AMAZON APPAREL RECOMMENDATIONS

Overview of the Data

Import the required libraries

```
from PIL import Image
import requests
from io import BytesIO
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
import warnings
from bs4 import BeautifulSoup
from nltk.corpus import stopwords
from nltk.tokenize import word_tokenize
import nltk
import math
import time
import re
import os
import seaborn as sns
from collections import Counter
from sklearn.feature_extraction.text import CountVectorizer
from sklearn.feature_extraction.text import TfidfVectorizer
from sklearn.metrics.pairwise import cosine_similarity
from sklearn.metrics import pairwise_distances
from matplotlib import gridspec
from scipy.sparse import hstack
import plotly
import plotly.figure_factory as ff
from plotly.graph_objs import Scatter, Layout

plotly.offline.init_notebook_mode(connected=True)
warnings.filterwarnings("ignore")
```

Connect to Google Drive

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mount("/content/drive", for
```

Load the Data

```
data = pd.read_json('/content/drive/My Drive/Colab Notebooks/Appareal Recommendation/tops_fashion.json')
```

```
print ('Number of data points : ', data.shape[0],'Number of features/variables:', data.shape[1])
```

```
Number of data points :  183138 Number of features/variables: 19
```

```
data.columns
```

```
Index(['sku', 'asin', 'product_type_name', 'formatted_price', 'author',
       'color', 'brand', 'publisher', 'availability', 'reviews',
       'large_image_url', 'availability_type', 'small_image_url',
       'editorial_review', 'title', 'model', 'medium_image_url',
       'manufacturer', 'editorial_reivew'],
      dtype='object')
```

Load only required columns

```
data = data[['asin', 'brand', 'color', 'medium_image_url', 'product_type_name', 'title', 'formatted_price']]
```

```
print ('Number of data points : ', data.shape[0], 'Number of features:', data.shape[1])
data.head()
```

```
Number of data points :  183138 Number of features: 7
```

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
0	B016I2TS4W	FNC7C	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	Minions Como Superheroes Ironman Long Sleeve R...	None
1	B01N49AI08	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Izo Tunic	None
2	B01JDPCOHO	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Won Top	None
				https://images-na.ssl-		Focal18 Sailor	

```
print(data['product_type_name'].describe())
```

```
count     183138
unique        72
top        SHIRT
freq      167794
Name: product_type_name, dtype: object
```

```
print(data['product_type_name'].unique())
```

```
['SHIRT' 'SWEATER' 'APPAREL' 'OUTDOOR_RECREATION_PRODUCT'
 'BOOKS_1973_AND_LATER' 'PANTS' 'HAT' 'SPORTING_GOODS' 'DRESS' 'UNDERWEAR'
 'SKIRT' 'OUTERWEAR' 'BRA' 'ACCESSORY' 'ART_SUPPLIES' 'SLEEPWEAR'
 'ORCA_SHIRT' 'HANDBAG' 'PET_SUPPLIES' 'SHOES' 'KITCHEN' 'ADULT_COSTUME'
 'HOME_BED_AND_BATH' 'MISC_OTHER' 'BLAZER' 'HEALTH_PERSONAL_CARE'
 'TOYS_AND_GAMES' 'SWIMWEAR' 'CONSUMER_ELECTRONICS' 'SHORTS' 'HOME'
 'AUTO_PART' 'OFFICE_PRODUCTS' 'ETHNIC_WEAR' 'BEAUTY'
 'INSTRUMENT_PARTS_AND_ACCESSORIES' 'POWERSPORTS_PROTECTIVE_GEAR' 'SHIRTS'
 'ABIS_APPAREL' 'AUTO_ACCESSORY' 'NONAPPARELMISC' 'TOOLS' 'BABY_PRODUCT'
 'SOCKSHOSIERY' 'POWERSPORTS_RIDING_SHIRT' 'EYEWEAR' 'SUIT'
 'OUTDOOR_LIVING' 'POWERSPORTS_RIDING_JACKET' 'HARDWARE' 'SAFETY_SUPPLY'
 'ABIS_DVD' 'VIDEO_DVD' 'GOLF_CLUB' 'MUSIC_POPULAR_VINYL'
 'HOME_FURNITURE_AND_DECOR' 'TABLET_COMPUTER' 'GUILD_ACCESSORIES'
 'ABIS_SPORTS' 'ART_AND_CRAFT_SUPPLY' 'BAG' 'MECHANICAL_COMPONENTS'
 'SOUND_AND_RECORDING_EQUIPMENT' 'COMPUTER_COMPONENT' 'JEWELRY'
 'BUILDING_MATERIAL' 'LUGGAGE' 'BABY_COSTUME' 'POWERSPORTS_VEHICLE_PART'
 'PROFESSIONAL_HEALTHCARE' 'SEEDS_AND_PLANTS' 'WIRELESS_ACCESSORY']
```

```
product_type_count = Counter(list(data['product_type_name']))
product_type_count.most_common(10)
```

```
[('SHIRT', 167794),
 ('APPAREL', 3549),
 ('BOOKS_1973_AND_LATER', 3336),
 ('DRESS', 1584),
 ('SPORTING_GOODS', 1281),
 ('SWEATER', 837),
 ('OUTERWEAR', 796),
 ('OUTDOOR_RECREATION_PRODUCT', 729),
 ('ACCESSORY', 636),
 ('UNDERWEAR', 425)]
```

Find Basic Stats for the Feature : Brand

```
print(data['brand'].describe())
```

```
count     182987
unique     10577
top         Zago
freq         223
Name: brand, dtype: object
```

```
brand_count = Counter(list(data['brand']))
brand_count.most_common(10)
```

```
[('Zago', 223),
 ('XQS', 222),
 ('Yayun', 215),
 ('YUNY', 198),
 ('XiaoTianXin-women clothes', 193),
 ('Generic', 192),
 ('Boohoo', 190),
 ('Alion', 188),
 ('Abetteric', 187),
 ('TheMogan', 187)]
```

Find Basic Stats for the Feature : Color

```
print(data['color'].describe())
```

```
count     64956
unique     7380
top       Black
freq      13207
Name: color, dtype: object
```

```
color_count = Counter(list(data['color']))
color_count.most_common(10)
```

```
[(None, 118182),
 ('Black', 13207),
 ('White', 8616),
 ('Blue', 3570),
 ('Red', 2289),
 ('Pink', 1842),
 ('Grey', 1499),
 ('*', 1388),
```

```
 ('Green', 1258),
 ('Multi', 1203)]
```

Find Basic Stats for the Feature : formatted_price

```
print(data['formatted_price'].describe())
```

```
count      28395
unique      3135
top       $19.99
freq         945
Name: formatted_price, dtype: object
```

```
price_count = Counter(list(data['formatted_price']))
price_count.most_common(10)
```

```
[(None, 154743),
 ('$19.99', 945),
 ('$9.99', 749),
 ('$9.50', 601),
 ('$14.99', 472),
 ('$7.50', 463),
 ('$24.99', 414),
 ('$29.99', 370),
 ('$8.99', 343),
 ('$9.01', 336)]
```

Find Basic Stats for the Feature : title

```
print(data['title'].describe())
```

```
count                                                183138
unique                                               175985
top       Nakoda Cotton Self Print Straight Kurti For Women
freq                                                     77
Name: title, dtype: object
```

```
data.to_pickle('./180k_apparel_data')
```

```
data = data.loc[~data['formatted_price'].isnull()]
print('Number of data points After eliminating price=NULL :', data.shape[0])
```

```
Number of data points After eliminating price=NULL : 28395
```

```
data =data.loc[~data['color'].isnull()]
print('Number of data points After eliminating color=NULL :', data.shape[0])
```

```
Number of data points After eliminating color=NULL : 28385
```

Remove the duplicates

Understand about the Duplicates

```
data = pd.read_pickle('/content/180k_apparel_data')
```

```
# find number of products that have duplicate titles.
print(sum(data.duplicated('title')))
```

```
7153
```

```
data.head()
```

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
0	B016I2TS4W	FNC7C	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	Minions Como Superheroes Ironman Long Sleeve R...	None
1	B01N49AI08	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Izo Tunic	None
2	B01JDPCOHO	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Won Top	None
				https://images-na.ssl-		Focal18 Sailor	

```
data_sorted = data[data['title'].apply(lambda x: len(x.split())>4)]
print("After removal of products with short description:", data_sorted.shape[0])
```

```
After removal of products with short description: 178026
```

```
data_sorted.sort_values('title',inplace=True, ascending=False)
data_sorted.head()
```

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
27547	B073W7P8KK	Nation LTD	Blue	https://images-na.ssl-images-amazon.com/images...	DRESS	❀Nation Women Stripe Blouse Long Sleeve Shirt ...	None
31277	B01M0PWMZ8	Anglin	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	✻ANGLIN✻ Women Striped Floral Long Sleeve Roun...	None
30453	B01M02GWRG	Anglin	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	✻ANGLIN✻ Women Striped Floral Long Sleeve Roun...	None

```
indices = []
for i,row in data_sorted.iterrows():
    indices.append(i)
```

```
import itertools
stage1_dedupe_asins = []
i = 0
j = 0
num_data_points = data_sorted.shape[0]
while i < num_data_points and j < num_data_points:

    previous_i = i

    # store the list of words of ith string in a, ex: a = ['tokidoki', 'The', 'Queen', 'of', 'Diamonds', 'Women's'
    a = data['title'].loc[indices[i]].split()

    # search for the similar products sequentially
```

```
    # search for the similar products sequentially
    j = i+1
    while j < num_data_points:

        # store the list of words of jth string in b, ex: b = ['tokidoki', 'The', 'Queen', 'of', 'Diamonds', 'Wome
        b = data['title'].loc[indices[j]].split()

        # store the maximum length of two strings
        length = max(len(a), len(b))

        # count is used to store the number of words that are matched in both strings
        count  = 0

        # itertools.zip_longest(a,b): will map the corresponding words in both strings, it will appened None in ca
        # example: a =['a', 'b', 'c', 'd']
        # b = ['a', 'b', 'd']
        # itertools.zip_longest(a,b): will give [('a','a'), ('b','b'), ('c','d'), ('d', None)]
        for k in itertools.zip_longest(a,b):
            if (k[0] == k[1]):
                count += 1

        # if the number of words in which both strings differ are > 2 , we are considering it as those two apperal
        # if the number of words in which both strings differ are < 2 , we are considering it as those two apperal
        if (length - count) > 2: # number of words in which both sensences differ
            # if both strings are differ by more than 2 words we include the 1st string index
            stage1_dedupe_asins.append(data_sorted['asin'].loc[indices[i]])


            # start searching for similar apperals corresponds 2nd string
            i = j
            break
        else:
            j += 1
    if previous_i == i:
        break
```

```
data = data.loc[data['asin'].isin(stage1_dedupe_asins)]
```

```
print('Number of data points : ', data.shape[0])
```

```
Number of data points :  151251
```

Text Preprocessing

```
data = pd.read_pickle('/content/drive/My Drive/Colab Notebooks/Appareal Recommendation/pickels/16k_apperal_data')
```

```
import nltk
nltk.download('stopwords')
```

```
[nltk_data] Downloading package stopwords to /root/nltk_data...
[nltk_data]   Unzipping corpora/stopwords.zip.
True
```

```
stop_words = set(stopwords.words('english'))
print ('list of stop words:', stop_words)

def nlp_preprocessing(total_text, index, column):
    if type(total_text) is not int:
        string = ""
        for words in total_text.split():
```

```
            # remove the special chars in review like '"#$@!%^&*()_+-~?>< etc.
            word = ("".join(e for e in words if e.isalnum()))
            # Conver all letters to lower-case
            word = word.lower()
            # stop-word removal
            if not word in stop_words:
                string += word + " "
        data[column][index] = string
```

```
list of stop words: {'again', "that'll", "you've", 'itself', 'what', 'than', 's', 'off', "you'd", 'is', 't', 'o
```

```
start_time = time.clock()
# we take each title and we text-preprocess it.
for index, row in data.iterrows():
    nlp_preprocessing(row['title'], index, 'title')
# we print the time it took to preprocess whole titles
print(time.clock() - start_time, "seconds")
```

```
5.199537999999997 seconds
```

```
data.head()
```

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies long sleeve stain resistant...	$26.26
6	B012YX2ZPI	HX-Kingdom Fashion T-shirts	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	womens unique 100 cotton special olympics wor...	$9.99
15	B003BSRPB0	FeatherLite	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies moisture free mesh sport sh...	$20.54

Stemming

```
from nltk.stem.porter import *
stemmer = PorterStemmer()
print(stemmer.stem('arguing'))
print(stemmer.stem('fishing'))
```

```
argu
fish
```

Text based product Similarity

```
data = pd.read_pickle('/content/drive/My Drive/Colab Notebooks/Appareal Recommendation/pickels/16k_apperal_data_pr
data.head()
```

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies long sleeve stain resistant...	$26.26
6	B012YX2ZPI	HX-Kingdom Fashion T-shirts	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	womens unique 100 cotton special olympics wor...	$9.99

```
def display_img(url,ax,fig):
    # we get the url of the apparel and download it
    response = requests.get(url)
    img = Image.open(BytesIO(response.content))
    # we will display it in notebook
    plt.imshow(img)

#plotting code to understand the algorithm's decision.
def plot_heatmap(keys, values, labels, url, text):
        # keys: list of words of recommended title
        # values: len(values) ==  len(keys), values(i) represents the occurence of the word keys(i)
        # labels: len(labels) == len(keys), the values of labels depends on the model we are using
                # if model == 'bag of words': labels(i) = values(i)
                # if model == 'tfidf weighted bag of words':labels(i) = tfidf(keys(i))
                # if model == 'idf weighted bag of words':labels(i) = idf(keys(i))
        # url : apparel's url

        # we will devide the whole figure into two parts
        gs = gridspec.GridSpec(2, 2, width_ratios=[4,1], height_ratios=[4,1])
        fig = plt.figure(figsize=(25,3))

        # 1st, ploting heat map that represents the count of commonly ocurred words in title2
        ax = plt.subplot(gs[0])
        # it displays a cell in white color if the word is intersection(lis of words of title1 and list of words o
        ax = sns.heatmap(np.array([values]), annot=np.array([labels]))
        ax.set_xticklabels(keys) # set that axis labels as the words of title
        ax.set_title(text) # apparel title

        # 2nd, plotting image of the the apparel
        ax = plt.subplot(gs[1])
        # we don't want any grid lines for image and no labels on x-axis and y-axis
        ax.grid(False)
        ax.set_xticks([])
        ax.set_yticks([])

        # we call dispaly_img based with paramete url
        display_img(url, ax, fig)

        # displays combine figure ( heat map and image together)
        plt.show()

def plot_heatmap_image(doc_id, vec1, vec2, url, text, model):

    # doc_id : index of the title1
    # vec1 : input apparels's vector, it is of a dict type {word:count}
    # vec2 : recommended apparels's vector, it is of a dict type {word:count}
    # url : apparels image url
    # text: title of recomonded apparel (used to keep title of image)
    # model, it can be any of the models,
        # 1. bag_of_words
        # 2. tfidf
        # 3. idf

```

```
    # we find the common words in both titles, because these only words contribute to the distance between two tit
    intersection = set(vec1.keys()) & set(vec2.keys())

    # we set the values of non intersecting words to zero, this is just to show the difference in heatmap
    for i in vec2:
        if i not in intersection:
            vec2[i]=0

    # for labeling heatmap, keys contains list of all words in title2
    keys = list(vec2.keys())
    #  if ith word in intersection(lis of words of title1 and list of words of title2): values(i)=count of that wo
    values = [vec2[x] for x in vec2.keys()]

    # labels: len(labels) == len(keys), the values of labels depends on the model we are using
        # if model == 'bag of words': labels(i) = values(i)
        # if model == 'tfidf weighted bag of words':labels(i) = tfidf(keys(i))
        # if model == 'idf weighted bag of words':labels(i) = idf(keys(i))

    if model == 'bag_of_words':
        labels = values
    elif model == 'tfidf':
        labels = []
        for x in vec2.keys():
            # tfidf_title_vectorizer.vocabulary_ it contains all the words in the corpus
            # tfidf_title_features[doc_id, index_of_word_in_corpus] will give the tfidf value of word in given doc
            if x in  tfidf_title_vectorizer.vocabulary_:
                labels.append(tfidf_title_features[doc_id, tfidf_title_vectorizer.vocabulary_[x]])
            else:
                labels.append(0)
    elif model == 'idf':
        labels = []
        for x in vec2.keys():
            # idf_title_vectorizer.vocabulary_ it contains all the words in the corpus
            # idf_title_features[doc_id, index_of_word_in_corpus] will give the idf value of word in given documer
            if x in  idf_title_vectorizer.vocabulary_:
                labels.append(idf_title_features[doc_id, idf_title_vectorizer.vocabulary_[x]])
            else:
                labels.append(0)

    plot_heatmap(keys, values, labels, url, text)


# this function gets a list of wrods along with the frequency of each
# word given "text"
def text_to_vector(text):
    word = re.compile(r'\w+')
    words = word.findall(text)
    # words stores list of all words in given string, you can try 'words = text.split()' this will also gives same
    return Counter(words) # Counter counts the occurence of each word in list, it returns dict type object {word1:



def get_result(doc_id, content_a, content_b, url, model):
    text1 = content_a
    text2 = content_b

    # vector1 = dict{word11:#count, word12:#count, etc.}
    vector1 = text_to_vector(text1)

    # vector1 = dict{word21:#count, word22:#count, etc.}
    vector2 = text_to_vector(text2)

    plot_heatmap_image(doc_id, vector1, vector2, url, text2, model)
```

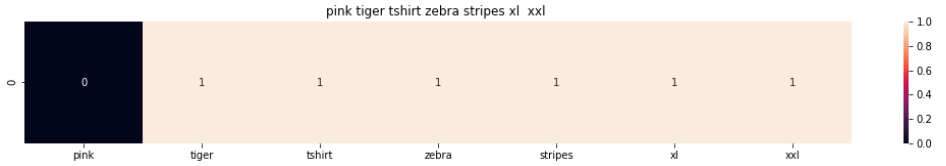
Apply Bag Of Words(BOW) on Product Titles

```
from sklearn.feature_extraction.text import CountVectorizer

title_vectorizer = CountVectorizer()
title_features   = title_vectorizer.fit_transform(data['title'])
title_features.get_shape()
```

```
(16042, 12609)
```

```
def bag_of_words_model(doc_id, num_results):
    pairwise_dist = pairwise_distances(title_features,title_features[doc_id])
    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]
    df_indices = list(data.index[indices])
    for i in range(0,len(indices)):
        # we will pass 1. doc_id, 2. title1, 3. title2, url, model
        get_result(indices[i],data['title'].loc[df_indices[0]], data['title'].loc[df_indices[i]], data['medium_ima
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print ('Brand:', data['brand'].loc[df_indices[i]])
        print ('Title:', data['title'].loc[df_indices[i]])
        print ('Euclidean similarity with the query image :', pdists[i])
        print('='*60)


bag_of_words_model(12566, 20) # change the index if you want to.
```

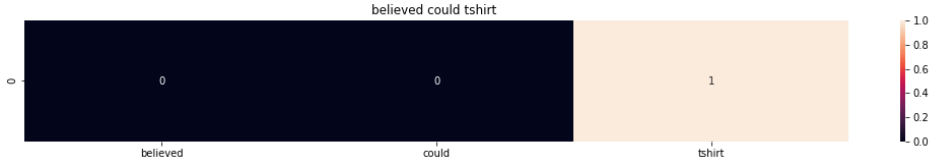
ASIN : B00JXQB5FQ
Brand: Si Row
Title: burnt umber tiger tshirt zebra stripes xl xxl
Euclidean similarity with the query image : 0.0
==



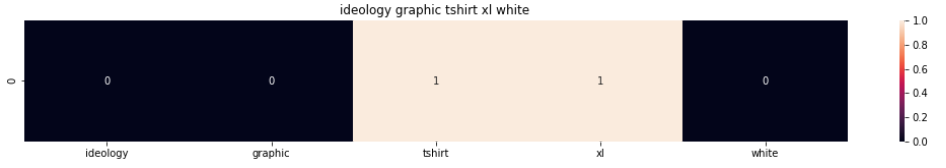
ASIN : B00JXQASS6
Brand: Si Row
Title: pink tiger tshirt zebra stripes xl xxl
Euclidean similarity with the query image : 1.7320508075688772
==

ASIN : B00JXQCWTO
Brand: Si Row
Title: brown white tiger tshirt tiger stripes xl xxl
Euclidean similarity with the query image : 2.449489742783178
==

ASIN : B00JXQCUIC
Brand: Si Row
Title: yellow tiger tshirt tiger stripes l
Euclidean similarity with the query image : 2.6457513110645907
==



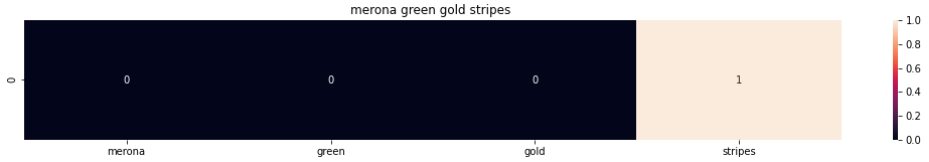
ASIN : B07568NZX4
Brand: Rustic Grace
Title: believed could tshirt
Euclidean similarity with the query image : 3.0
==



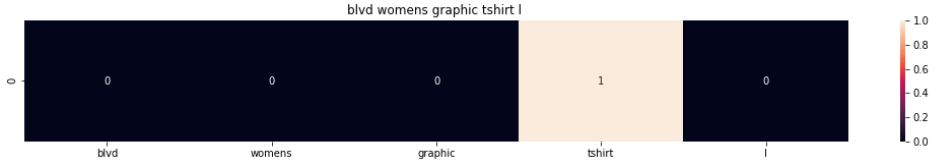
ASIN : B01NB0NKRO
Brand: Ideology
Title: ideology graphic tshirt xl white
Euclidean similarity with the query image : 3.0
==

ASIN : B00JXQAFZ2
Brand: Si Row
Title: grey white tiger tank top tiger stripes xl xxl
Euclidean similarity with the query image : 3.0
==========

ASIN : B01CLS8LMW
Brand: Awake
Title: morning person tshirt troll picture xl
Euclidean similarity with the query image : 3.1622776601683795
==========

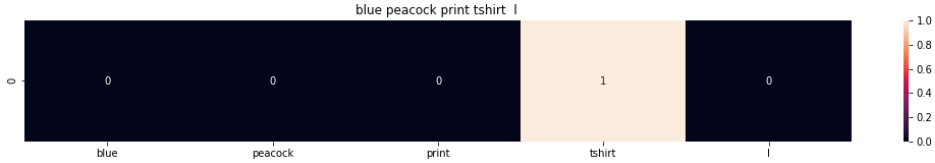


ASIN : B01KVZUB6G
Brand: Merona
Title: merona green gold stripes
Euclidean similarity with the query image : 3.1622776601683795
==========



ASIN : B0733R2CJK
Brand: BLVD
Title: blvd womens graphic tshirt l
Euclidean similarity with the query image : 3.1622776601683795
==========

ASIN : B012VQLT6Y
Brand: KM T-shirt
Title: km tiger printed sleeveless vest tshirt
Euclidean similarity with the query image : 3.1622776601683795
==========

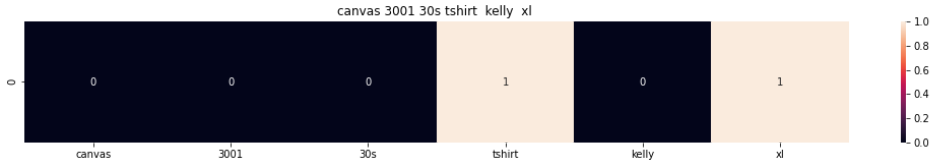


ASIN : B00JXQC8L6
Brand: Si Row
Title: blue peacock print tshirt l
Euclidean similarity with the query image : 3.1622776601683795
==========

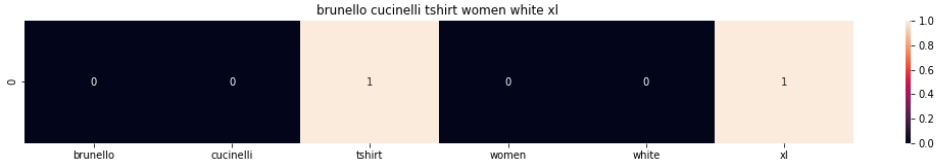
ASIN : B06XC3CZF6
Brand: Fjallraven
Title: fjallraven womens ovik tshirt plum xxl

```
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```

```
ASIN : B005IT8OBA
Brand: Hetalia
Title: hetalia us girl tshirt
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```

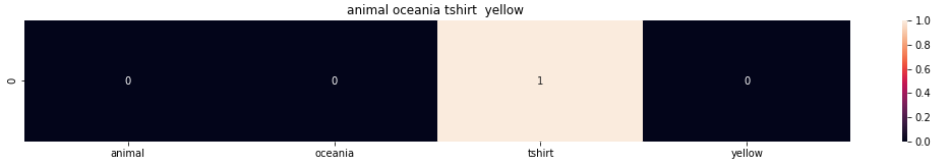


