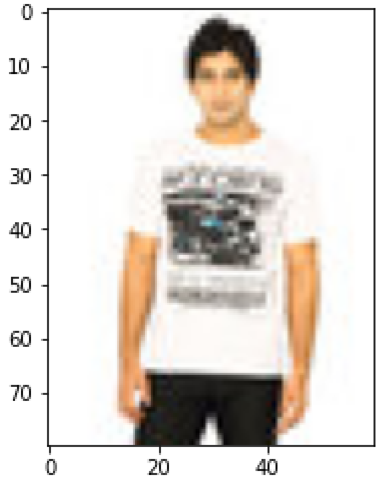
In [53]:

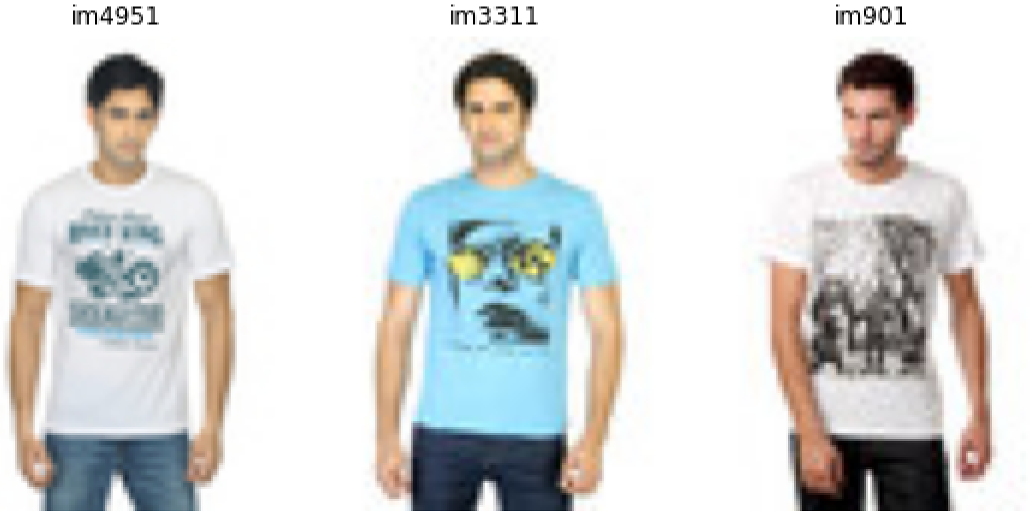
```
# Idx Item to Recommender
idx_ref = 4100

# Recommendations
idx_rec, idx_sim = get_recommender(idx_ref, df, max_rec = 3)

# Plot
#===================
plt.imshow(cv2.cvtColor(load_image(df.iloc[idx_ref].image), cv2.COLOR_BGR2RGB))

# generation of a dictionary of (title, images)
figures = {'im'+str(i): load_image(row.image) for i, row in df.loc[idx_rec].iterr
# plot of the images in a figure, with 2 rows and 3 columns
plot_figures(figures, 1, 3)
```



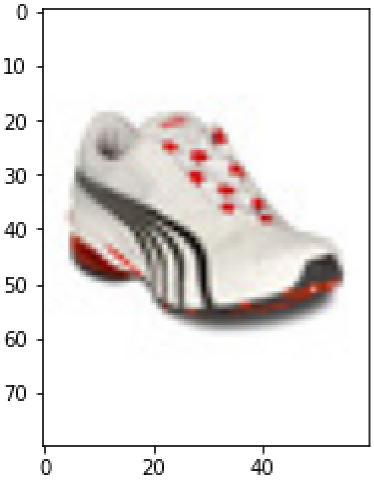


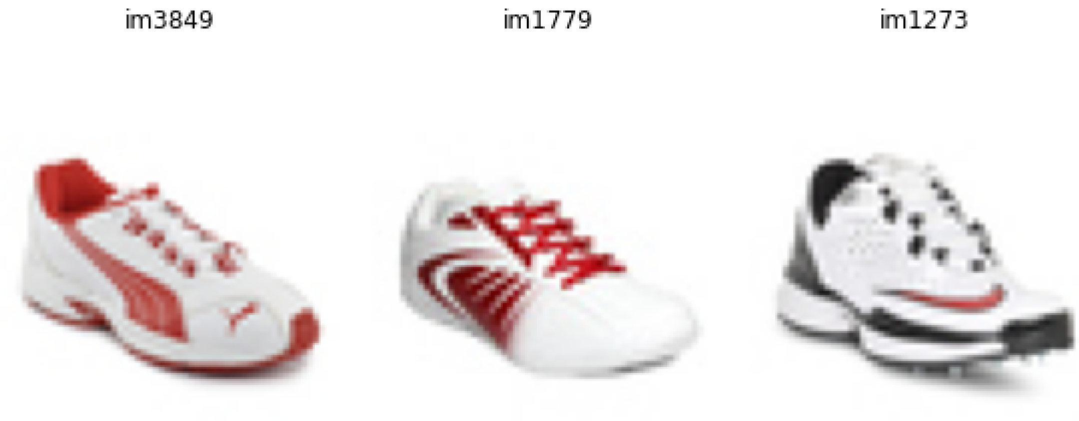
In [54]:
```
idx_ref = 987

# Recommendations
idx_rec, idx_sim = get_recommender(idx_ref, df, max_rec = 3)

# Plot
#====================
plt.imshow(cv2.cvtColor(load_image(df.iloc[idx_ref].image), cv2.COLOR_BGR2RGB))

# generation of a dictionary of (title, images)
figures = {'im'+str(i): load_image(row.image) for i, row in df.loc[idx_rec].iterr
# plot of the images in a figure, with 2 rows and 3 columns
plot_figures(figures, 1, 3)
```