```
ASIN : B0088PN0LA
Brand: Red House
Title: canvas 3001 30s tshirt  kelly  xl
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```



```
ASIN : B06X99V6WC
Brand: Brunello Cucinelli
Title: brunello cucinelli tshirt women white xl
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```

```
ASIN : B06Y1JPW1Q
Brand: Xhilaration
Title: xhilaration womens lace tshirt salmon xxl
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```



```
ASIN : B06X6GX6WG
Brand: Animal
Title: animal oceania tshirt  yellow
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```

```
ASIN : B017X8PW9U
Brand: Diesel
Title: diesel tserraf tshirt black
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```

TFIDF based Product Similarity

==========

```
tfidf_title_vectorizer = TfidfVectorizer(min_df = 0)
tfidf_title_features = tfidf_title_vectorizer.fit_transform(data['title'])
```

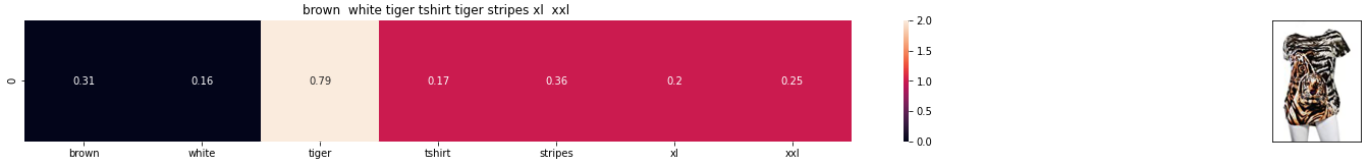
```
def tfidf_model(doc_id, num_results):
    pairwise_dist = pairwise_distances(tfidf_title_features,tfidf_title_features[doc_id])
    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]
    df_indices = list(data.index[indices])
    for i in range(0,len(indices)):
        # we will pass 1. doc_id, 2. title1, 3. title2, url, model
        get_result(indices[i], data['title'].loc[df_indices[0]], data['title'].loc[df_indices[i]], data['medium_im
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('BRAND :',data['brand'].loc[df_indices[i]])
        print ('Eucliden distance from the given image :', pdists[i])
        print('='*125)
tfidf_model(12566, 20)
```

ASIN : B00JXQB5FQ
BRAND : Si Row
Eucliden distance from the given image : 0.0

==========

ASIN : B00JXQASS6
BRAND : Si Row
Eucliden distance from the given image : 0.7536331912451363

==========

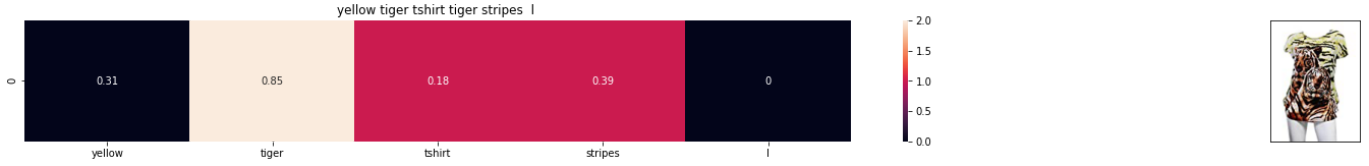


ASIN : B00JXQCWTO
BRAND : Si Row
Eucliden distance from the given image : 0.9357643943769647

==========

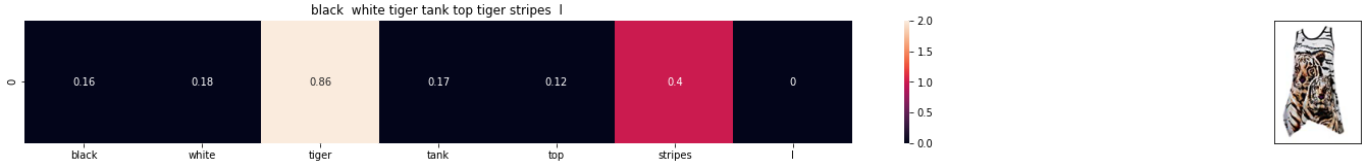
ASIN : B00JXQAFZ2
BRAND : Si Row
Eucliden distance from the given image : 0.9586153524200749

==========



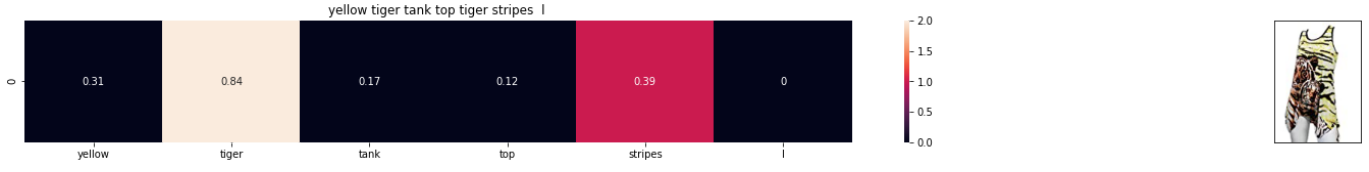
ASIN : B00JXQCUIC
BRAND : Si Row
Eucliden distance from the given image : 1.000074961446881

==========



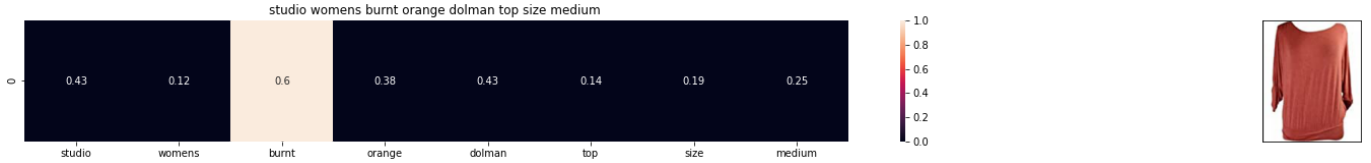
ASIN : B00JXQAO94
BRAND : Si Row
Eucliden distance from the given image : 1.023215552457452

==========



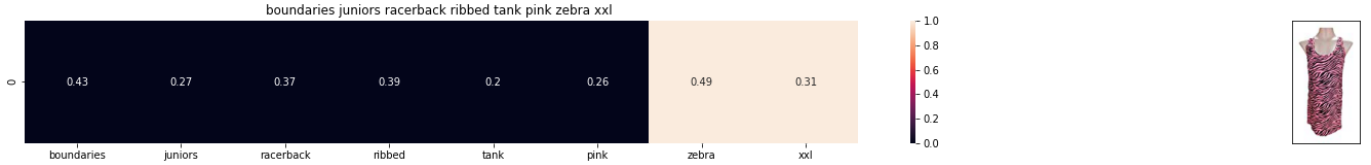
ASIN : B00JXQAUWA
BRAND : Si Row
Eucliden distance from the given image : 1.031991846303421

==========



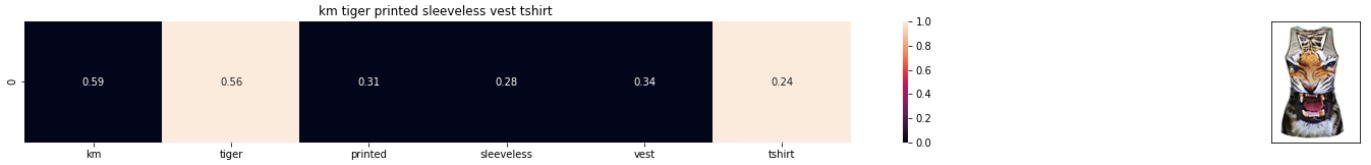
ASIN : B06XSCVFT5
BRAND : Studio M
Eucliden distance from the given image : 1.2106843670424716

==========



ASIN : B06Y2GTYPM
BRAND : No Boundaries
Eucliden distance from the given image : 1.2121683810720831

==========

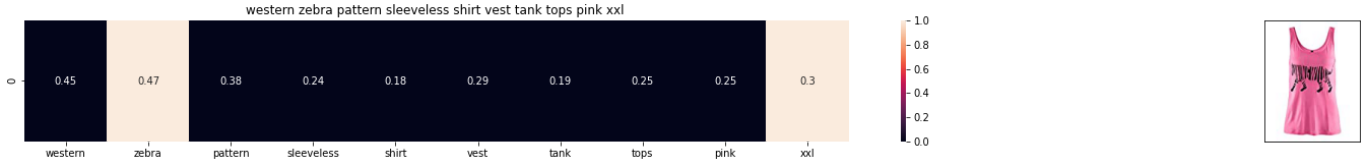


ASIN : B012VQLT6Y
BRAND : KM T-shirt
Eucliden distance from the given image : 1.219790640280982

==========

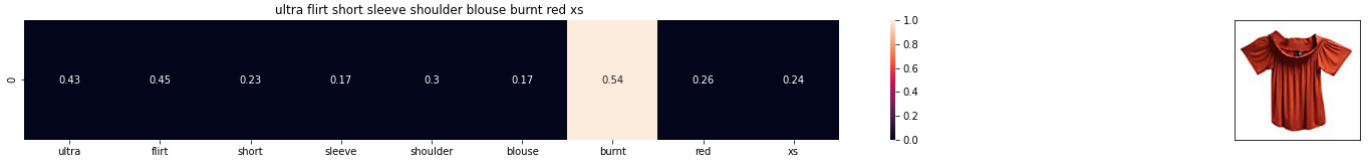
ASIN : B06Y1VN8WQ
BRAND : Black Swan
Eucliden distance from the given image : 1.2206849659998316

==========



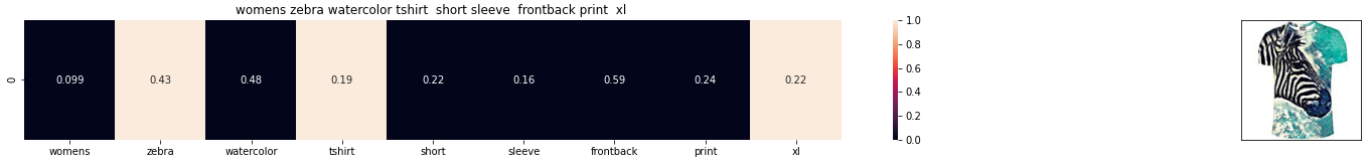
ASIN : B00Z6HEXWI
BRAND : Black Temptation
Eucliden distance from the given image : 1.221281392120943

==========



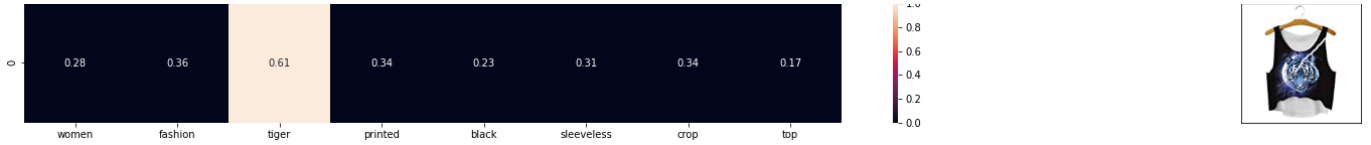
ASIN : B074TR12BH
BRAND : Ultra Flirt
Eucliden distance from the given image : 1.2313364094597743

==========

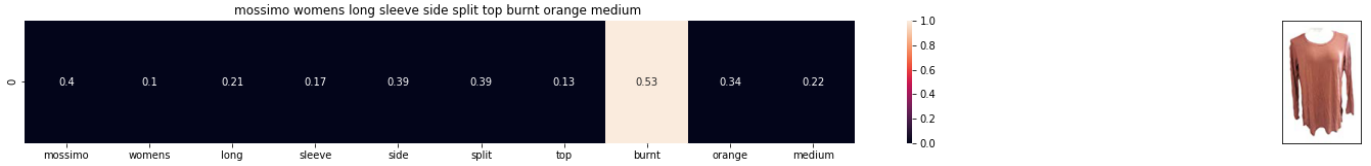


ASIN : B072R2JXKW
BRAND : WHAT ON EARTH
Eucliden distance from the given image : 1.2318451972624516

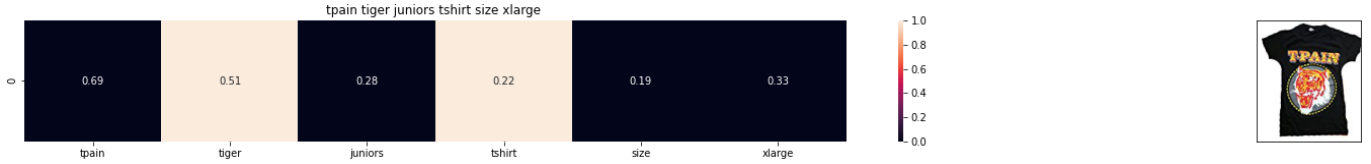
==========



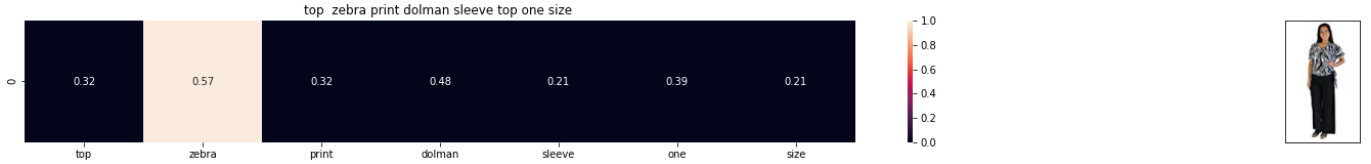
ASIN : B074T8ZYGX
BRAND : MKP Crop Top
Eucliden distance from the given image : 1.2340607457359425
==========



ASIN : B071ZDF6T2
BRAND : Mossimo
Eucliden distance from the given image : 1.2352785577664824
==========



ASIN : B01K0H02OG
BRAND : Tultex
Eucliden distance from the given image : 1.236457298812782
==========



ASIN : B00H8A6ZLI
BRAND : Vivian's Fashions
Eucliden distance from the given image : 1.24996155052848
==========

ASIN : B010NN9RXO
BRAND : YICHUN
Eucliden distance from the given image : 1.2535461420856102
==========

IDF Based Product Similarity

```
idf_title_vectorizer = CountVectorizer()
idf_title_features = idf_title_vectorizer.fit_transform(data['title'])
```

Eucliden distance from the given image : 1.2538832938357722

```
def n_containing(word):
    # return the number of documents which had the given word
    return sum(1 for blob in data['title'] if word in blob.split())

def idf(word):
    # idf = log(#number of docs / #number of docs which had the given word)
    return math.log(data.shape[0] / (n_containing(word)))
```

```
idf_title_features  = idf_title_features.astype(np.float)

for i in idf_title_vectorizer.vocabulary_.keys():
```

```
    # for every word in whole corpus we will find its idf value
    idf_val = idf(i)

    # to calculate idf_title_features we need to replace the count values with the idf values of the word
    # idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()[0] will return all documents in which t
    for j in idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()[0]:

        # we replace the count values of word i in document j with  idf_value of word i
        # idf_title_features[doc_id, index_of_word_in_courpus] = idf value of word
        idf_title_features[j,idf_title_vectorizer.vocabulary_[i]] = idf_val
```

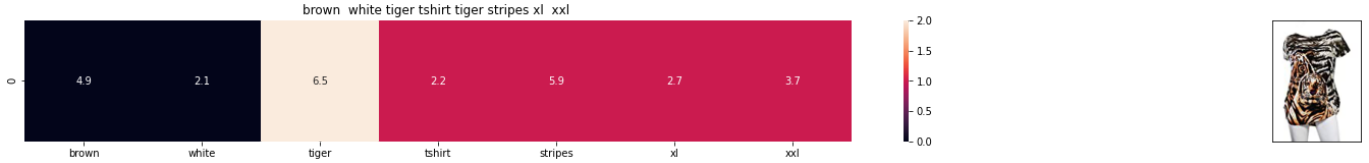
```
def idf_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

    # pairwise_dist will store the distance from given input apparel to all remaining apparels
    # the metric we used here is cosine, the coside distance is mesured as K(X, Y) = <X, Y> / (||X||*||Y||)
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(idf_title_features,idf_title_features[doc_id])

    # np.argsort will return indices of 9 smallest distances
    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    #pdists will store the 9 smallest distances
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]

    #data frame indices of the 9 smallest distace's
    df_indices = list(data.index[indices])

    for i in range(0,len(indices)):
        get_result(indices[i],data['title'].loc[df_indices[0]], data['title'].loc[df_indices[i]], data['medium_ima
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('Brand :',data['brand'].loc[df_indices[i]])
        print ('euclidean distance from the given image :', pdists[i])
        print('='*125)


idf_model(12566,20)
```

ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from the given image : 0.0

==========

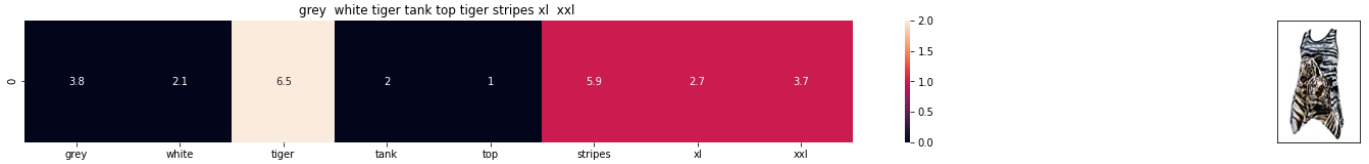
ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from the given image : 12.20507131122177

==========



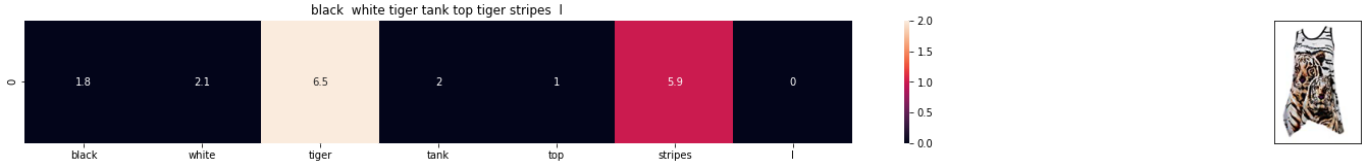
ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from the given image : 14.468362685603465

==========



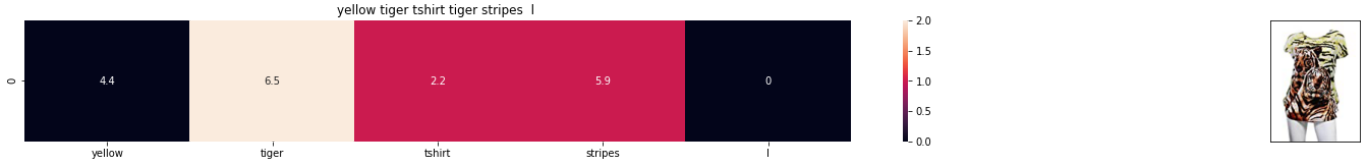
ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from the given image : 14.486832924778964

==========



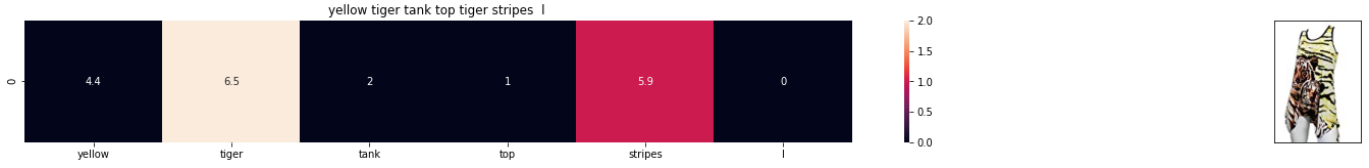
ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from the given image : 14.833392966672909

==========



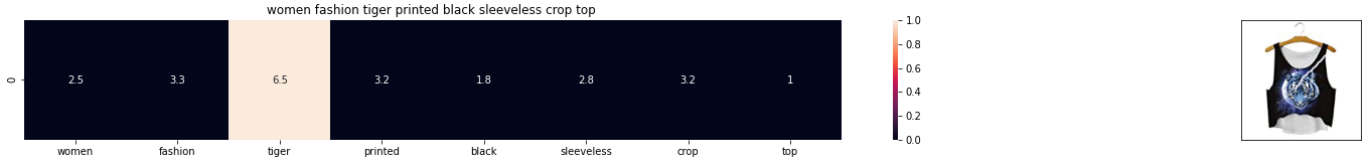
ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from the given image : 14.898744516719225

==========



ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from the given image : 15.224458287343769

==========



ASIN : B074T8ZYGX
Brand : MKP Crop Top
euclidean distance from the given image : 17.080812955631995

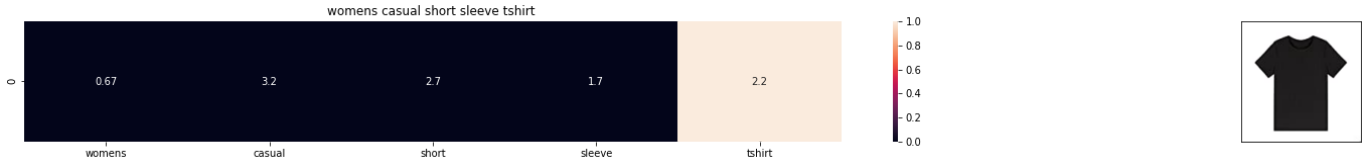
==========

ASIN : B00KF2N5PU
Brand : Vietsbay
euclidean distance from the given image : 17.090168125645416

==========

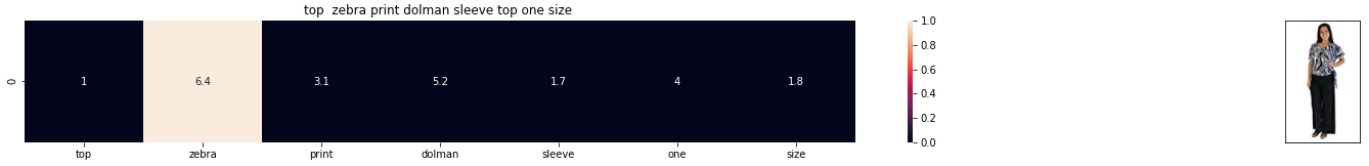
ASIN : B00JPOZ9GM
Brand : Sofra
euclidean distance from the given image : 17.153215337562703

==========



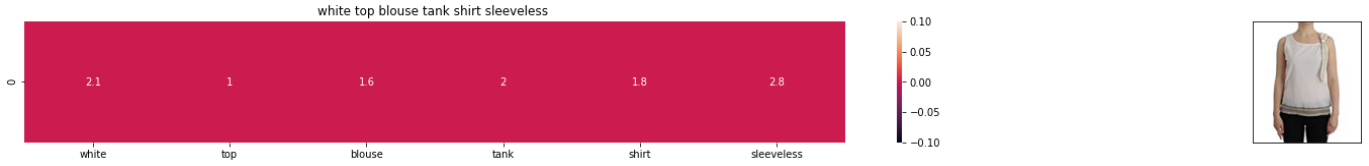
ASIN : B074T9KG9Q
Brand : Rain
euclidean distance from the given image : 17.33671523874989

==========



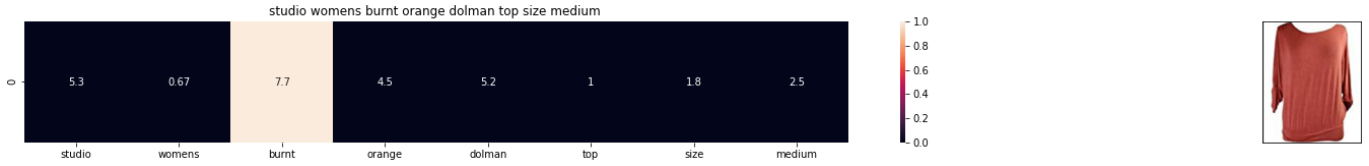
ASIN : B00H8A6ZLI
Brand : Vivian's Fashions
euclidean distance from the given image : 17.410075941001253

==========



ASIN : B074G5G5RK
Brand : ERMANNO SCERVINO
euclidean distance from the given image : 17.539921335459557

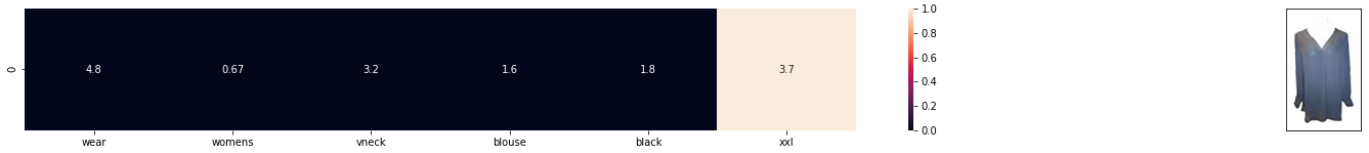
==========



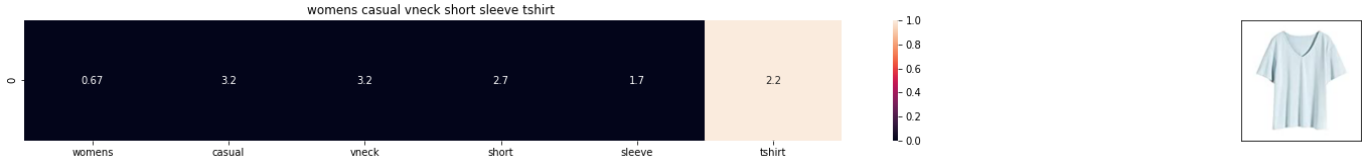
ASIN : B06XSCVFT5
Brand : Studio M
euclidean distance from the given image : 17.61275854366134

==========

wear womens vneck blouse black xxl

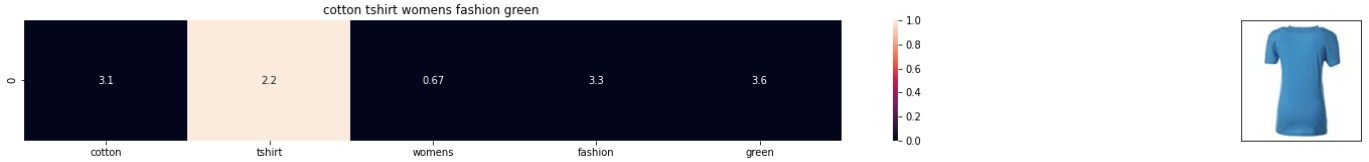


ASIN : B06Y6FH453
Brand : Who What Wear
euclidean distance from the given image : 17.623745282500135
==========

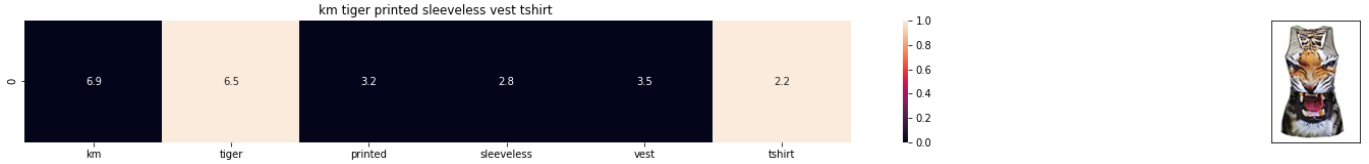


ASIN : B074V45DCX
Brand : Rain
euclidean distance from the given image : 17.634342496835046
==========

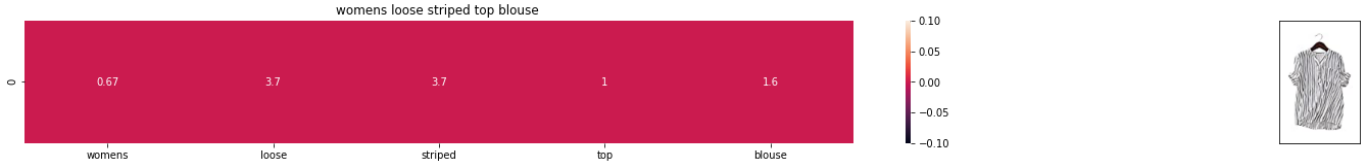
ASIN : B07583CQFT
Brand : Very J
euclidean distance from the given image : 17.63753712743611
==========



ASIN : B073GJGVBN
Brand : Ivan Levi
euclidean distance from the given image : 17.7230738913371
==========



ASIN : B012VQLT6Y
Brand : KM T-shirt
euclidean distance from the given image : 17.762588561202364
==========



ASIN : B00ZZMYBRG
Brand : HP-LEISURE
euclidean distance from the given image : 17.779536864674238
==========

Text Semantics based product simiarity

```
1 from gensim.models import Word2Vec
```

```
from gensim.models import KeyedVectors
import pickle

with open('/content/drive/My Drive/Colab Notebooks/Appareal Recommendation/word2vec_model', 'rb') as handle:
    model = pickle.load(handle)
```

```
def get_word_vec(sentence, doc_id, m_name):
    vec = []
    for i in sentence.split():
        if i in vocab:
            if m_name == 'weighted' and i in  idf_title_vectorizer.vocabulary_:
                vec.append(idf_title_features[doc_id, idf_title_vectorizer.vocabulary_[i]] * model[i])
            elif m_name == 'avg':
                vec.append(model[i])
        else:

            vec.append(np.zeros(shape=(300,)))
    return  np.array(vec)

def get_distance(vec1, vec2):
    final_dist = []
    for i in vec1:
        dist = []
        for j in vec2:
            dist.append(np.linalg.norm(i-j))
        final_dist.append(np.array(dist))
    return np.array(final_dist)


def heat_map_w2v(sentence1, sentence2, url, doc_id1, doc_id2, model):
    s1_vec = get_word_vec(sentence1, doc_id1, model)
    s2_vec = get_word_vec(sentence2, doc_id2, model)
    s1_s2_dist = get_distance(s1_vec, s2_vec)
    gs = gridspec.GridSpec(2, 2, width_ratios=[4,1],height_ratios=[2,1])
    fig = plt.figure(figsize=(15,15))

    ax = plt.subplot(gs[0])

    ax = sns.heatmap(np.round(s1_s2_dist,4), annot=True)
    # set the x axis labels as recommended apparels title
    ax.set_xticklabels(sentence2.split())
    # set the y axis labels as input apparels title
    ax.set_yticklabels(sentence1.split())
    # set title as recommended apparels title
    ax.set_title(sentence2)

    ax = plt.subplot(gs[1])
    # we remove all grids and axis labels for image
    ax.grid(False)
    ax.set_xticks([])
    ax.set_yticks([])
    display_img(url, ax, fig)

    plt.show()
```

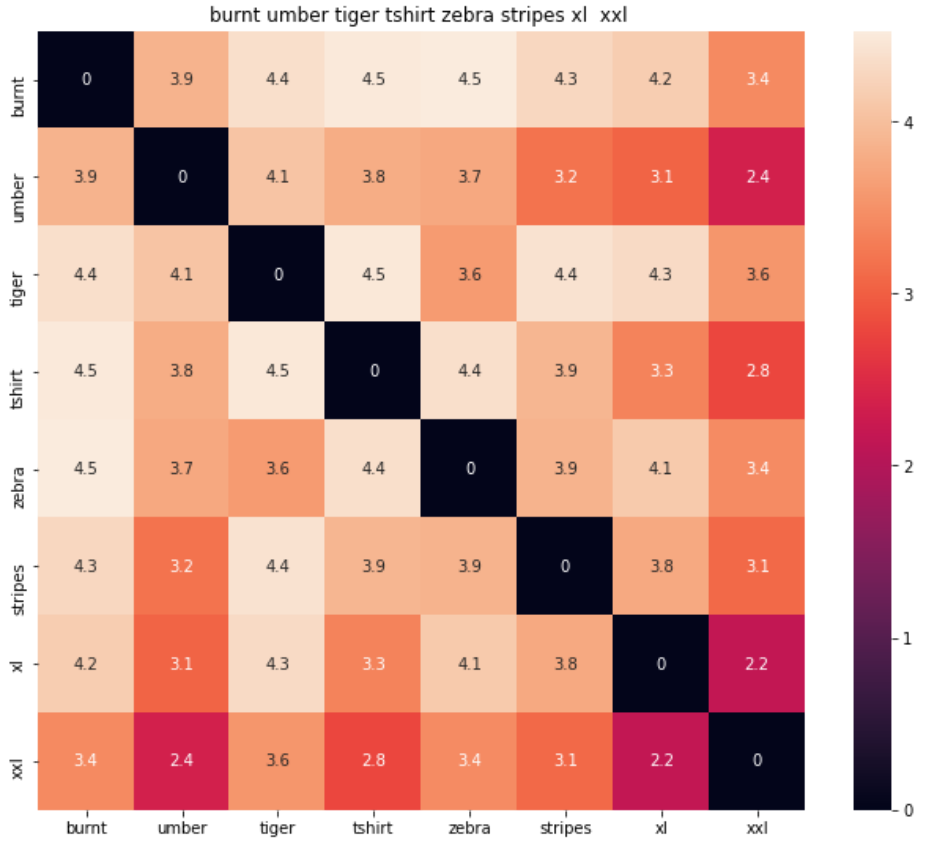
```
vocab = model.keys()

def build_avg_vec(sentence, num_features, doc_id, m_name):
    featureVec = np.zeros((num_features,), dtype="float32")
    nwords = 0
    for word in sentence.split():
        nwords += 1
        if word in vocab:
```

```
            if m_name == 'weighted' and word in  idf_title_vectorizer.vocabulary_:
                featureVec = np.add(featureVec, idf_title_features[doc_id, idf_title_vectorizer.vocabulary_[word]]
            elif m_name == 'avg':
                featureVec = np.add(featureVec, model[word])
    if(nwords>0):
        featureVec = np.divide(featureVec, nwords)
    # returns the avg vector of given sentance, its of shape (1, 300)
    return featureVec
```

Average Word2Vec Product Similarity

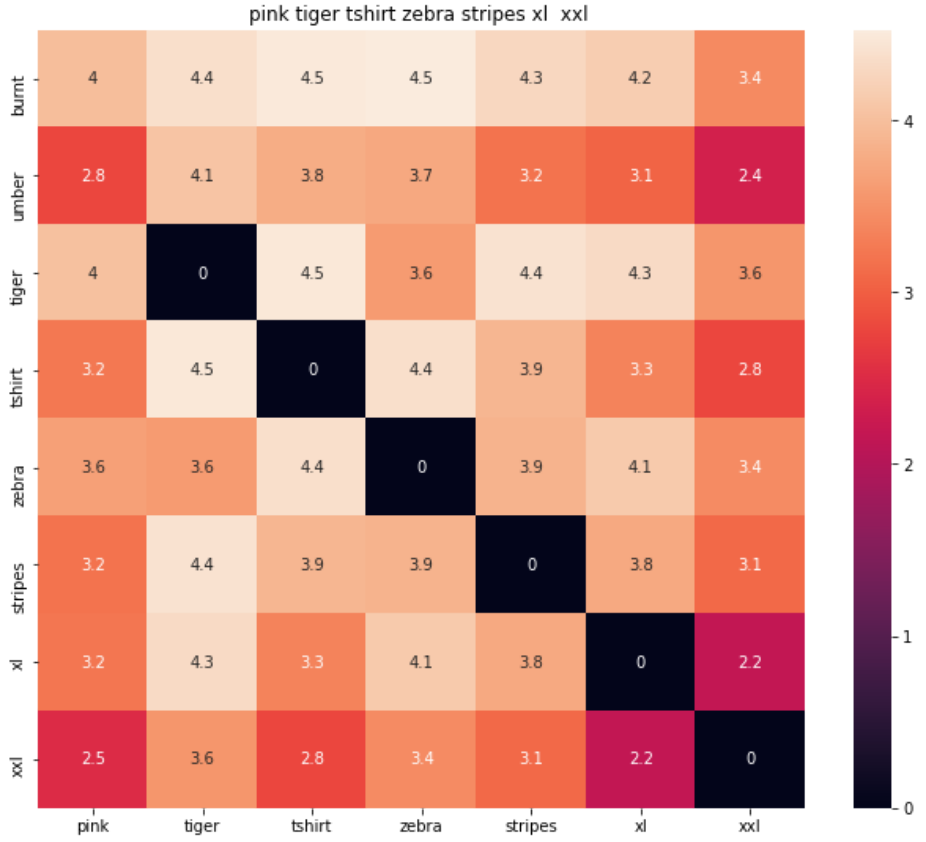
```
doc_id = 0
w2v_title = []
# for every title we build a avg vector representation
for i in data['title']:
    w2v_title.append(build_avg_vec(i, 300, doc_id,'avg'))
    doc_id += 1

# w2v_title = np.array(# number of doc in courpus * 300), each row corresponds to a doc
w2v_title = np.array(w2v_title)
```

```
def avg_w2v_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

    # dist(x, y) = sqrt(dot(x, x) - 2 * dot(x, y) + dot(y, y))
    pairwise_dist = pairwise_distances(w2v_title, w2v_title[doc_id].reshape(1,-1))

    # np.argsort will return indices of 9 smallest distances
    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    #pdists will store the 9 smallest distances
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]

    #data frame indices of the 9 smallest distace's
    df_indices = list(data.index[indices])

    for i in range(0, len(indices)):
        heat_map_w2v(data['title'].loc[df_indices[0]],data['title'].loc[df_indices[i]], data['medium_image_url'].l
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('BRAND :',data['brand'].loc[df_indices[i]])
        print ('euclidean distance from given input image :', pdists[i])
        print('='*125)


avg_w2v_model(12566, 20)
```



ASIN : B00JXQB5FQ
BRAND : Si Row
euclidean distance from given input image : 0.0

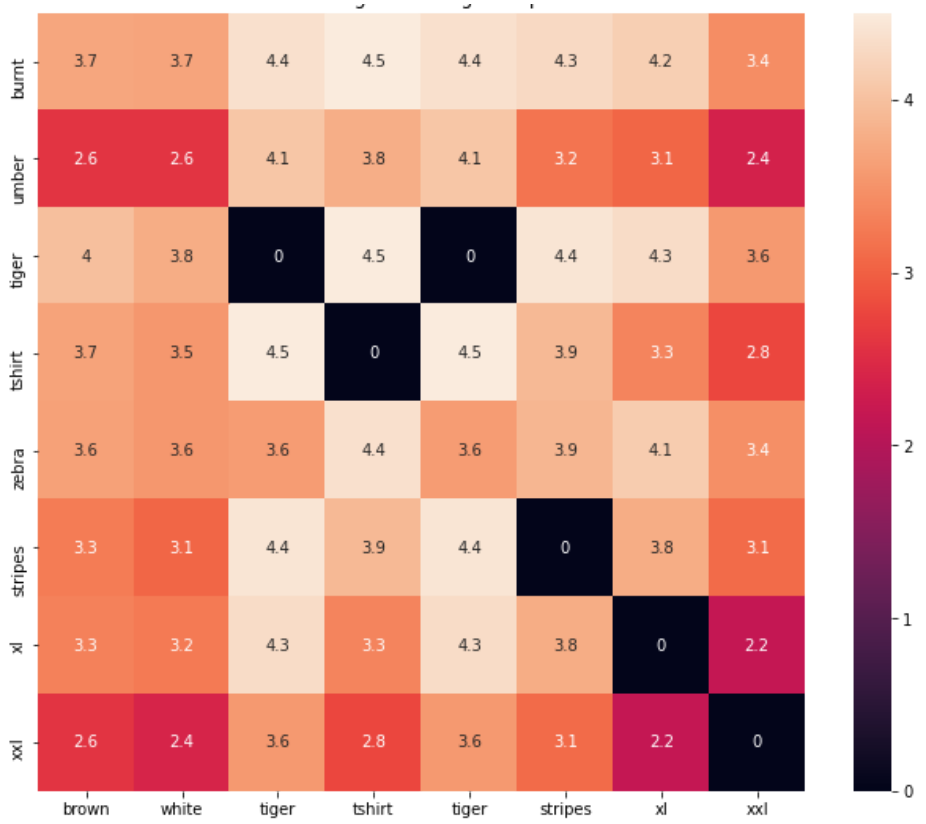
==========



ASIN : B00JXQASS6
BRAND : Si Row
euclidean distance from given input image : 0.5891926

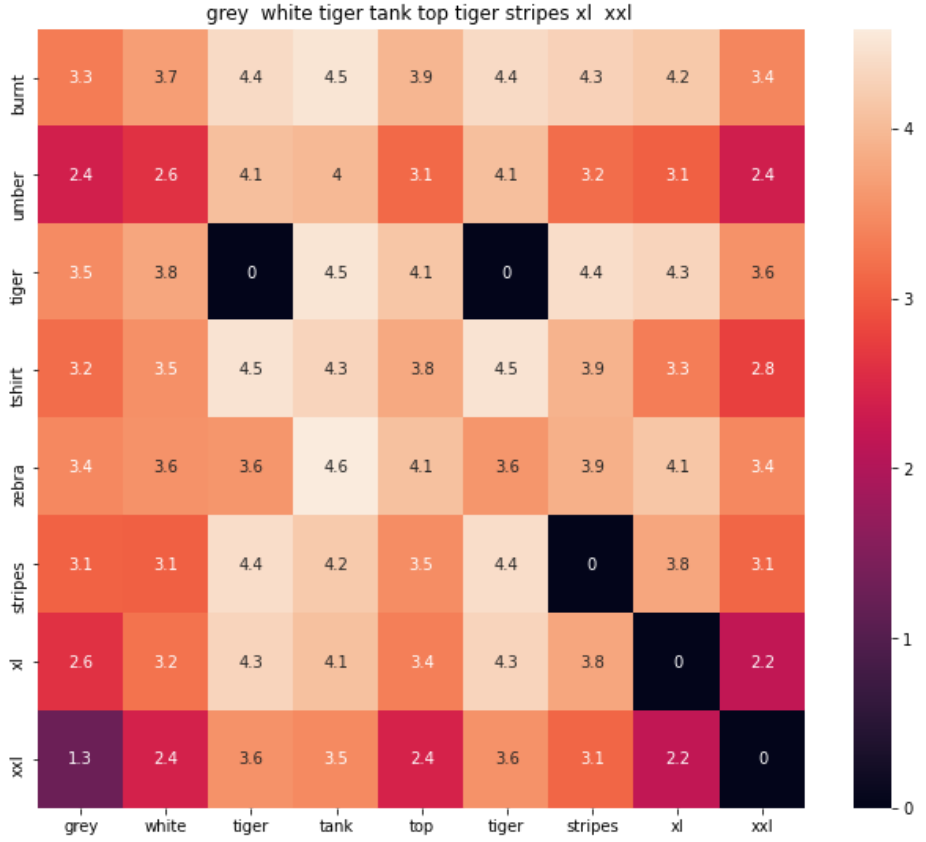
==========

brown white tiger tshirt tiger stripes xl xxl



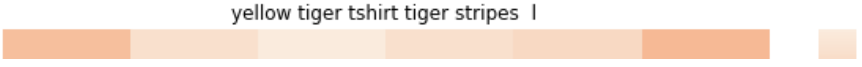
ASIN : B00JXQCWTO
BRAND : Si Row
euclidean distance from given input image : 0.7003438

==========



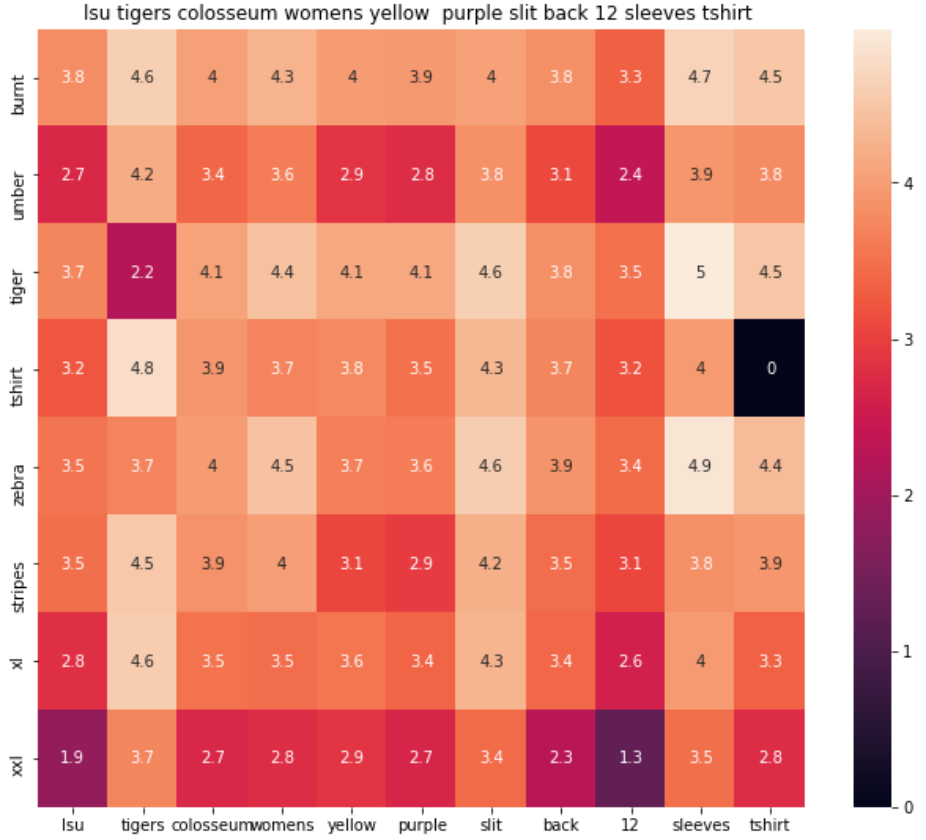
ASIN : B00JXQAFZ2
BRAND : Si Row
euclidean distance from given input image : 0.89283955

==========



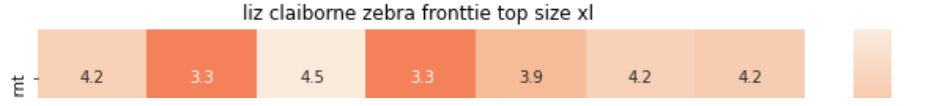
ASIN : B00JXQCUIC
BRAND : Si Row
euclidean distance from given input image : 0.95601255

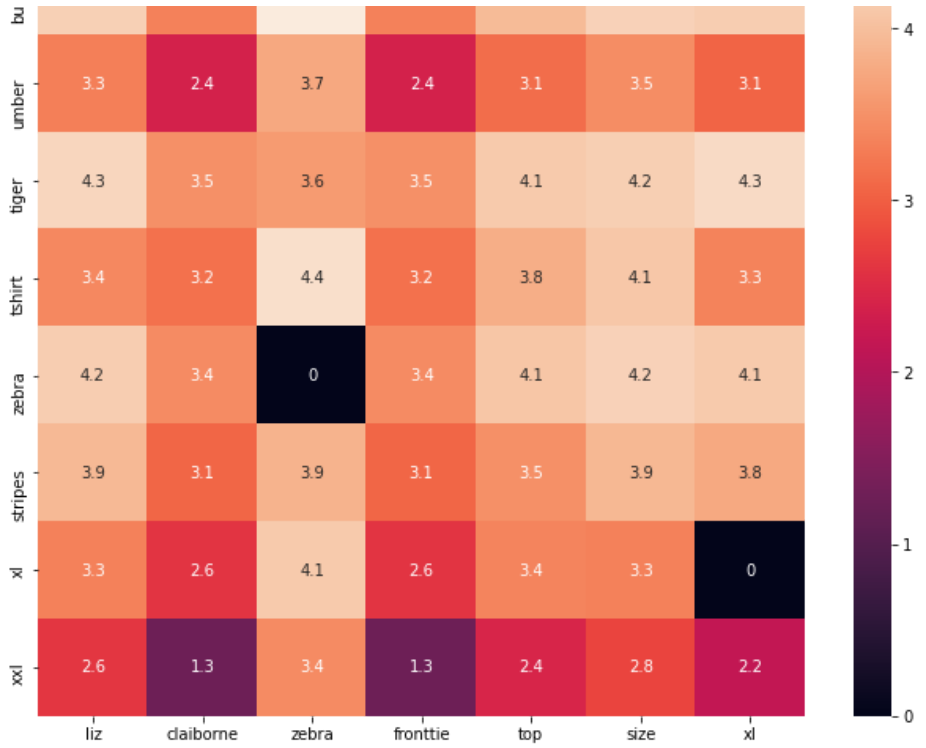
==========



ASIN : B073R5Q8HD
BRAND : Colosseum
euclidean distance from given input image : 1.022969

==========



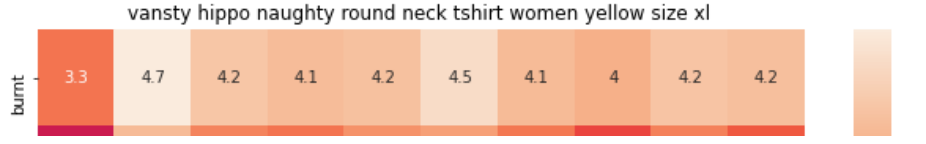


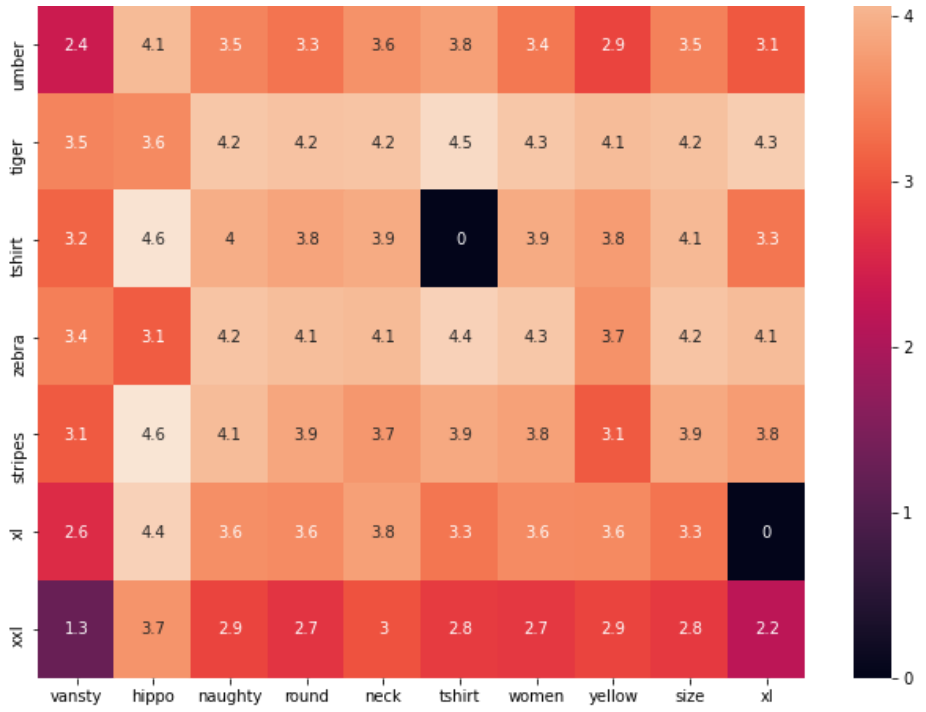
ASIN : B06XBY5QXL
BRAND : Liz Claiborne
euclidean distance from given input image : 1.0669324