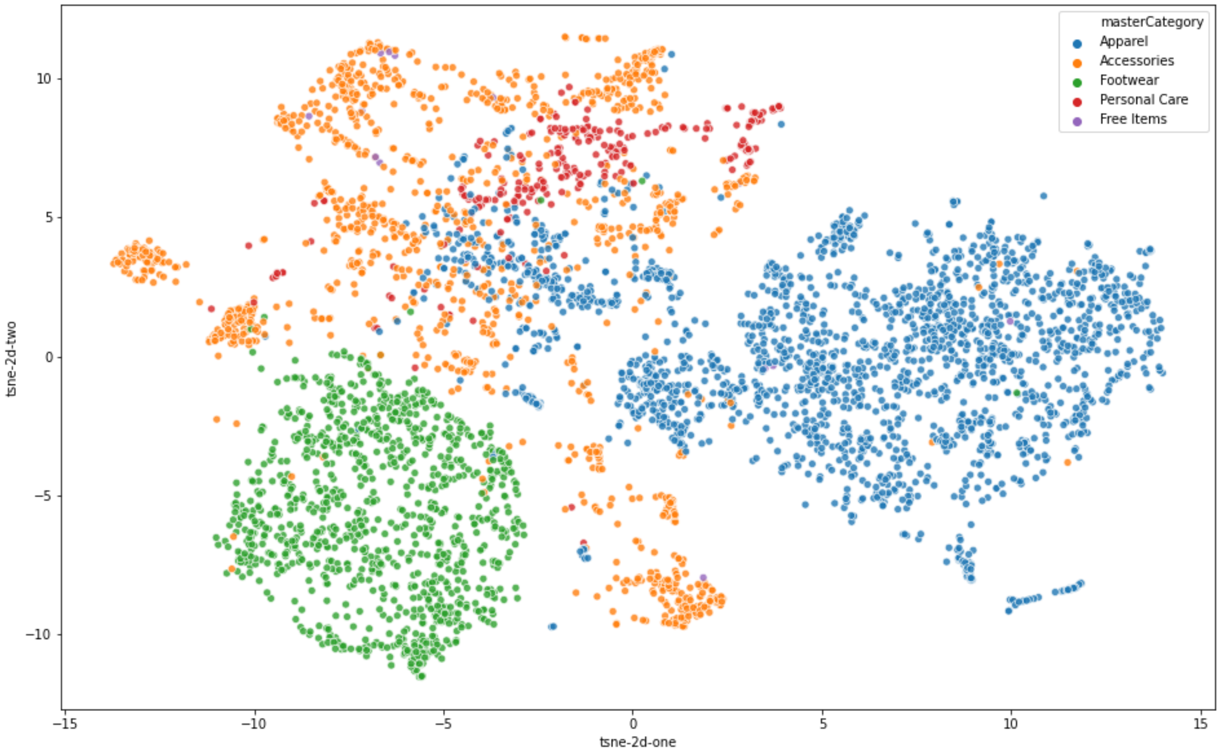
```
In [25]: time_start = time.time()
         tsne = TSNE(n_components=2, verbose=0, perplexity=40, n_iter=300)
         tsne_results = tsne.fit_transform(df_embs)
         print('t-SNE done! Time elapsed: {} seconds'.format(time.time()-time_start))

         t-SNE done! Time elapsed: 119.30700016021729 seconds
```

```
In [26]: df['tsne-2d-one'] = tsne_results[:,0]
         df['tsne-2d-two'] = tsne_results[:,1]
```