==========

ASIN : B01L8L73M2
BRAND : Hotgirl4 Raglan Design
euclidean distance from given input image : 1.0731405

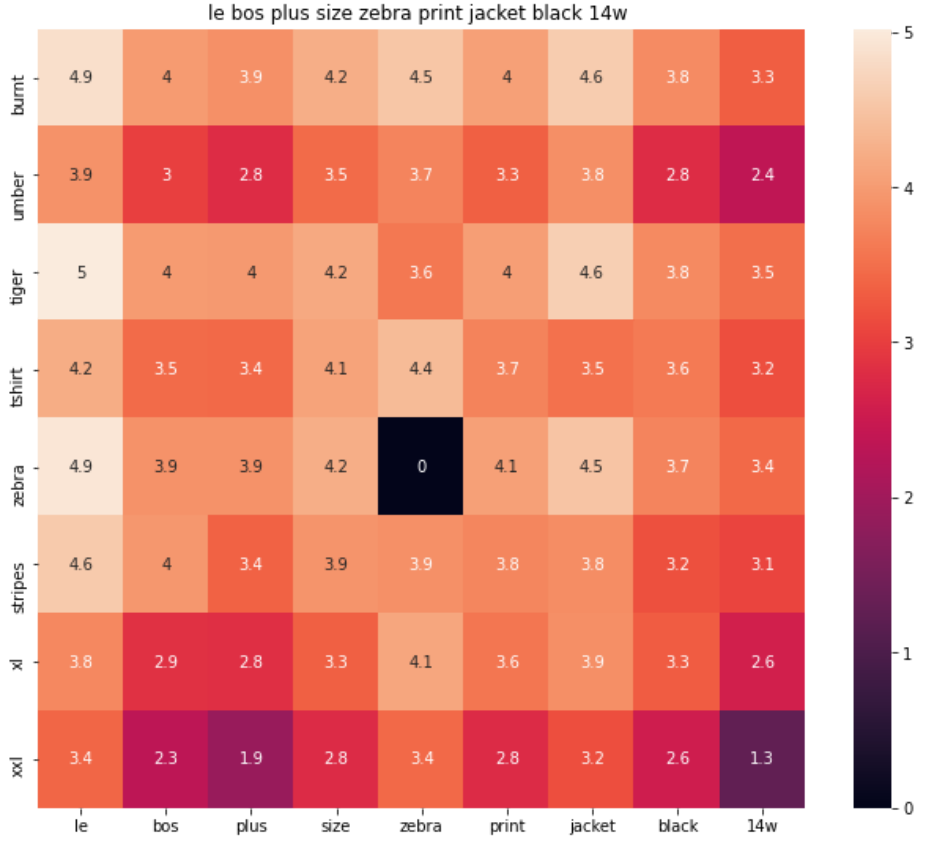
==========





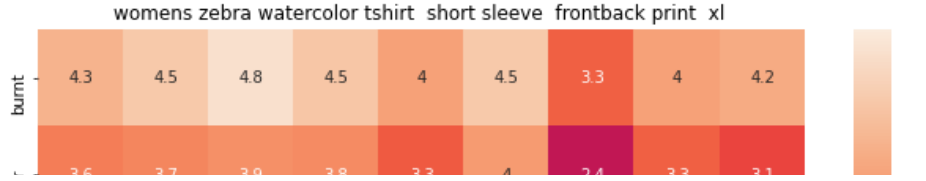
ASIN : B01EJS5H06
BRAND : Vansty
euclidean distance from given input image : 1.075719

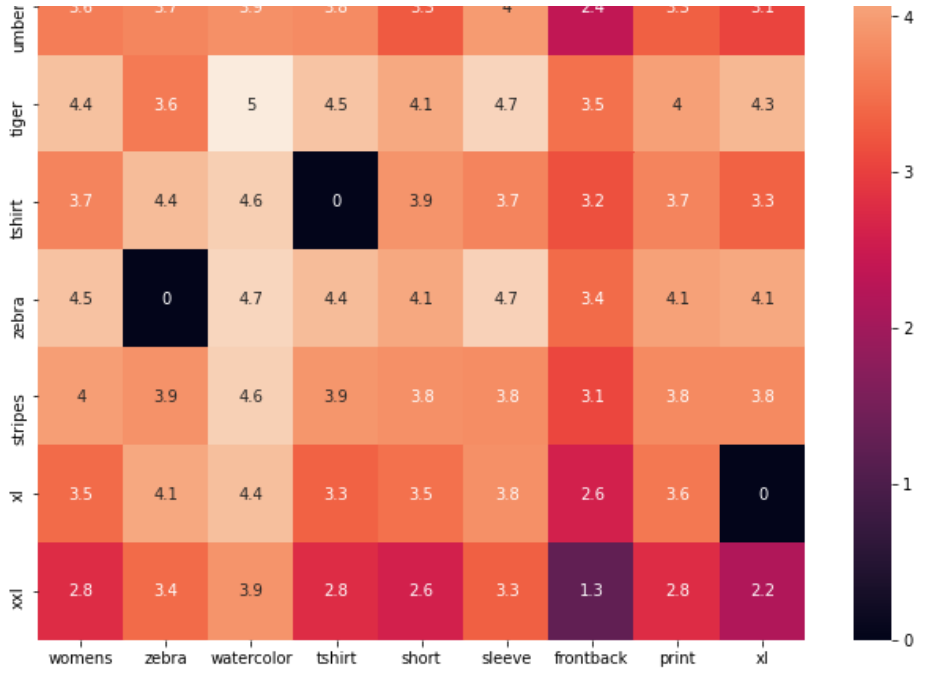
==========



ASIN : B01BO1XRK8
BRAND : Le Bos
euclidean distance from given input image : 1.0839964

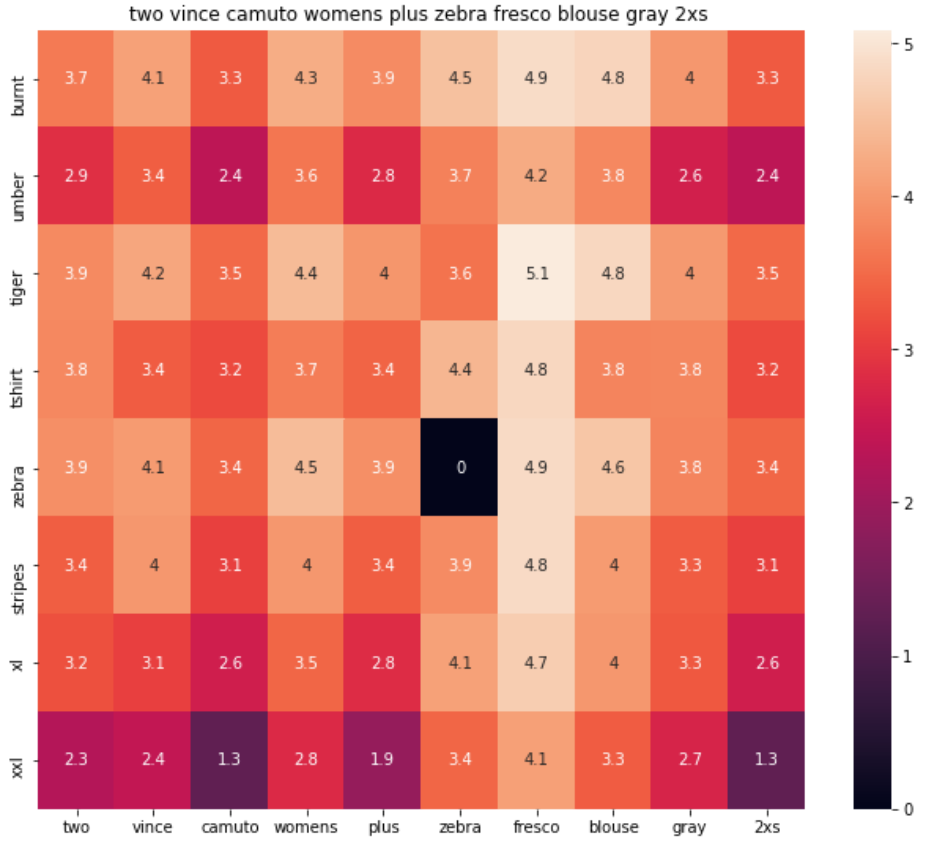
==========





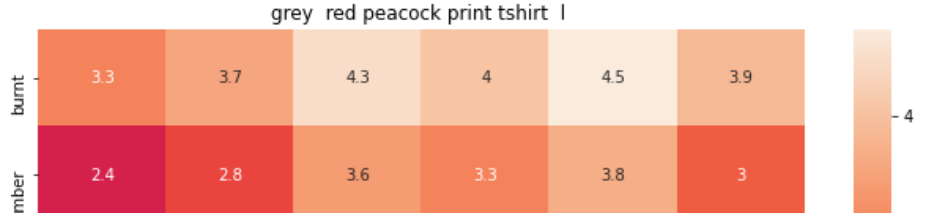
ASIN : B072R2JXKW
BRAND : WHAT ON EARTH
euclidean distance from given input image : 1.0842218

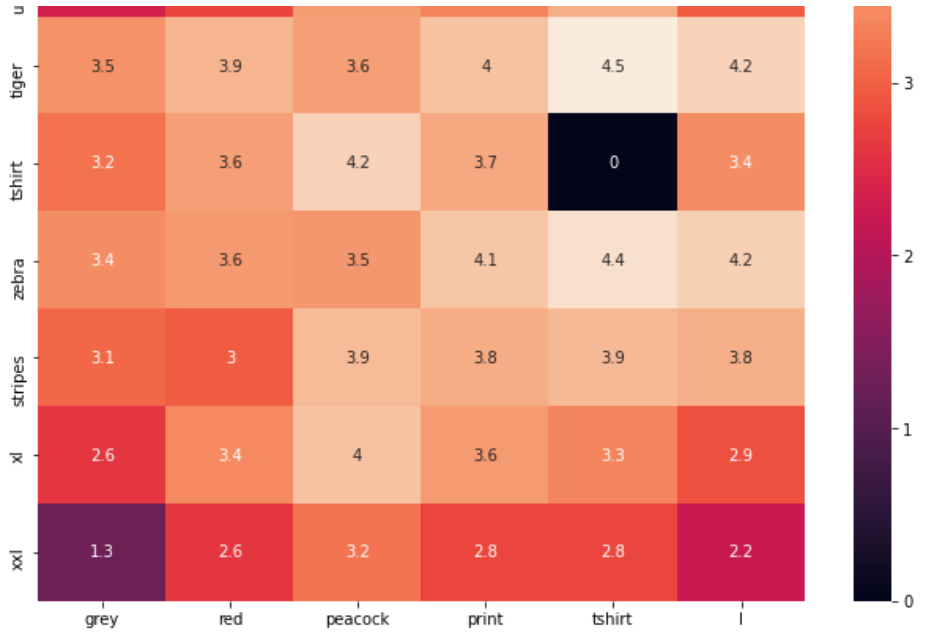
==========



ASIN : B074MJRGW6
BRAND : Two by Vince Camuto
euclidean distance from given input image : 1.0895038

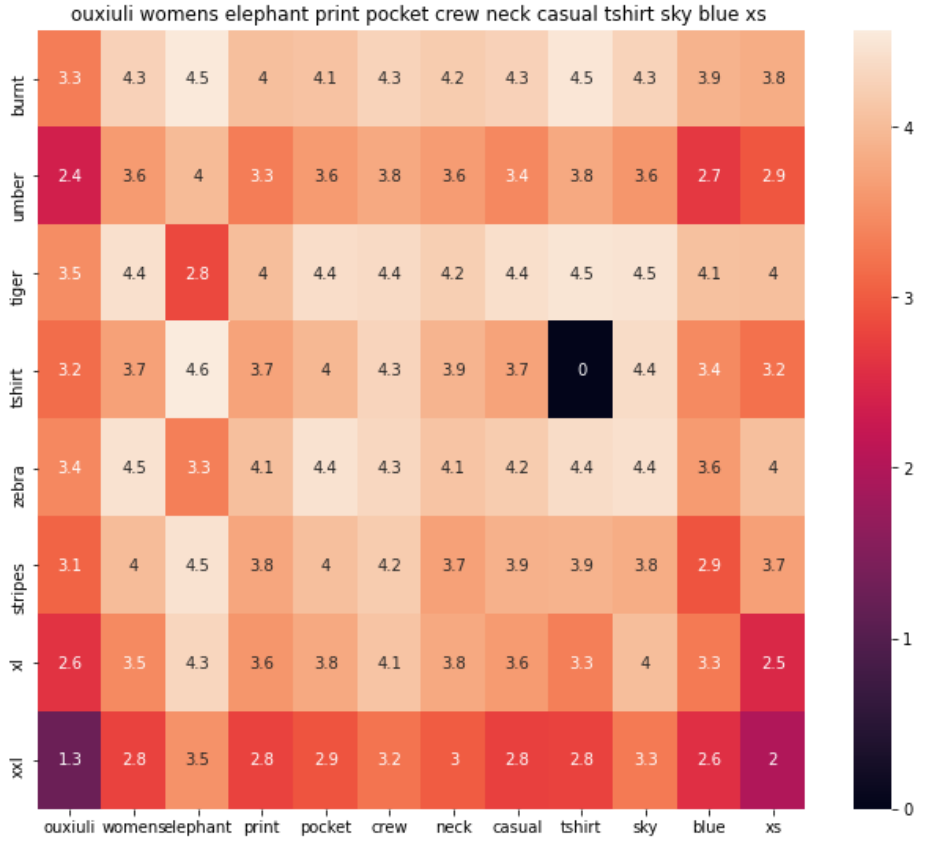
==========





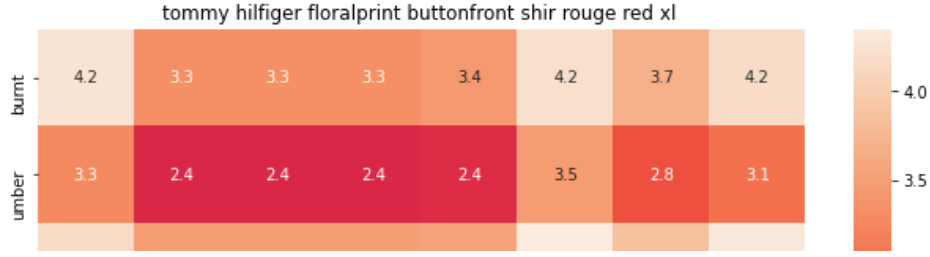
ASIN : B00JXQCFRS
BRAND : Si Row
euclidean distance from given input image : 1.0900588

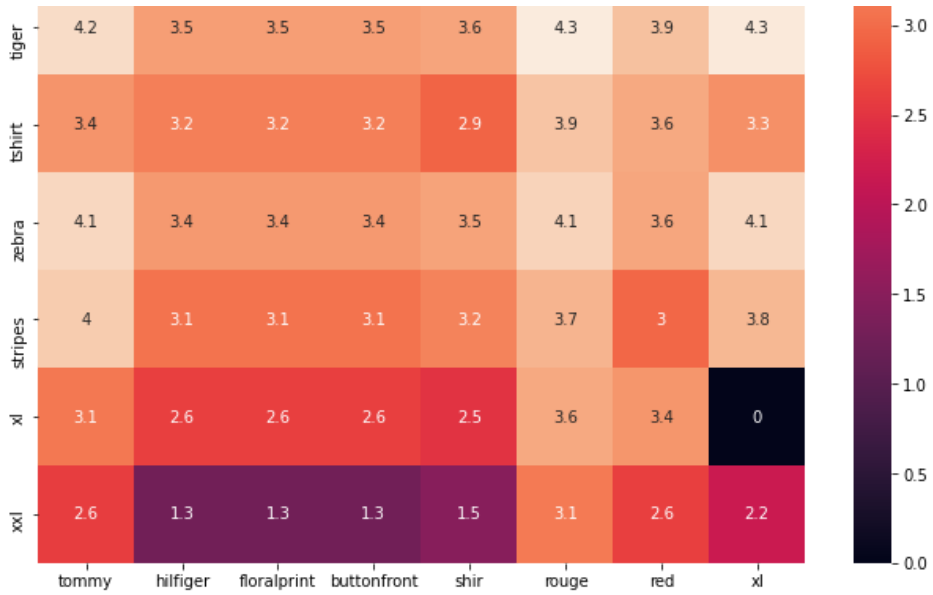
==========



ASIN : B01I53HU6K
BRAND : ouxiuli
euclidean distance from given input image : 1.0920111

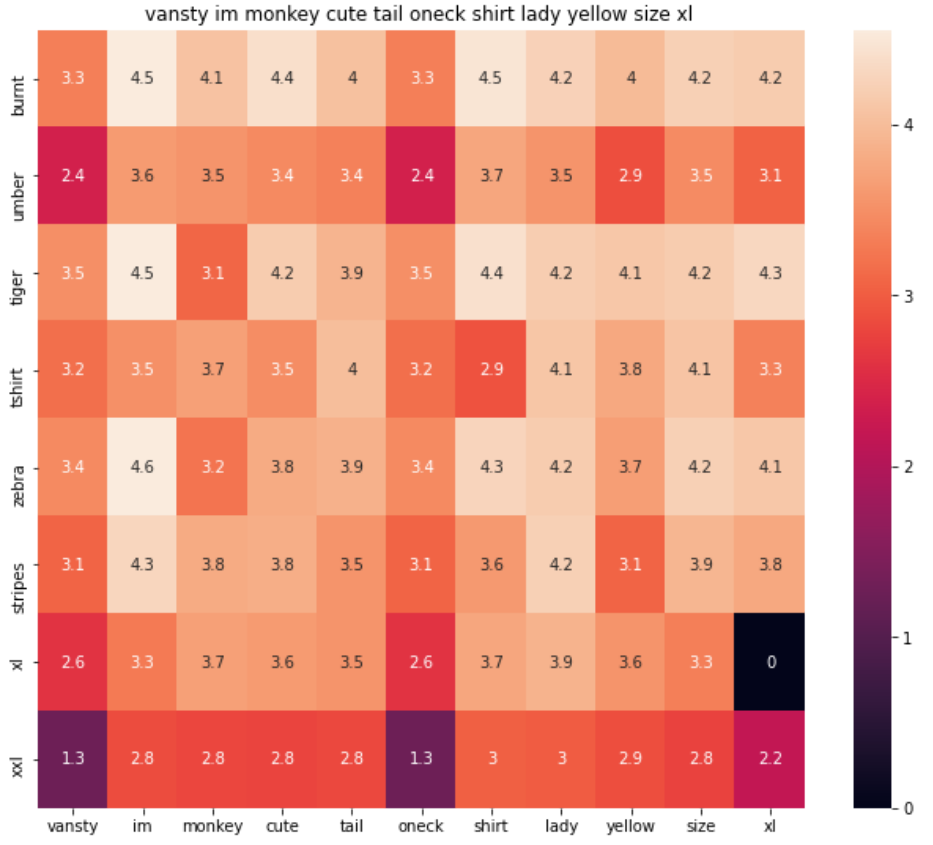
==========





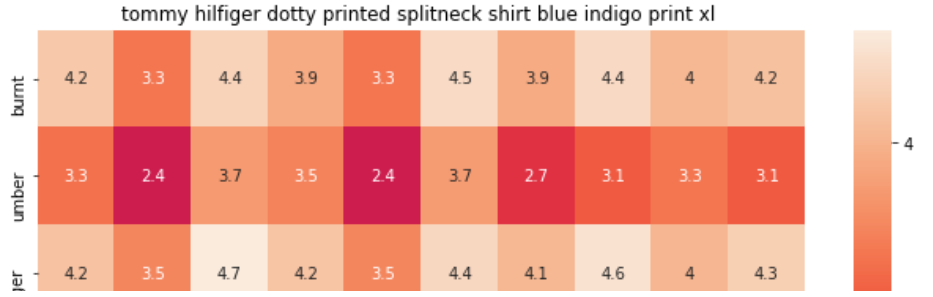
ASIN : B0711NGTQM
BRAND : THILFIGER RTW
euclidean distance from given input image : 1.0923415

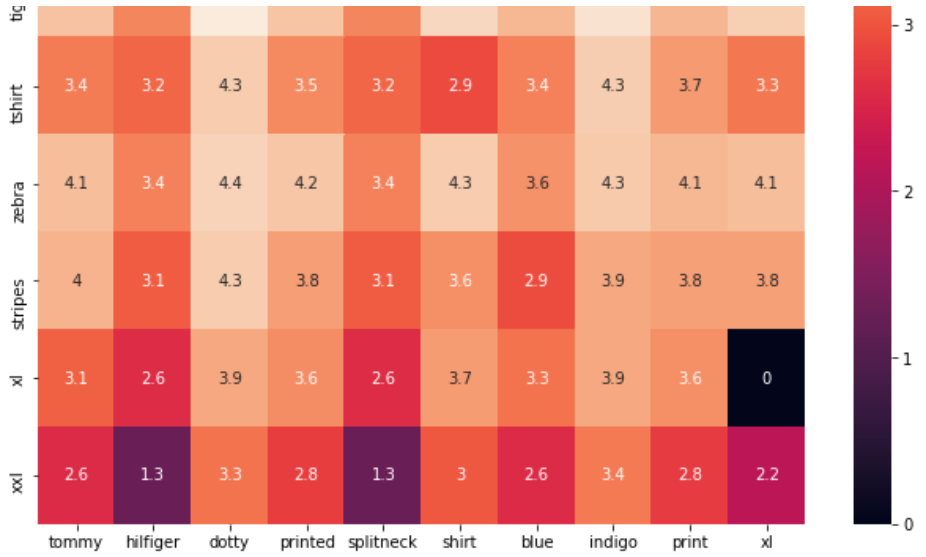
==========



ASIN : B01EFSLO8Y
BRAND : Vansty
euclidean distance from given input image : 1.0934004

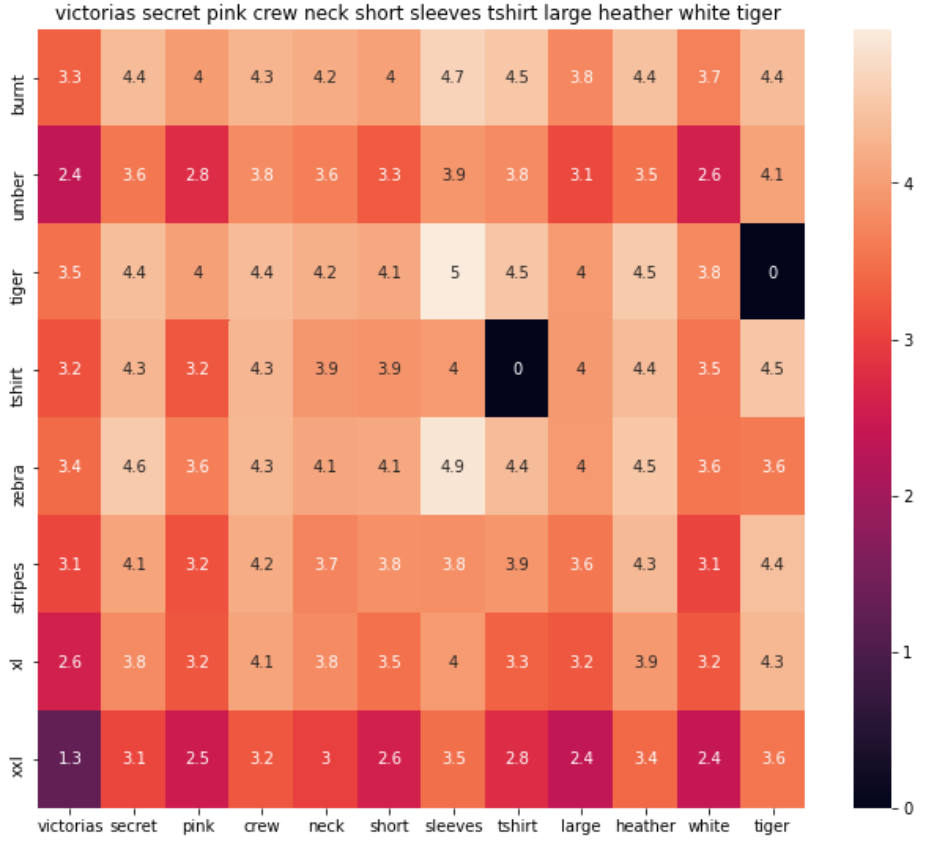
==========





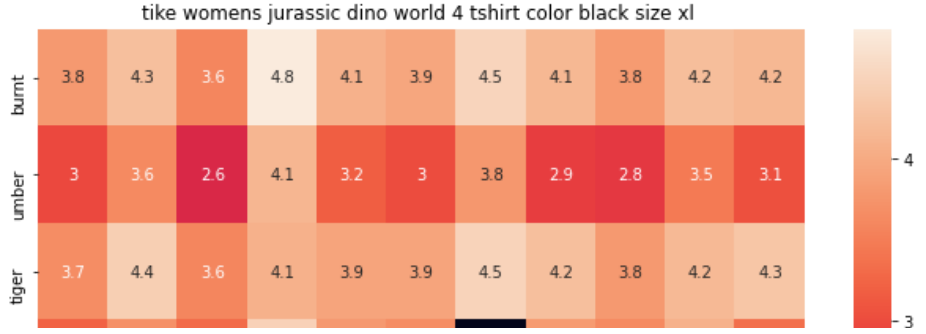
ASIN : B0716TVWQ4
BRAND : THILFIGER RTW
euclidean distance from given input image : 1.0942024

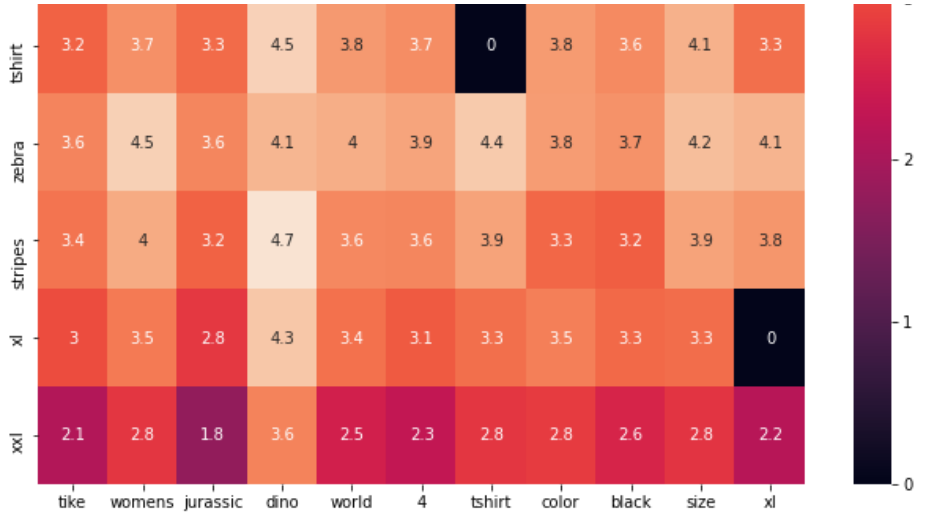
==========



ASIN : B0716MVPGV
BRAND : V.Secret
euclidean distance from given input image : 1.0948304

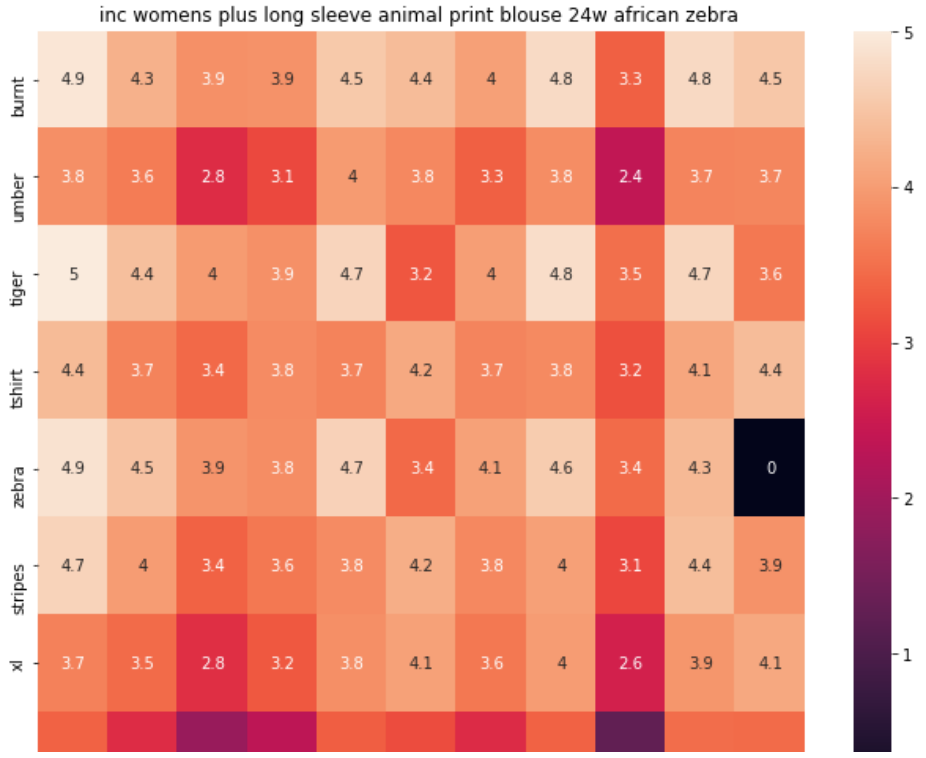
==========





ASIN : B016OPN4OI
BRAND : TIKE Fashions
euclidean distance from given input image : 1.0951275

==========

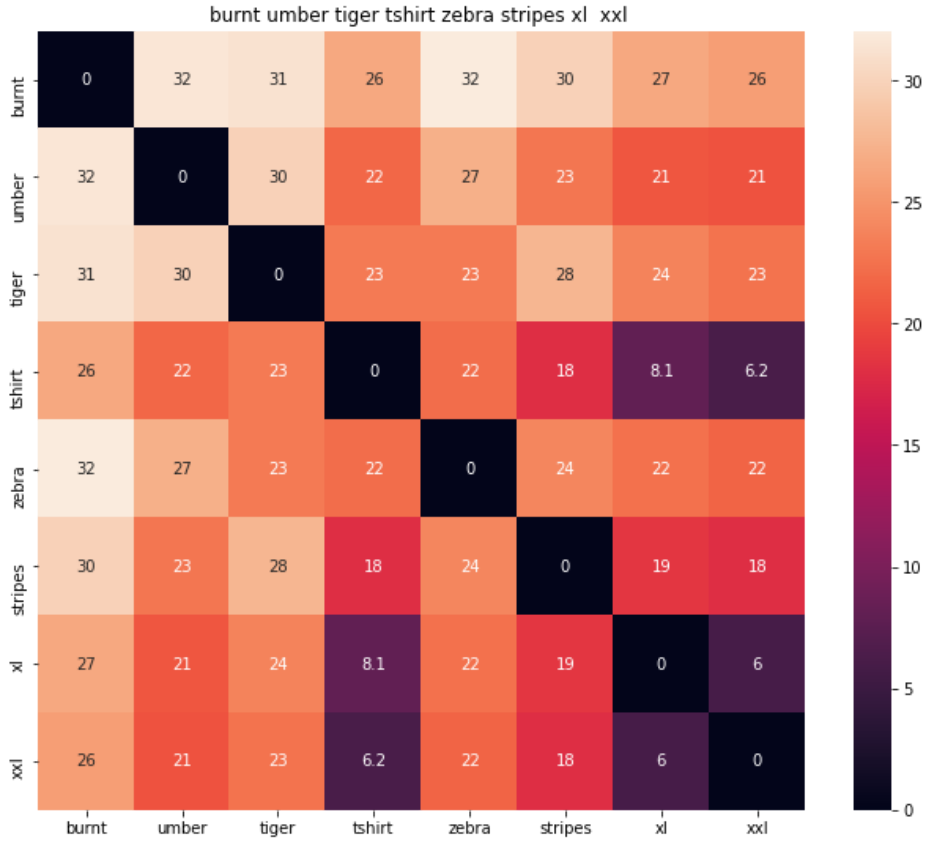


IDF Weighted Word2Vec for Product Similarity

```
doc_id = 0
w2v_title_weight = []
# for every title we build a weighted vector representation
for i in data['title']:
    w2v_title_weight.append(build_avg_vec(i, 300, doc_id,'weighted'))
    doc_id += 1
# w2v_title = np.array(# number of doc in courpus * 300), each row corresponds to a doc
w2v_title_weight = np.array(w2v_title_weight)
```

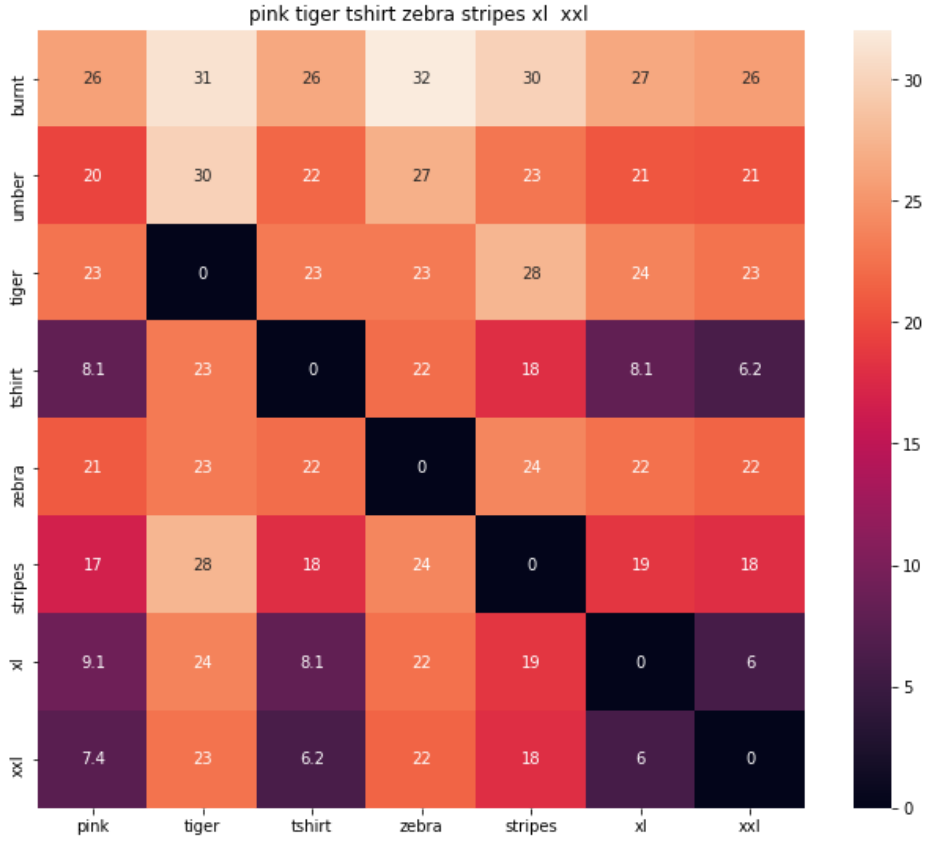
```
def weighted_w2v_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

    # pairwise_dist will store the distance from given input apparel to all remaining apparels
```

```
    # the metric we used here is cosine, the cosine distance is mesured as K(X, Y) = <X, Y> / (||X||*||Y||)
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(w2v_title_weight, w2v_title_weight[doc_id].reshape(1,-1))

    # np.argsort will return indices of 9 smallest distances
    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    #pdists will store the 9 smallest distances
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]

    #data frame indices of the 9 smallest distace's
    df_indices = list(data.index[indices])

    for i in range(0, len(indices)):
        heat_map_w2v(data['title'].loc[df_indices[0]],data['title'].loc[df_indices[i]], data['medium_image_url'].l
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('Brand :',data['brand'].loc[df_indices[i]])
        print('euclidean distance from input :', pdists[i])
        print('='*125)

weighted_w2v_model(12566, 20)
```



ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from input : 0.0

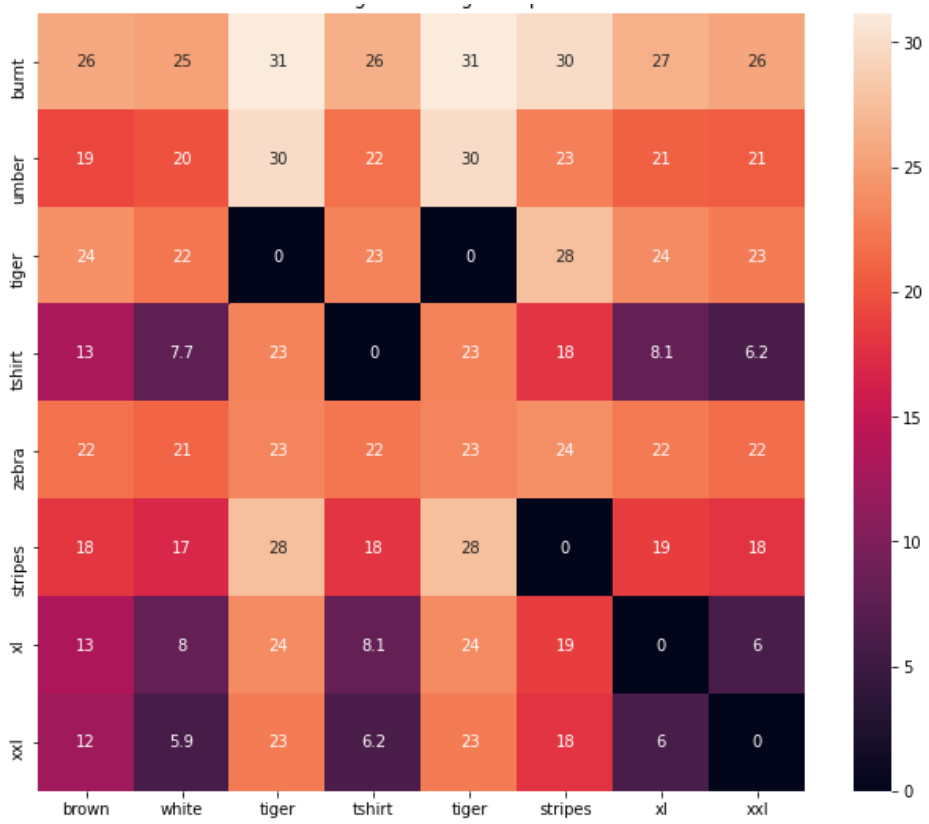
==========



ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from input : 4.0638866

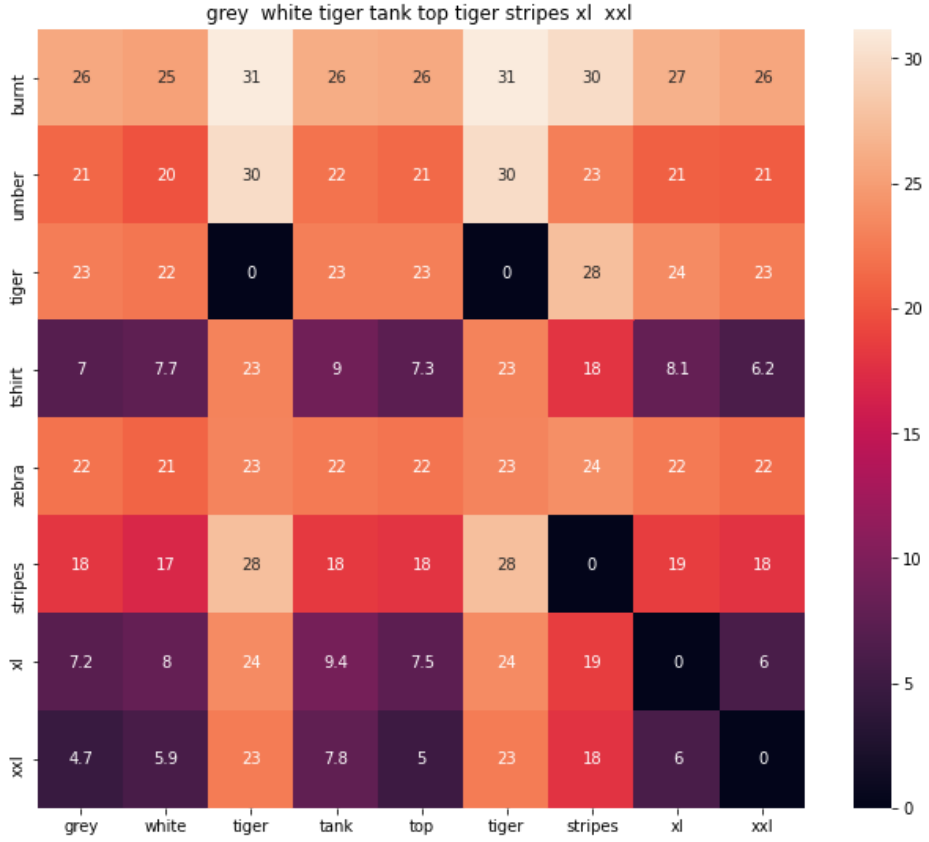
==========

brown white tiger tshirt tiger stripes xl xxl



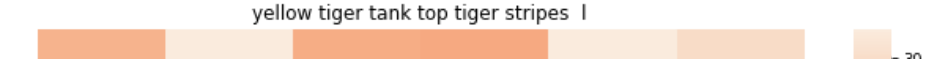
ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from input : 4.7709413

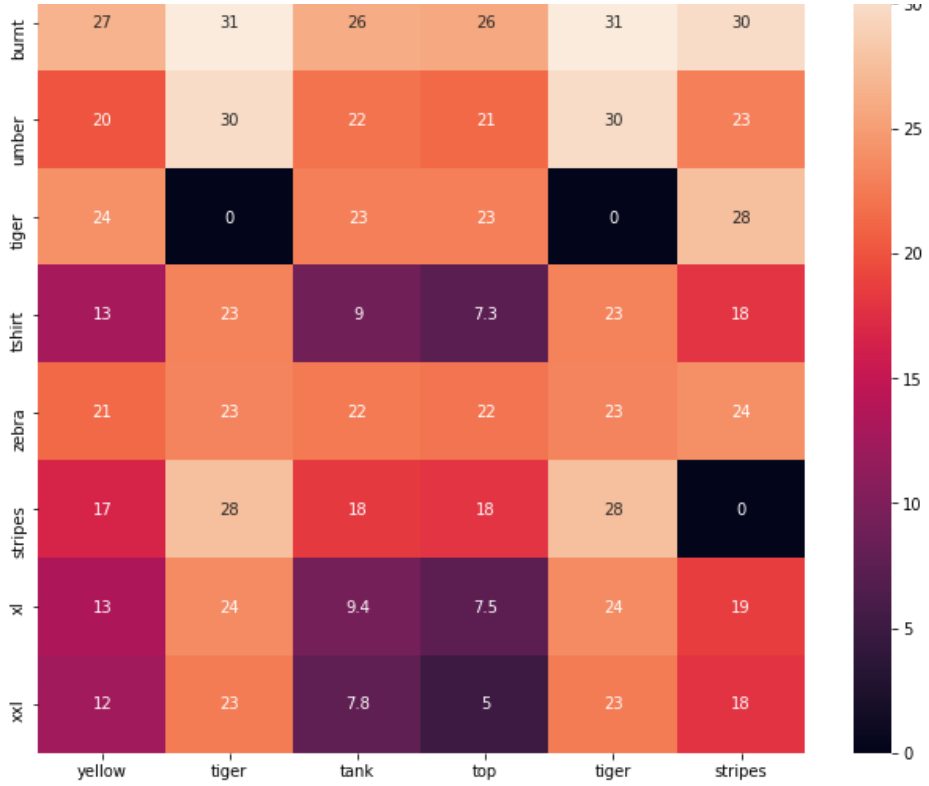
==========



ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from input : 5.3601604

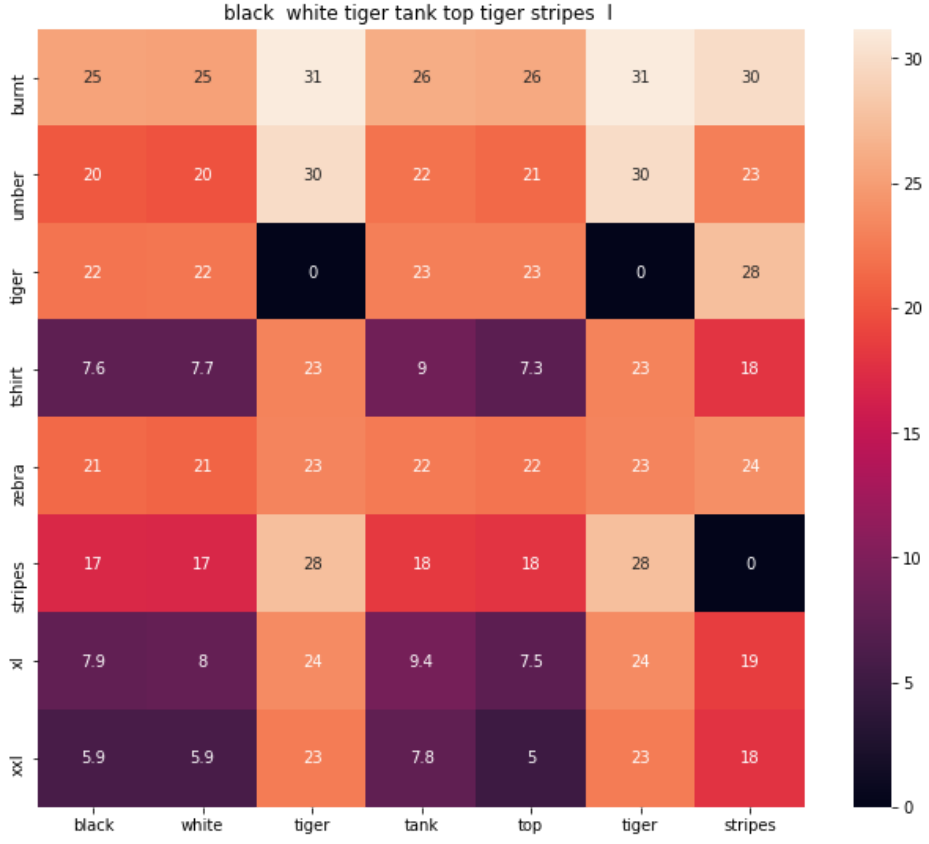
==========





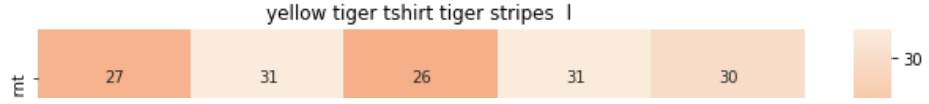
ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from input : 5.6895227