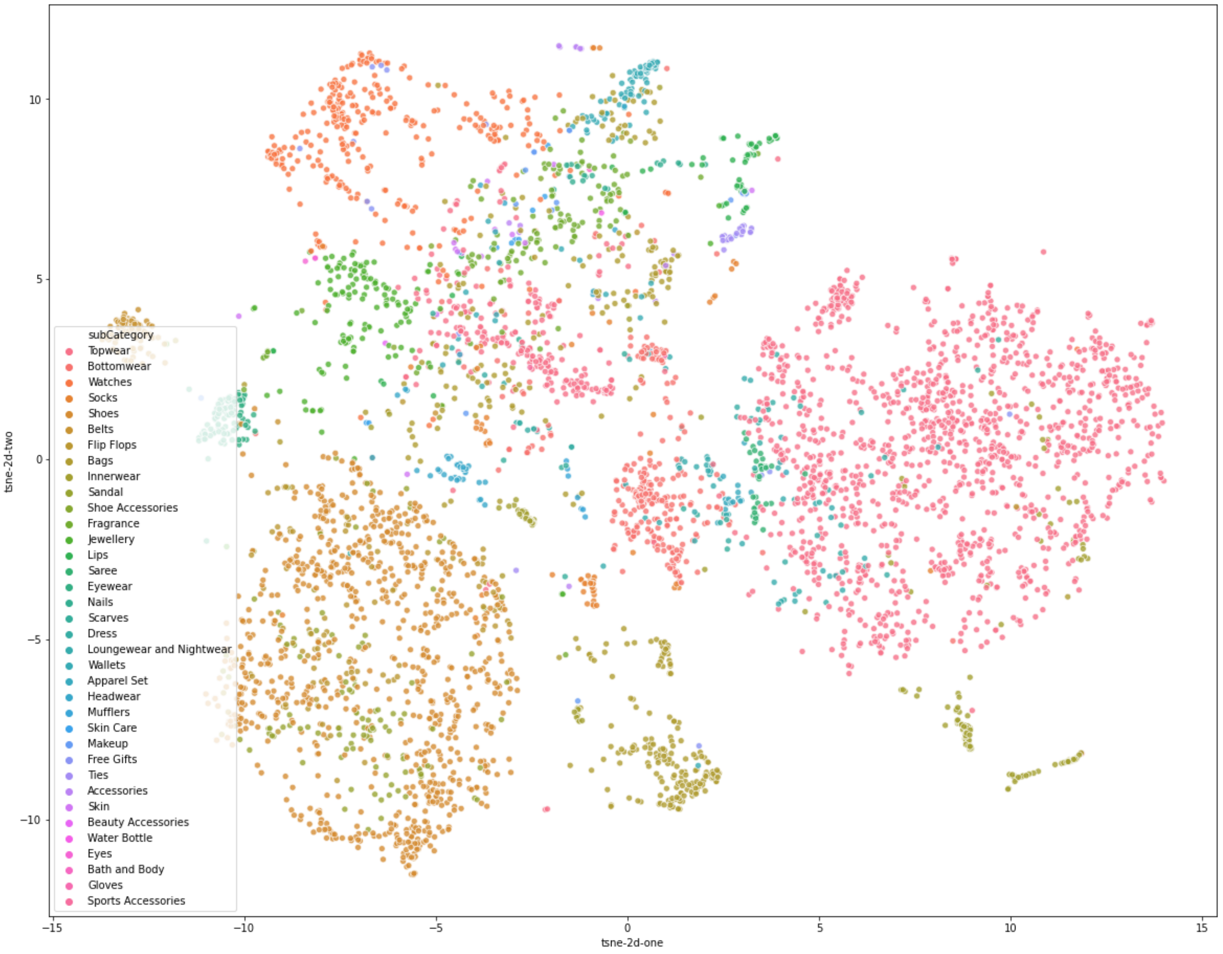
```
In [27]: plt.figure(figsize=(16,10))
         sns.scatterplot(x="tsne-2d-one", y="tsne-2d-two",
                         hue="masterCategory",
                         data=df,
                         legend="full",
                         alpha=0.8)

Out[27]: <matplotlib.axes._subplots.AxesSubplot at 0x484babe0>
```



```
In [28]: plt.figure(figsize=(20,16))
         sns.scatterplot(x="tsne-2d-one", y="tsne-2d-two",
                         hue="subCategory",
                         data=df,
                         legend="full",
                         alpha=0.8)
```

```
Out[28]: <matplotlib.axes._subplots.AxesSubplot at 0x5d1972e0>
```


tsne-2d-two
tsne-2d-one
subCategory
Topwear
Bottomwear
Watches
Socks
Shoes
Belts
Flip Flops
Bags
Innerwear
Sandal
Shoe Accessories
Fragrance
Jewellery
Lips
Saree
Eyewear
Nails
Scarves
Dress
Loungewear and Nightwear
Wallets
Apparel Set
Headwear
Mufflers
Skin Care
Makeup
Free Gifts
Ties
Accessories
Skin
Beauty Accessories
Water Bottle
Eyes
Bath and Body
Gloves
Sports Accessories