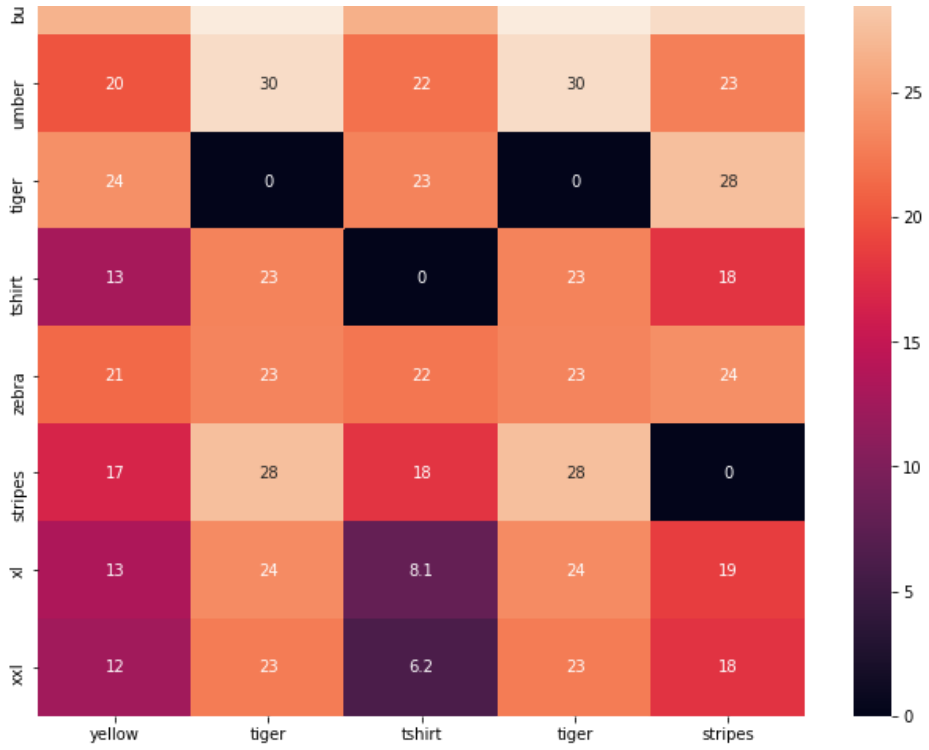
==========



ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from input : 5.693021

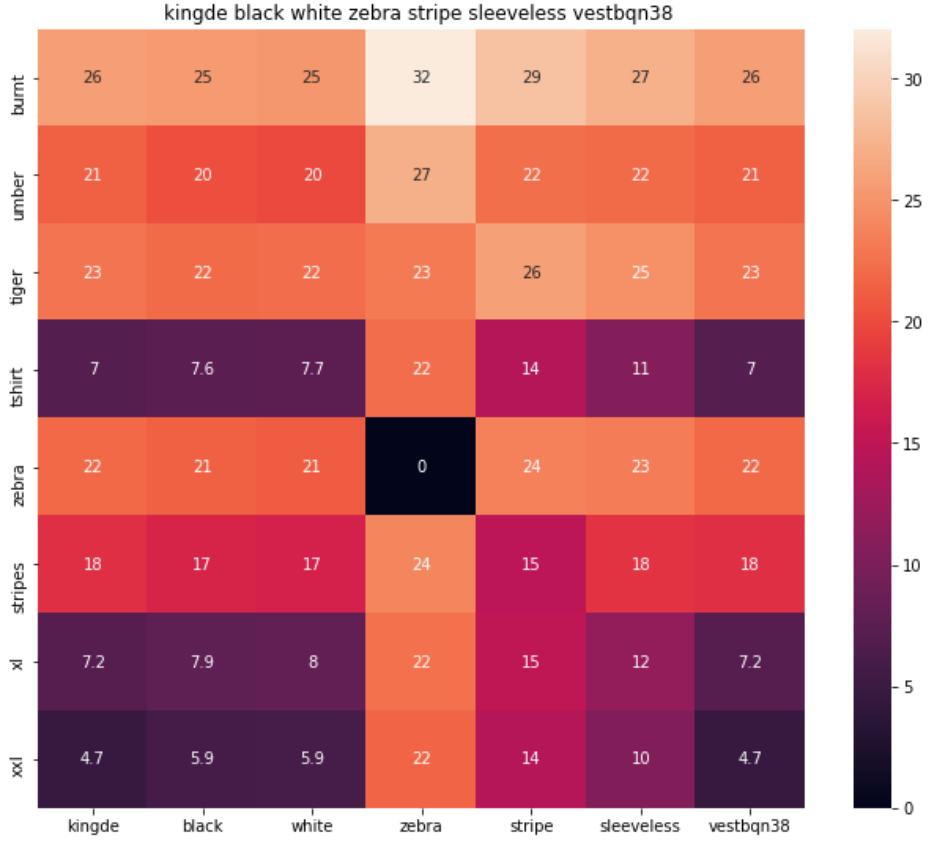
==========





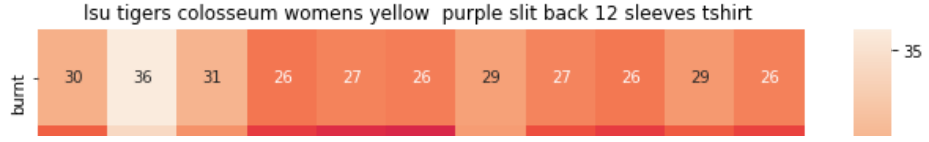
ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from input : 5.893442

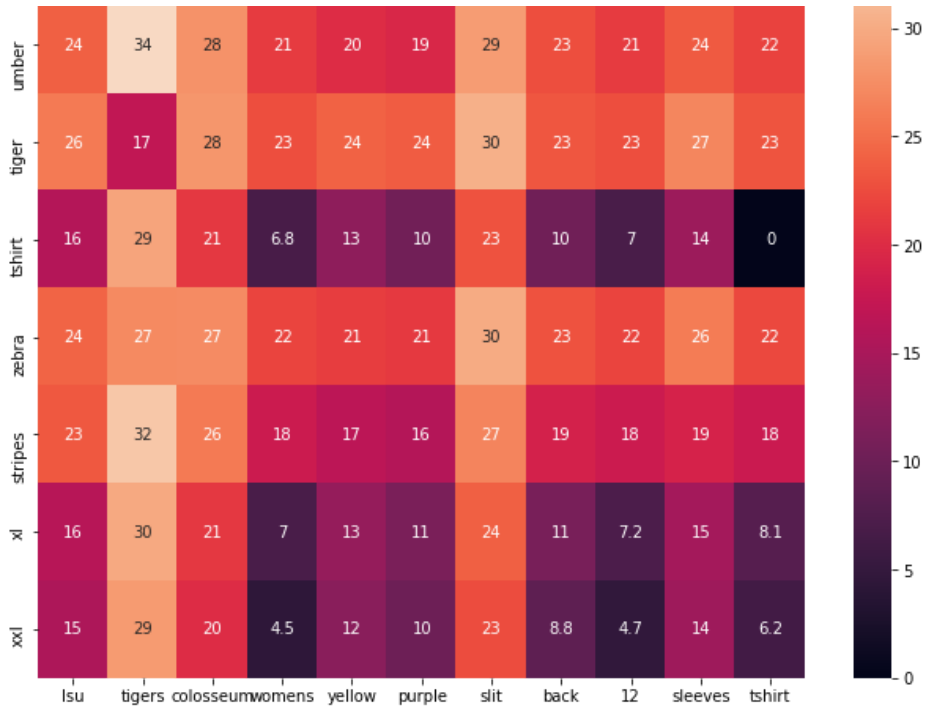
==========



ASIN : B015H41F6G
Brand : KINGDE
euclidean distance from input : 6.1329894

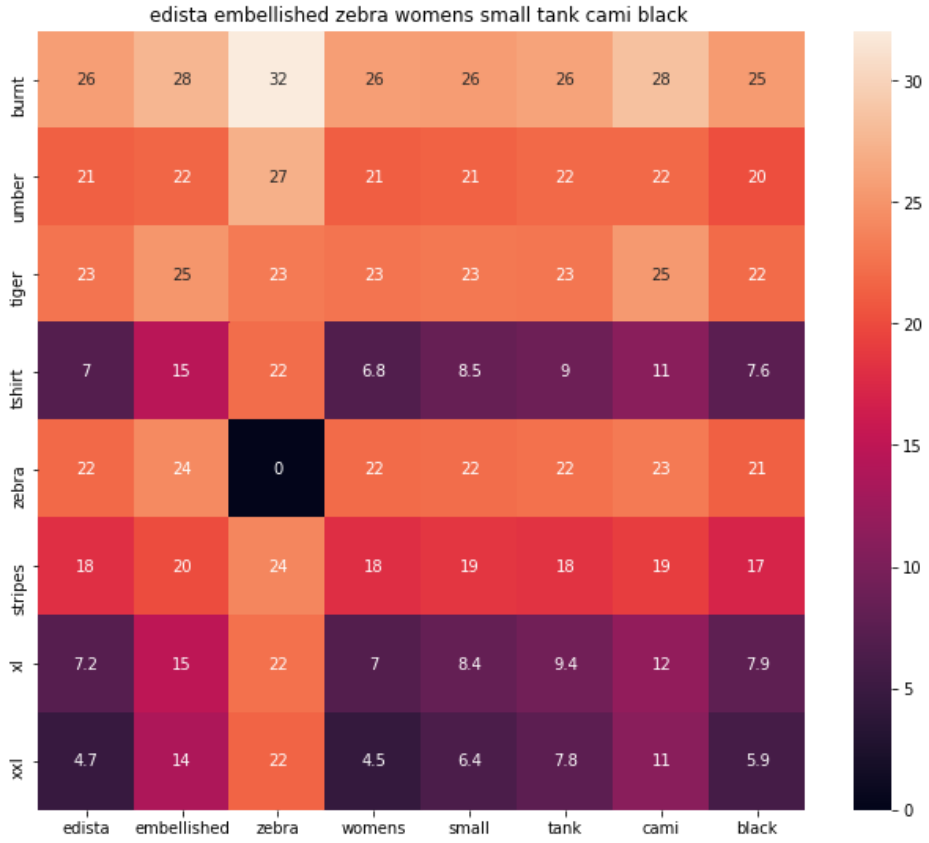
==========





ASIN : B073R5Q8HD
Brand : Colosseum
euclidean distance from input : 6.2567053

==========



ASIN : B074P8MD22
Brand : Edista
euclidean distance from input : 6.3922033

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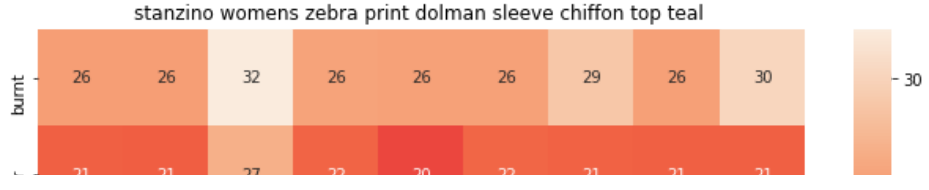

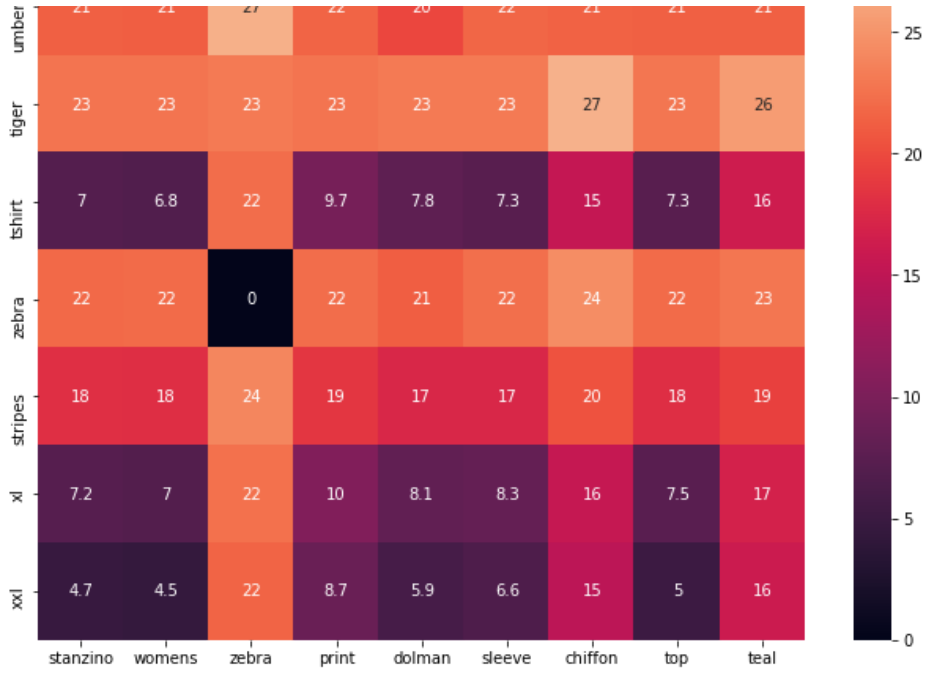

ASIN : B00C0I3U3E
Brand : Stanzino
euclidean distance from input : 6.4149003

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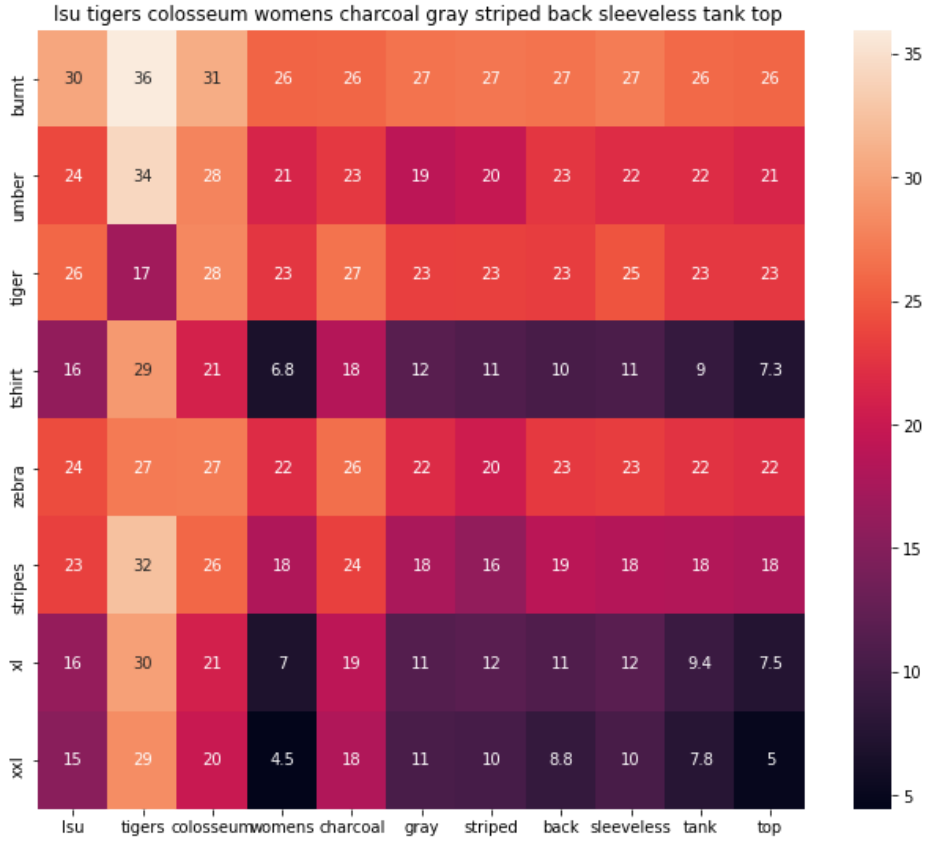
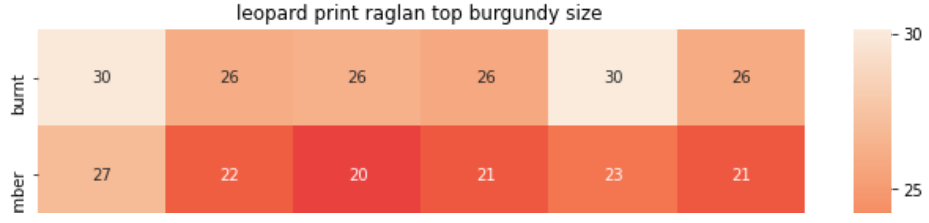
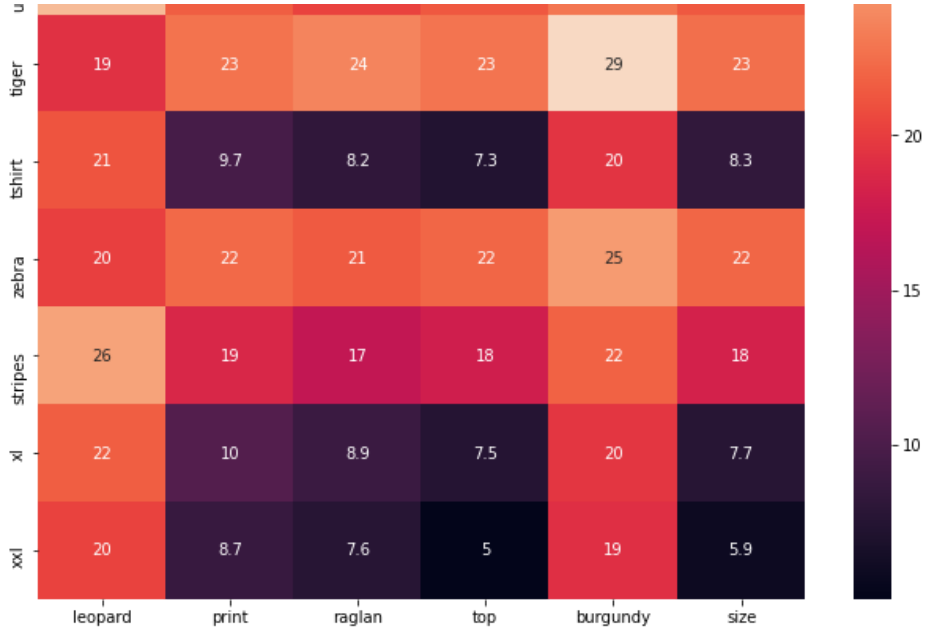


ASIN : B073R4ZM7Y
Brand : Colosseum
euclidean distance from input : 6.450959

==========





ASIN : B01C6ORLDQ
Brand : 1 Mad Fit
euclidean distance from input : 6.463409

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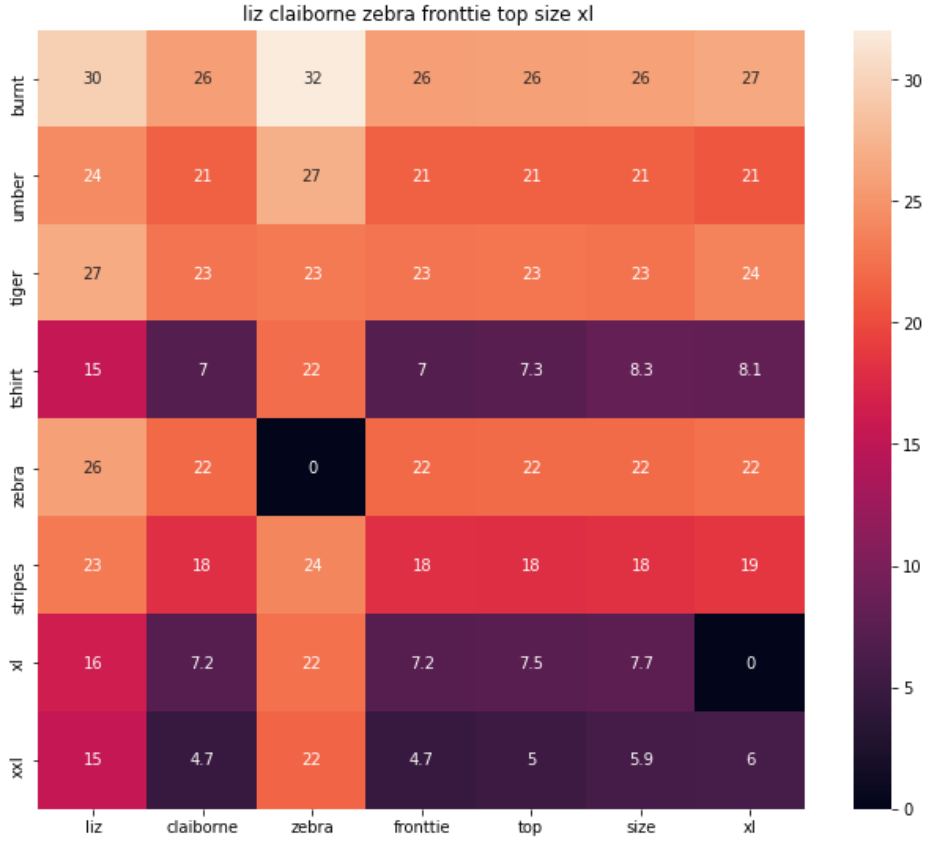
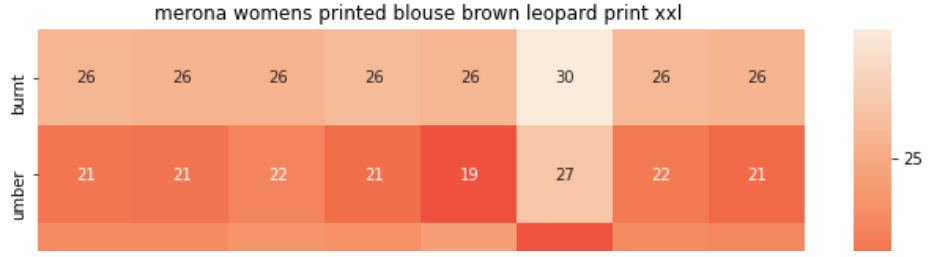
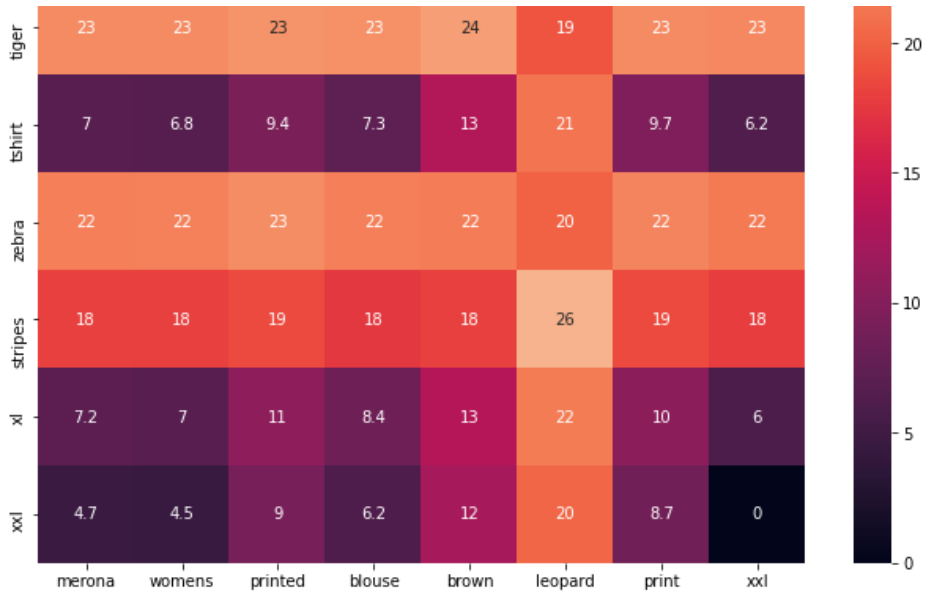


ASIN : B06XBY5QXL
Brand : Liz Claiborne
euclidean distance from input : 6.5392227

==========





ASIN : B071YF3WDD
Brand : Merona
euclidean distance from input : 6.5755024

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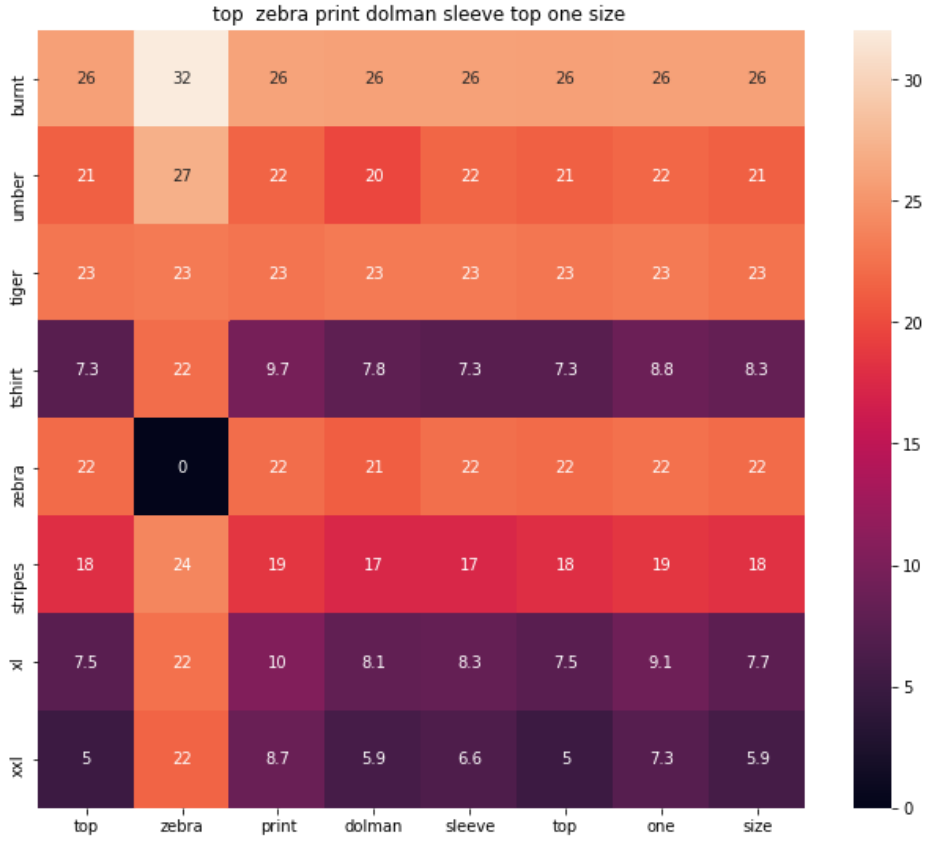
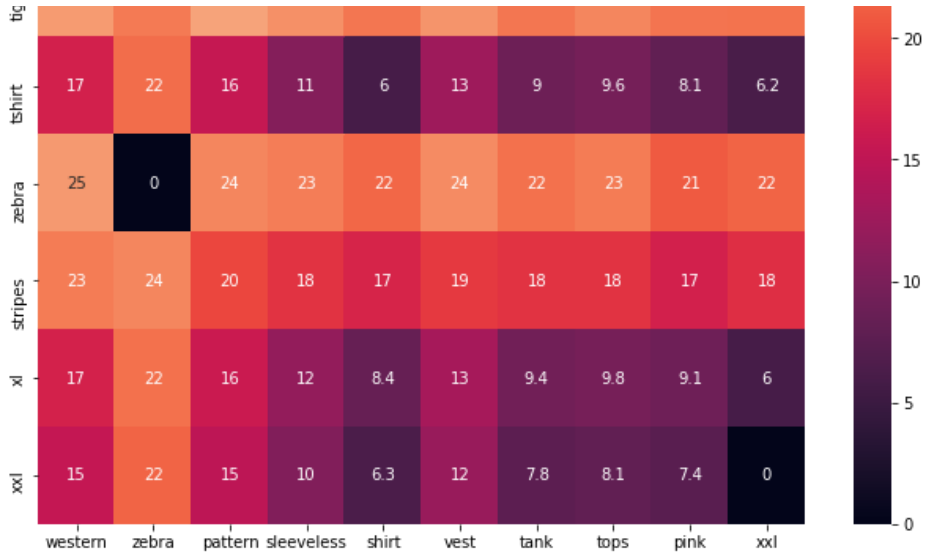


ASIN : B00H8A6ZLI
Brand : Vivian's Fashions
euclidean distance from input : 6.6382146

==========



ASIN : B00Z6HEXWI
Brand : Black Temptation
euclidean distance from input : 6.6607366

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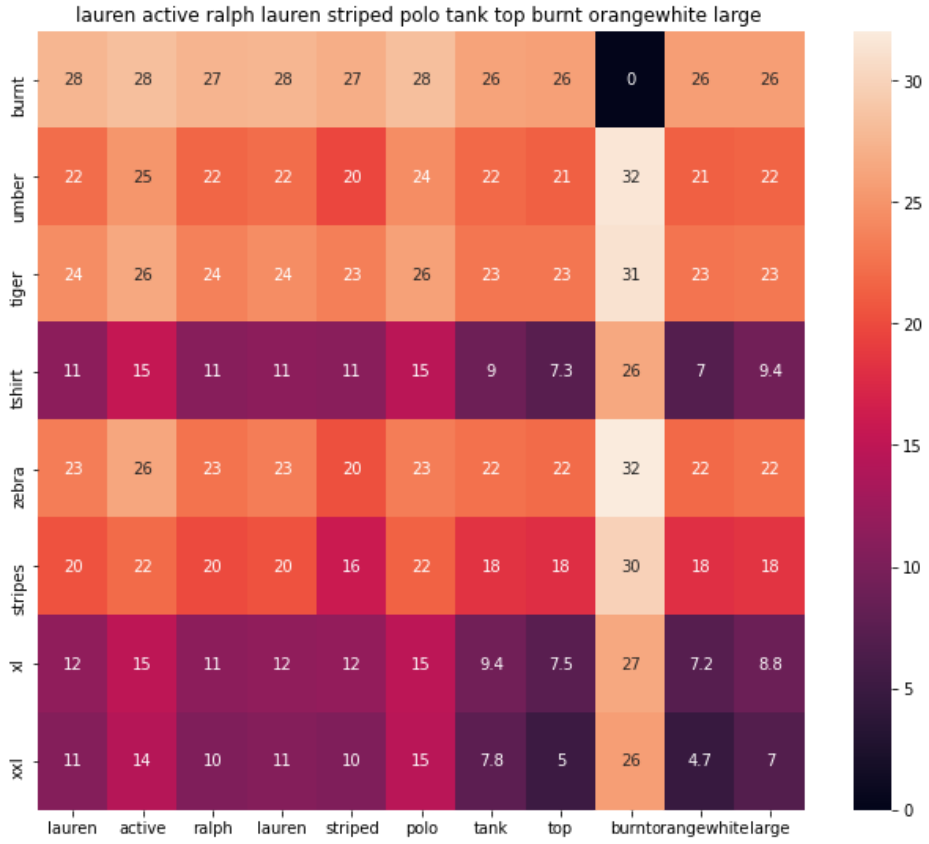
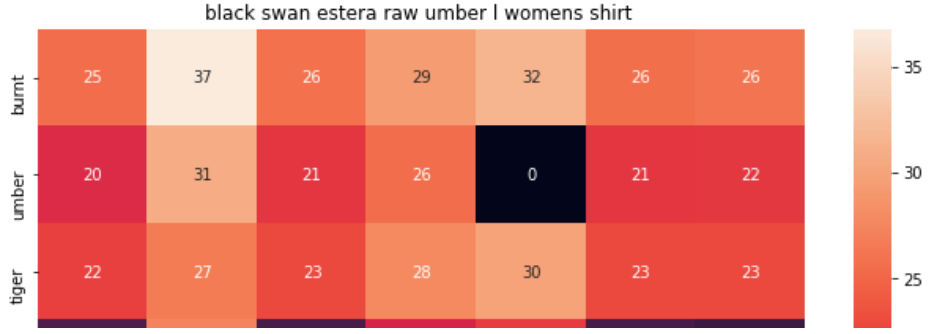
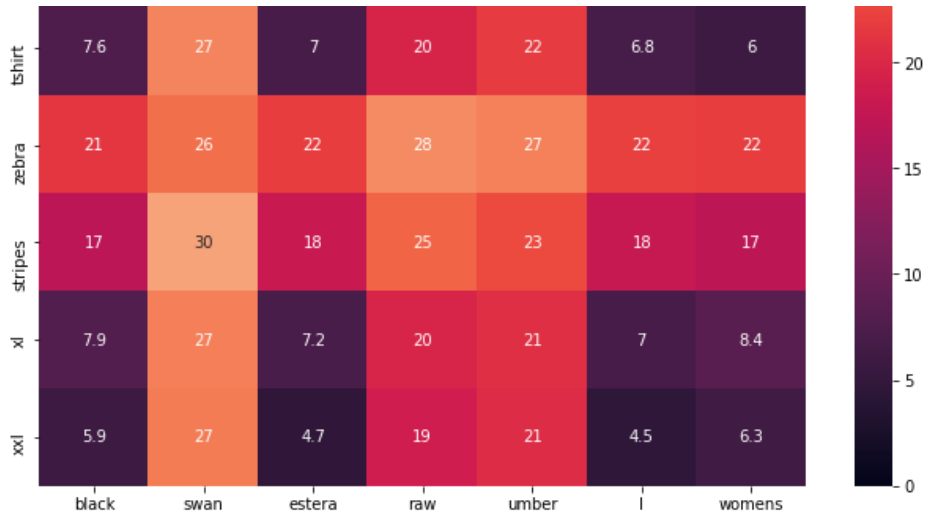


ASIN : B00ILGH5OY
Brand : Ralph Lauren Active
euclidean distance from input : 6.6839046

==========





ASIN : B06Y1VN8WQ

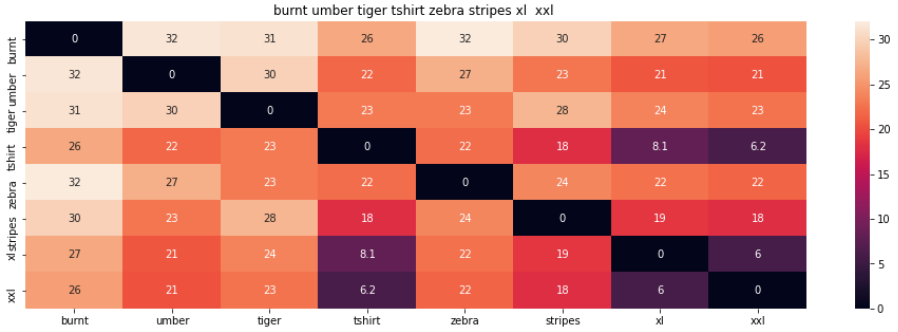
Weighted Similarity using Brand and Color

```
data['brand'].fillna(value="Not given", inplace=True )

# replace spaces with hypen
brands = [x.replace(" ", "-") for x in data['brand'].values]
types = [x.replace(" ", "-") for x in data['product_type_name'].values]
colors = [x.replace(" ", "-") for x in data['color'].values]

brand_vectorizer = CountVectorizer()
brand_features = brand_vectorizer.fit_transform(brands)

type_vectorizer = CountVectorizer()
type_features = type_vectorizer.fit_transform(types)

color_vectorizer = CountVectorizer()
color_features = color_vectorizer.fit_transform(colors)

extra_features = hstack((brand_features, type_features, color_features)).tocsr()
```

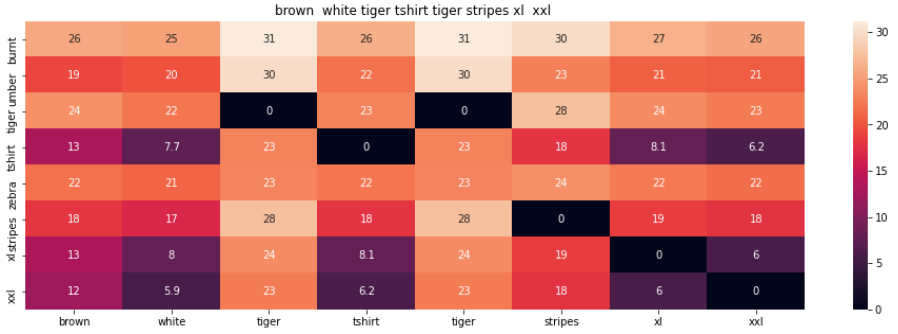
```
def heat_map_w2v_brand(sentance1, sentance2, url, doc_id1, doc_id2, df_id1, df_id2, model):

    s1_vec = get_word_vec(sentance1, doc_id1, model)
    s2_vec = get_word_vec(sentance2, doc_id2, model)

    s1_s2_dist = get_distance(s1_vec, s2_vec)

    data_matrix = [['Asin','Brand', 'Color', 'Product type'],
                [data['asin'].loc[df_id1],brands[doc_id1], colors[doc_id1], types[doc_id1]], # input apparel's feat
                [data['asin'].loc[df_id2],brands[doc_id2], colors[doc_id2], types[doc_id2]]] # recommonded apparel'

    colorscale = [[0, '#1d004d'],[.5, '#f2e5ff'],[1, '#f2e5d1']] # to color the headings of each column

    table = ff.create_table(data_matrix, index=True, colorscale=colorscale)
    plotly.offline.iplot(table, filename='simple_table')

    gs = gridspec.GridSpec(25, 15)
    fig = plt.figure(figsize=(25,5))

    ax1 = plt.subplot(gs[:, :-5])
    ax1 = sns.heatmap(np.round(s1_s2_dist,6), annot=True)
    ax1.set_xticklabels(sentance2.split())
    ax1.set_yticklabels(sentance1.split())
```

```
    ax1.set_title(sentance2)

    ax2 = plt.subplot(gs[:, 10:16])
    ax2.grid(False)
    ax2.set_xticks([])
    ax2.set_yticks([])

    display_img(url, ax2, fig)

    plt.show()
```

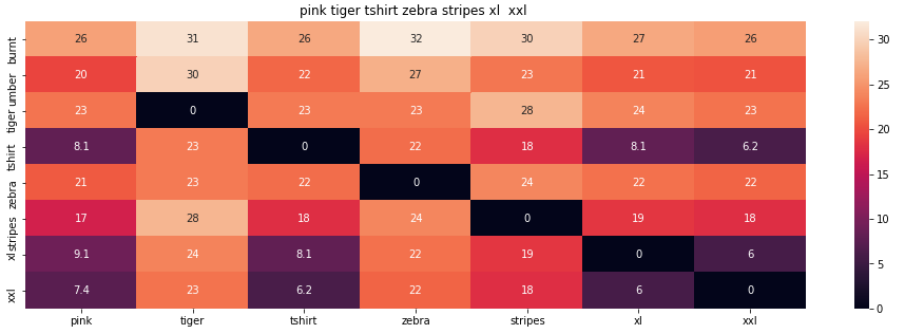
```
def idf_w2v_brand(doc_id, w1, w2, num_results):
    idf_w2v_dist  = pairwise_distances(w2v_title_weight, w2v_title_weight[doc_id].reshape(1,-1))
    ex_feat_dist = pairwise_distances(extra_features, extra_features[doc_id])
    pairwise_dist   = (w1 * idf_w2v_dist +  w2 * ex_feat_dist)/float(w1 + w2)

    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]

    df_indices = list(data.index[indices])


    for i in range(0, len(indices)):
        heat_map_w2v_brand(data['title'].loc[df_indices[0]],data['title'].loc[df_indices[i]], data['medium_image_u
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('Brand :',data['brand'].loc[df_indices[i]])
        print('euclidean distance from input :', pdists[i])
        print('='*125)

idf_w2v_brand(12566, 5, 5, 20)
```



ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from input : 0.0
==========

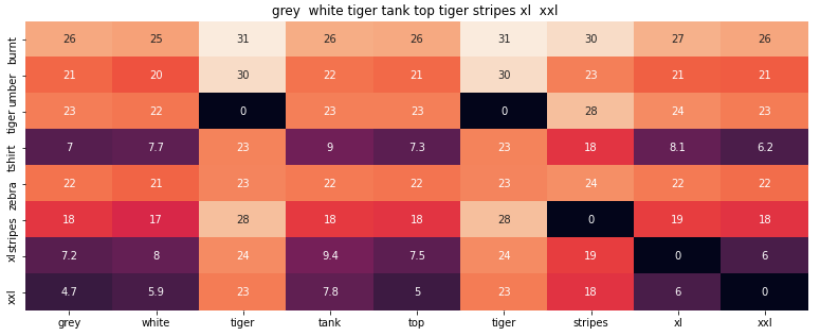


ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from input : 2.3854705810546877
==========

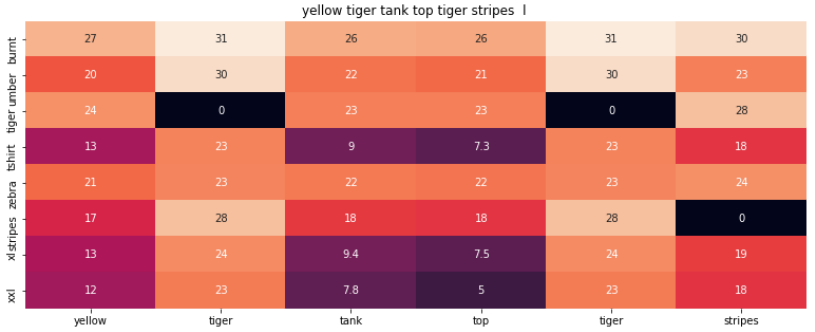


ASIN : B00JXQASS6
Brand : Si Row

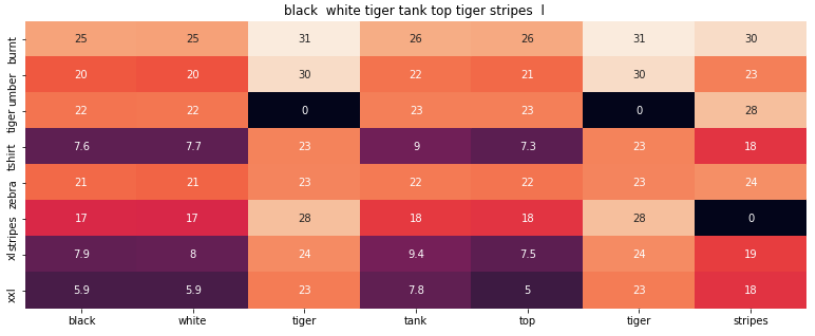
```
euclidean distance from input : 2.739050102414575
```



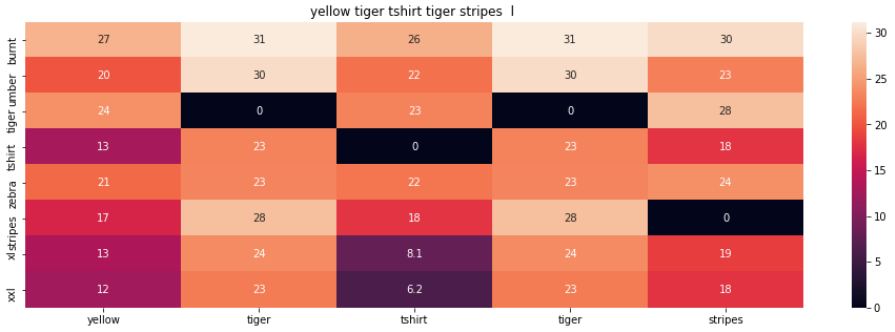
```
ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from input : 3.387187004270044
```



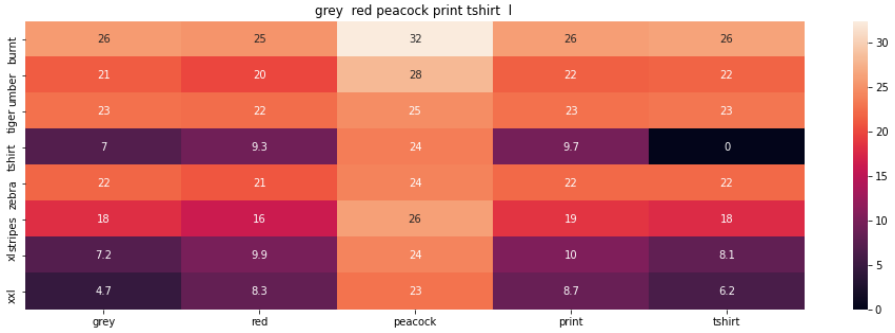
```
ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from input : 3.5518680574316646
```



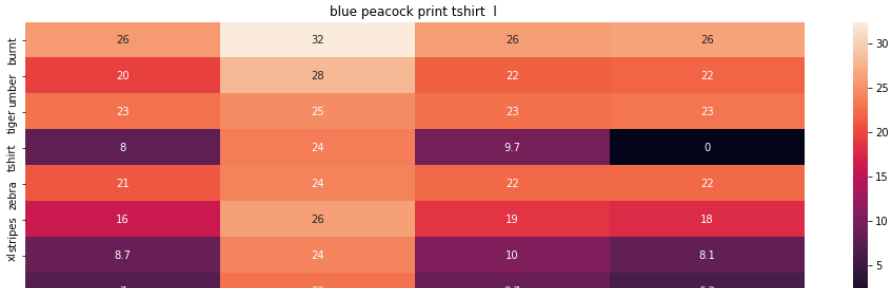
```
ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from input : 3.5536170961279536
```



```
ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from input : 3.6538278581518795
```

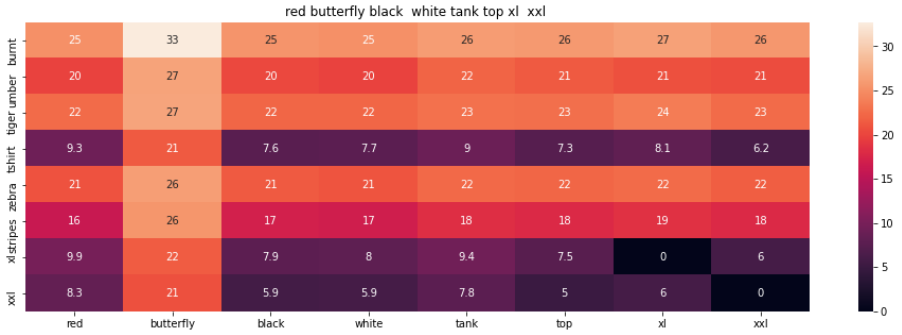


```
ASIN : B00JXQCFRS
Brand : Si Row
euclidean distance from input : 4.128811264218774
```



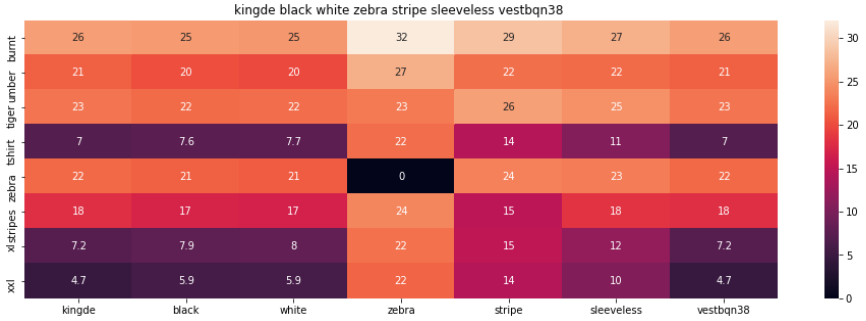
ASIN : B00JXQC8L6
Brand : Si Row
euclidean distance from input : 4.203900146665063

==========



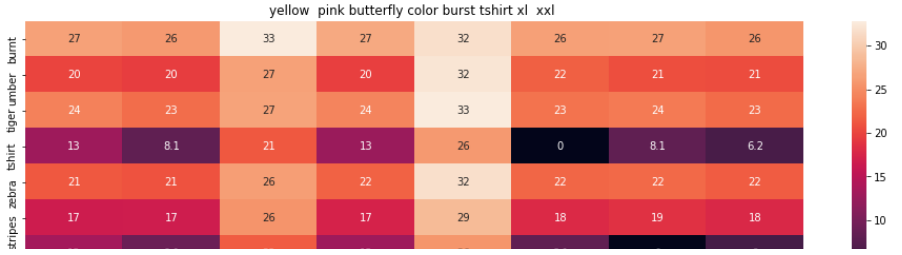
ASIN : B00JV63CW2
Brand : Si Row
euclidean distance from input : 4.286586380185571

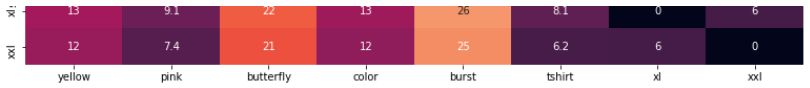
==========



ASIN : B015H41F6G
Brand : KINGDE
euclidean distance from input : 4.389370406508858

==========





ASIN : B00JXQBBMI
Brand : Si Row
euclidean distance from input : 4.397909927548852
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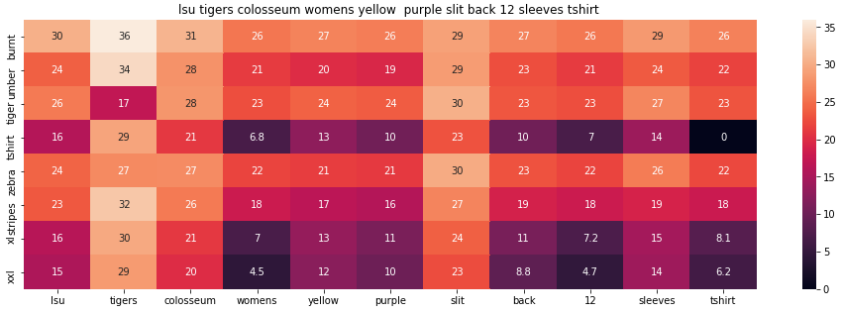
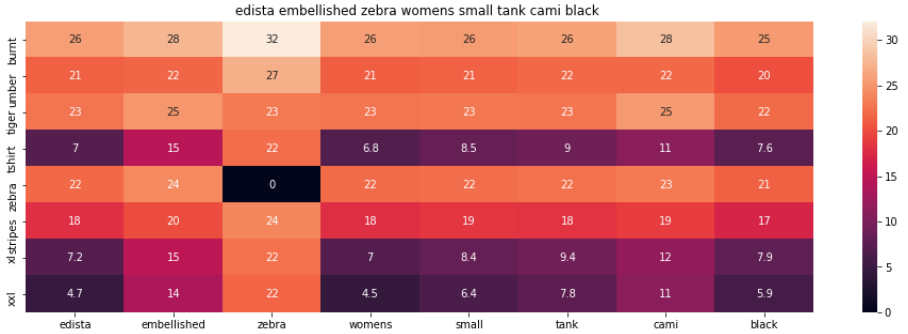


ASIN : B073R5Q8HD
Brand : Colosseum
euclidean distance from input : 4.451228392959053
==========



ASIN : B074P8MD22
Brand : Edista
euclidean distance from input : 4.518977416396553
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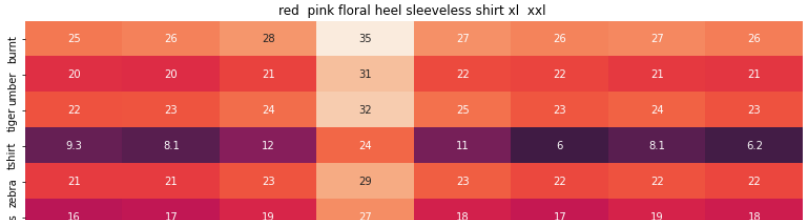
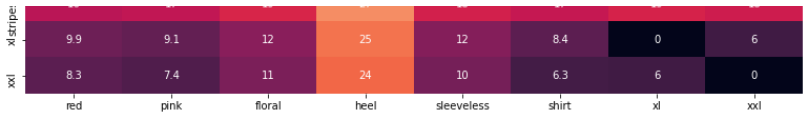
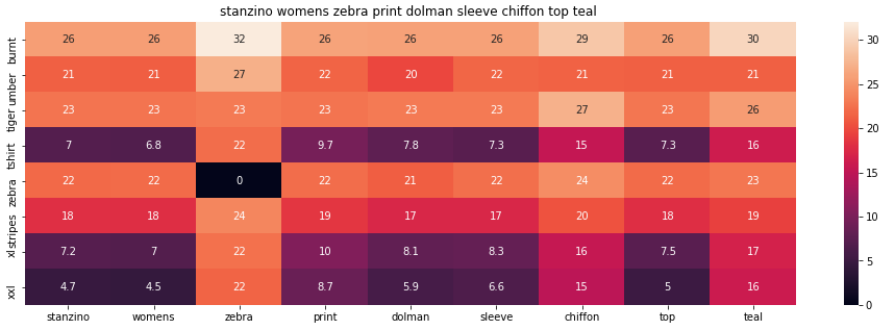
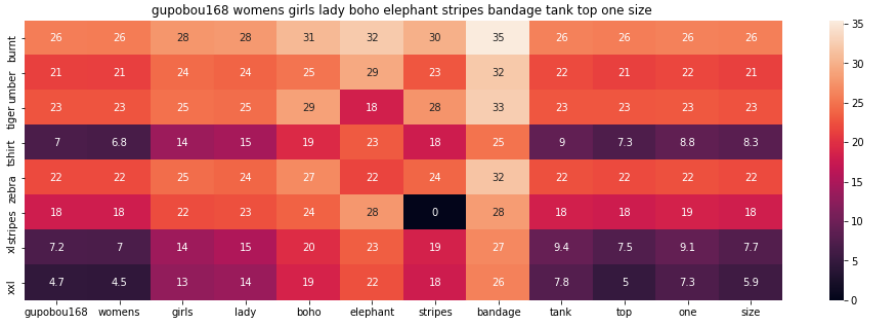




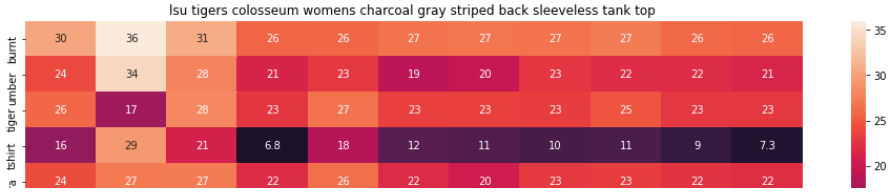
ASIN : B00JV63QQE
Brand : Si Row
euclidean distance from input : 4.529374695004907

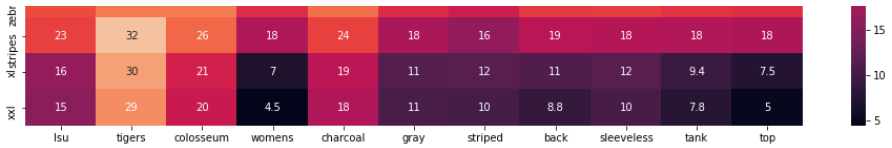


ASIN : B00C0I3U3E
Brand : Stanzino
euclidean distance from input : 4.530325759292061

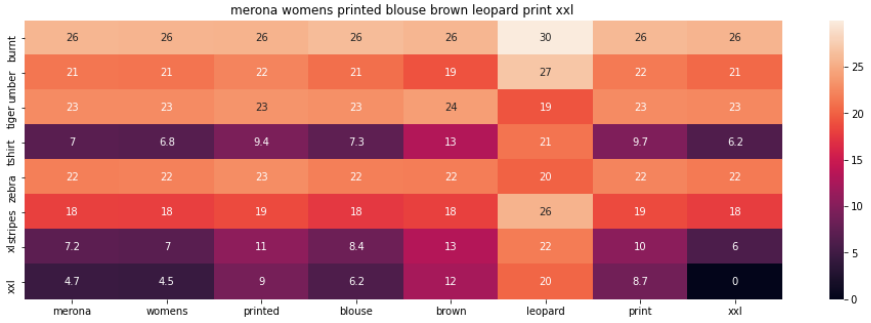


ASIN : B01ER184O6
Brand : GuPoBoU168
euclidean distance from input : 4.546816642558488

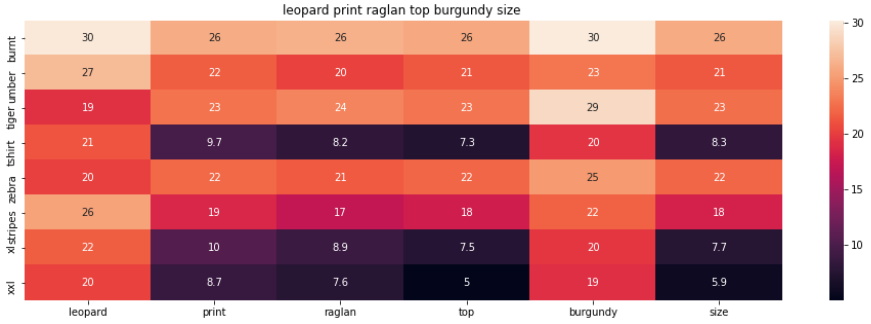




ASIN : B073R4ZM7Y
Brand : Colosseum
euclidean distance from input : 4.548355162978584
==========



ASIN : B071YF3WDD
Brand : Merona
euclidean distance from input : 4.610626662612374
==========



ASIN : B01C6ORLDQ
Brand : 1 Mad Fit
euclidean distance from input : 4.645917892817431
==========

Keras and TensorFlow to Extract Features

```
import numpy as np
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Sequential
from keras.layers import Dropout, Flatten, Dense
from keras import applications
from sklearn.metrics import pairwise_distances
import matplotlib.pyplot as plt
import requests
from PIL import Image
import pandas as pd
import pickle
```

Visual Features based product similarity

```
bottleneck_features_train = np.load('/content/drive/My Drive/Colab Notebooks/Appareal Recommendation/6k_data_cnn_f
asins = np.load('/content/drive/My Drive/Colab Notebooks/Appareal Recommendation/16k_data_cnn_feature_asins.npy')
asins = list(asins)

# load the original 16K dataset
data = pd.read_pickle('/content/drive/My Drive/Colab Notebooks/Appareal Recommendation/pickels/16k_apperal_data_pr
df_asins = list(data['asin'])


from IPython.display import display, Image, SVG, Math, YouTubeVideo


#get similar products using CNN features (VGG-16)
def get_similar_products_cnn(doc_id, num_results):
    doc_id = asins.index(df_asins[doc_id])
    pairwise_dist = pairwise_distances(bottleneck_features_train, bottleneck_features_train[doc_id].reshape(1,-1))

    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]

    for i in range(len(indices)):
        rows = data[['medium_image_url','title']].loc[data['asin']==asins[indices[i]]]
        for indx, row in rows.iterrows():
            display(Image(url=row['medium_image_url'], embed=True))
            print('Product Title: ', row['title'])
            print('Euclidean Distance from input image:', pdists[i])
            print('Amazon Url: www.amzon.com/dp/'+ asins[indices[i]])

get_similar_products_cnn(12566, 20)
```

Product Title: burnt umber tiger tshirt zebra stripes xl xxl
Euclidean Distance from input image: 6.32596e-06
Amazon Url: www.amzon.com/dp/B00JXQB5FQ

Product Title: pink tiger tshirt zebra stripes xl xxl
Euclidean Distance from input image: 30.05017
Amazon Url: www.amzon.com/dp/B00JXQASS6

Product Title: yellow tiger tshirt tiger stripes l
Euclidean Distance from input image: 41.261116
Amazon Url: www.amzon.com/dp/B00JXQCUIC

Product Title: brown white tiger tshirt tiger stripes xl xxl
Euclidean Distance from input image: 44.000156
Amazon Url: www.amzon.com/dp/B00JXQCWTO

Product Title: kawaii pastel tops tees pink flower design
Euclidean Distance from input image: 47.38248
Amazon Url: www.amzon.com/dp/B071FCWD97

Product Title: womens thin style tops tees pastel watermelon print
Euclidean Distance from input image: 47.71842
Amazon Url: www.amzon.com/dp/B01JUNHBRM

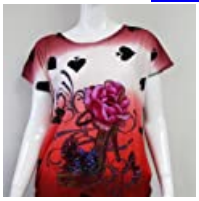
Product Title: kawaii pastel tops tees baby blue flower design
Euclidean Distance from input image: 47.90206
Amazon Url: www.amzon.com/dp/B071SBCY9W

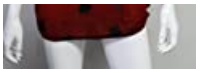
Product Title: edv cheetah run purple multi xl
Euclidean Distance from input image: 48.046482
Amazon Url: www.amzon.com/dp/B01CUPYBM0

Product Title: danskin womens vneck loose performance tee xsmall pink ombre
Euclidean Distance from input image: 48.101837
Amazon Url: www.amzon.com/dp/B01F7PHXY8

Product Title: summer alpaca 3d pastel casual loose tops tee design
Euclidean Distance from input image: 48.118866
Amazon Url: www.amzon.com/dp/B01I80A93G

Product Title: miss chievous juniors striped peplum tank top medium shadowpeach
Euclidean Distance from input image: 48.13122
Amazon Url: www.amzon.com/dp/B0177DM70S





Product Title: red pink floral heel sleeveless shirt xl xxl
Euclidean Distance from input image: 48.16945
Amazon Url: www.amzon.com/dp/B00JV63QQE

Product Title: moana logo adults hot v neck shirt black xxl
Euclidean Distance from input image: 48.256786
Amazon Url: www.amzon.com/dp/B01LX6H43D

Product Title: abaday multicolor cartoon cat print short sleeve longline shirt large
Euclidean Distance from input image: 48.265686
Amazon Url: www.amzon.com/dp/B01CR57YY0

ASSIGNMENT ASK

```
from IPython.display import display, Image, SVG, Math, YouTubeVideo


#get similar products using CNN features (VGG-16)
def get_similar_products_cnn(doc_id,weighted_text,weighted_brand,weighted_color,weighted_image, num_results):
    doc_id = asins.index(df_asins[doc_id])

    idf_w2v_dist  = pairwise_distances(w2v_title_weight, w2v_title_weight[doc_id].reshape(1,-1))
    brand_dist = pairwise_distances(brand_features, brand_features[doc_id])
    color_dist = pairwise_distances(color_features, color_features[doc_id])
    bottleneck_features_dist = pairwise_distances(bottleneck_features_train, bottleneck_features_train[doc_id].res

    pairwise_dist = (weighted_text * idf_w2v_dist +  weighted_brand * brand_dist + weighted_color * color_dist + w

    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    pdists  = np.sort(pairwise_dist.flatten())[0:num_results]

    for i in range(len(indices)):
        rows = data[['medium_image_url','title']].loc[data['asin']==asins[indices[i]]]
        for indx, row in rows.iterrows():
            display(Image(url=row['medium_image_url'], embed=True))
            print('Product Title: ', row['title'])
            print('Euclidean Distance from input image:', pdists[i])
            print('Amazon Url: www.amzon.com/dp/'+ asins[indices[i]])

get_similar_products_cnn(12562,50,30,20,100,20)
```

Product Title: im huckleberry doc holliday 34sleeve raglan long sleeve
Euclidean Distance from input image: 3.09025781461969e-06
Amazon Url: www.amzon.com/dp/B01MG2JKHS

Product Title: chubby unicorn need love 34sleeve raglan long sleeve
Euclidean Distance from input image: 10.435585098356945
Amazon Url: www.amzon.com/dp/B01M67SUP1

Product Title: bibliophile literary like party 34sleeve raglan long sleeve
Euclidean Distance from input image: 10.636690874878477
Amazon Url: www.amzon.com/dp/B01MFAZI9M

Product Title: kanye west pinterest 34sleeve raglan long sleeve
Euclidean Distance from input image: 10.997035369963392
Amazon Url: www.amzon.com/dp/B01MG2KZTK

Product Title: rip harambe cartoon 17th birthday killed 34sleeve raglan long sleeve
Euclidean Distance from input image: 11.19805931100343
Amazon Url: www.amzon.com/dp/B01MPZYO3I

Product Title: jesus drank wine 34sleeve raglan long sleeve
Euclidean Distance from input image: 11.286864700407728
Amazon Url: www.amzon.com/dp/B01MG2KH61

Product Title: xjbd womens peaky drama series long sleeve blended baseball shirt size xl
Euclidean Distance from input image: 11.46103263864015
Amazon Url: www.amzon.com/dp/B01M0B32NI

Product Title: engineer good math 34sleeve raglan long sleeve
Euclidean Distance from input image: 11.609403152556165
Amazon Url: www.amzon.com/dp/B01MG2PTEZ

Product Title: tell time pm 34sleeve raglan long sleeve
Euclidean Distance from input image: 11.876585311979992
Amazon Url: www.amzon.com/dp/B01MFBI9GM

Product Title: choose violence 34sleeve raglan long sleeve
Euclidean Distance from input image: 12.031382605456672
Amazon Url: www.amzon.com/dp/B01MPZYO33

Product Title: xjbd womens care pizza long sleeve blended baseball tshirts size
Euclidean Distance from input image: 12.691571932617736
Amazon Url: www.amzon.com/dp/B01M0B32OT

Product Title: harambe gorilla 19992016 34sleeve raglan long sleeve
Euclidean Distance from input image: 12.799911499059576
Amazon Url: www.amzon.com/dp/B01MG2K8BM

Product Title: youre killing smalls 34sleeve raglan long sleeve
Euclidean Distance from input image: 12.818527270142148
Amazon Url: www.amzon.com/dp/B01MFAZEVC

Product Title: pizza 34sleeve raglan long sleeve
Euclidean Distance from input image: 12.8656582642505
Amazon Url: www.amzon.com/dp/B01MPZYO3E

Product Title: love husband 34sleeve raglan long sleeve
Euclidean Distance from input image: 12.903641433806165
Amazon Url: www.amzon.com/dp/B01M30HH5A

Product Title: daddys little monster 34sleeve raglan long sleeve
Euclidean Distance from input image: 12.971011886687025
Amazon Url: www.amzon.com/dp/B01M4MWVNV

Product Title: xjbd womens team jesus long sleeve blended baseball tshirts size xl
Euclidean Distance from input image: 13.118819461991782
Amazon Url: www.amzon.com/dp/B01M0B6BLO

Product Title: xjbd womens parkour dance long sleeve contrast raglan sleeve rib tshirt size l
Euclidean Distance from input image: 13.167239608854993
Amazon Url: www.amzon.com/dp/B01M0B8EMX

Product Title: daddy lils squirt 34sleeve raglan long sleeve
Euclidean Distance from input image: 13.217423782438978
Amazon Url: www.amzon.com/dp/B01MG2SGVM

PERFORMING DIFFERENT VALUES OF WEIGHTS

WEIGHT TEXT = 100 , WEIGHT BRAND=50 , WEIGHT COLOR = 50 & WEIGHT IMAGE=150 & DOCUMENT ID = 12560

```
1 get_similar_products_cnn(12560,100,50,50,150,20)
```

Product Title: womens 7 ronaldo quotes love win tshirts xxl black short sleeve
Euclidean Distance from input image: 2.584956819191575e-06
Amazon Url: www.amzon.com/dp/B01JSLCWXO

Product Title: baby funny slim fit roger federer tshirt size xl color black
Euclidean Distance from input image: 9.62749973852401
Amazon Url: www.amzon.com/dp/B00ZCFTMOS

Product Title: girls fairy tail exceed tee shirts black
Euclidean Distance from input image: 10.081477359768495
Amazon Url: www.amzon.com/dp/B01L9F153U

Product Title: womens ptx pentatonix piano logo shirts black cool
Euclidean Distance from input image: 10.686583037781888
Amazon Url: www.amzon.com/dp/B01JLSSCRY

Product Title: fashion womens dodge truck tee black size xs
Euclidean Distance from input image: 11.011278559545282
Amazon Url: www.amzon.com/dp/B01IY8UBQ2

Product Title: womens ptx pentatonix piano logo tee shirt black cool
Euclidean Distance from input image: 11.074204933708229
Amazon Url: www.amzon.com/dp/B01JLSSLWA

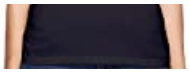
Product Title: fashion womens amazing spider shirt black size l
Euclidean Distance from input image: 11.3093916539816
Amazon Url: www.amzon.com/dp/B01INFD3WA

Product Title: f2 freestylers ultimate soccer woman black short sleeve tshirt
Euclidean Distance from input image: 11.314722290142313
Amazon Url: www.amzon.com/dp/B01J6WYQ48

Product Title: fashion womens amazing spider short sleeve black size xxl
Euclidean Distance from input image: 11.371863450728318
Amazon Url: www.amzon.com/dp/B01INFDTV0

Product Title: fashion womens jmj rio 2016 tee black size
Euclidean Distance from input image: 11.517479731420282
Amazon Url: www.amzon.com/dp/B01INF7NKI

Product Title: rob zombie shirts womens xxxl black
Euclidean Distance from input image: 11.550858590365527
Amazon Url: www.amzon.com/dp/B01KFGQ700



Product Title: womens art ring spun cotton poldark teeshirt size color black
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Product Title: fashion womens parkour art sports short sleeve black size
Euclidean Distance from input image: 11.695985935807764
Amazon Url: www.amzon.com/dp/B01J1AP3TM

Product Title: fashion womens amazing spider tees black size xl
Euclidean Distance from input image: 11.736824864082045
Amazon Url: www.amzon.com/dp/B01INFDLJK

Product Title: fashion womens sesame street cookie tshirts black size xl
Euclidean Distance from input image: 11.810330770761798
Amazon Url: www.amzon.com/dp/B01IY8TXBQ

Product Title: fashion womens parkour art sports tshirts black size xxl
Euclidean Distance from input image: 11.828663856996448
Amazon Url: www.amzon.com/dp/B01J1AP6JO

Product Title: fashion womens family shirts black size xl
Euclidean Distance from input image: 11.997498783056717
Amazon Url: www.amzon.com/dp/B01IY8UL4O

WEIGHT TEXT = 150 , WEIGHT BRAND=150 , WEIGHT COLOR = 150 & WEIGHT IMAGE=150 & DOCUMENT ID = 12560

```
1 get_similar_products_cnn(12560,150,150,150,150,20)
```

Product Title: womens 7 ronaldo quotes love win tshirts xxl black short sleeve
Euclidean Distance from input image: 1.5078914778617522e-06
Amazon Url: www.amzon.com/dp/B01JSLCWXO

Product Title: baby funny slim fit roger federer tshirt size xl color black
Euclidean Distance from input image: 6.50953170794436
Amazon Url: www.amzon.com/dp/B00ZCFTMOS

Product Title: girls fairy tail exceed tee shirts black
Euclidean Distance from input image: 6.930815156613098
Amazon Url: www.amzon.com/dp/B01L9F153U

Product Title: womens ptx pentatonix piano logo shirts black cool
Euclidean Distance from input image: 7.294907970740702
Amazon Url: www.amzon.com/dp/B01JLSSCRY

Product Title: fashion womens dodge truck tee black size xs
Euclidean Distance from input image: 7.50144076696466
Amazon Url: www.amzon.com/dp/B01IY8UBQ2

Product Title: fashion womens amazing spider shirt black size l
Euclidean Distance from input image: 7.504998423439151
Amazon Url: www.amzon.com/dp/B01INFD3WA

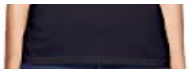
Product Title: f2 freestylers ultimate soccer woman black short sleeve tshirt
Euclidean Distance from input image: 7.589648386818058
Amazon Url: www.amzon.com/dp/B01J6WYQ48

Product Title: fashion womens amazing spider short sleeve black size xxl
Euclidean Distance from input image: 7.599391002967265
Amazon Url: www.amzon.com/dp/B01INFDTV0

Product Title: womens ptx pentatonix piano logo tee shirt black cool
Euclidean Distance from input image: 7.63407728226414
Amazon Url: www.amzon.com/dp/B01JLSSLWA

Product Title: womens art ring spun cotton poldark teeshirt size color black
Euclidean Distance from input image: 7.654730536364876
Amazon Url: www.amzon.com/dp/B010FJ4GUA

Product Title: rob zombie shirts womens xxxl black
Euclidean Distance from input image: 7.693023122332381
Amazon Url: www.amzon.com/dp/B01KFGQ700



Product Title: fashion womens jmj rio 2016 tee black size
Euclidean Distance from input image: 7.731586132361796
Amazon Url: www.amzon.com/dp/B01INF7NKI

Product Title: womens shirtsfashion university albany suny black sizem
Euclidean Distance from input image: 7.761357345671398
Amazon Url: www.amzon.com/dp/B01ID3AXIO

Product Title: fashion womens parkour art sports short sleeve black size
Euclidean Distance from input image: 7.84566205351645
Amazon Url: www.amzon.com/dp/B01J1AP3TM

Product Title: fashion womens sesame street cookie tshirts black size xl
Euclidean Distance from input image: 7.8668312902394
Amazon Url: www.amzon.com/dp/B01IY8TXBQ

WEIGHT TEXT = 200 , WEIGHT BRAND=200 , WEIGHT COLOR = 200 & WEIGHT IMAGE=200 & DOCUMENT ID = 12560

Euclidean Distance from input image: 7.879002533139672

```
1 get_similar_products_cnn(12560,200,200,200,200,20)
```

Product Title: womens 7 ronaldo quotes love win tshirts xxl black short sleeve
Euclidean Distance from input image: 1.5078915748745204e-06
Amazon Url: www.amzon.com/dp/B01JSLCWXO

Product Title: baby funny slim fit roger federer tshirt size xl color black
Euclidean Distance from input image: 6.509531555356469
Amazon Url: www.amzon.com/dp/B00ZCFTMOS

Product Title: girls fairy tail exceed tee shirts black
Euclidean Distance from input image: 6.930815054887837
Amazon Url: www.amzon.com/dp/B01L9F153U

Product Title: womens ptx pentatonix piano logo shirts black cool
Euclidean Distance from input image: 7.294908072465962
Amazon Url: www.amzon.com/dp/B01JLSSCRY

Product Title: fashion womens dodge truck tee black size xs
Euclidean Distance from input image: 7.501440665239399
Amazon Url: www.amzon.com/dp/B01IY8UBQ2

Product Title: fashion womens amazing spider shirt black size l
Euclidean Distance from input image: 7.504998626889672
Amazon Url: www.amzon.com/dp/B01INFD3WA

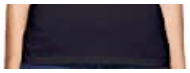
Product Title: f2 freestylers ultimate soccer woman black short sleeve tshirt
Euclidean Distance from input image: 7.589648285092798
Amazon Url: www.amzon.com/dp/B01J6WYQ48

Product Title: fashion womens amazing spider short sleeve black size xxl
Euclidean Distance from input image: 7.599391104692525
Amazon Url: www.amzon.com/dp/B01INFDTV0

Product Title: womens ptx pentatonix piano logo tee shirt black cool
Euclidean Distance from input image: 7.634077231401509
Amazon Url: www.amzon.com/dp/B01JLSSLWA

Product Title: womens art ring spun cotton poldark teeshirt size color black
Euclidean Distance from input image: 7.654730994128547
Amazon Url: www.amzon.com/dp/B010FJ4GUA

Product Title: rob zombie shirts womens xxxl black
Euclidean Distance from input image: 7.693023529233423
Amazon Url: www.amzon.com/dp/B01KFGQ700



Product Title: fashion womens jmj rio 2016 tee black size
Euclidean Distance from input image: 7.731585623735493
Amazon Url: www.amzon.com/dp/B01INF7NKI

Product Title: womens shirtsfashion university albany suny black sizem
Euclidean Distance from input image: 7.761357345671399
Amazon Url: www.amzon.com/dp/B01ID3AXIO

Product Title: fashion womens parkour art sports short sleeve black size
Euclidean Distance from input image: 7.84566185006593
Amazon Url: www.amzon.com/dp/B01J1AP3TM

Product Title: fashion womens sesame street cookie tshirts black size xl
Euclidean Distance from input image: 7.866831137651509
Amazon Url: www.amzon.com/dp/B01IY8TXBQ

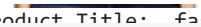
Product Title: fashion womens amazing spider tees black size xl
Euclidean Distance from input image: 7.8790026857275635
Amazon Url: www.amzon.com/dp/B01INFDLJK

Product Title: fashion womens parkour art sports tshirts black size xxl
Euclidean Distance from input image: 8.0014846867555
Amazon Url: www.amzon.com/dp/B01J1AP6JO

```
Product Title:  fashion womens cornell university cu logo shirt black size xs
Euclidean Distance from input image: 8.002943878264173
Amazon Url: www.amzon.com/dp/B01IY8TBI6
```

CONCLUSION :

1. WHEN WE TRY DIFFERENT WEIGHTS ON TEXT/BRAND/COLOR & IMAGE , THE SIMILAR PRODUCT RECOMMENDATION ALSO GETS CHANGE. THE ALGORITHM SHOWS DIFFERENT SIMILAR PRODUCTS
2. WHEN WE TRY DIFFERENT WEIGHTS , THE EUCLIDEAN DISTANCE ALSO GET REDUCES FOR THE RECOMMENDED PRODUCTS



```
Product Title:  fashion womens family shirts black size xl
```

```
1
```