Amazon Apparel Recommendations

[4.2] Data and Code:

https://drive.google.com/open?id=0BwNkduBnePt2VWhCYXhMV3p4dTg (https://drive.google.com/open?id=0BwNkduBnePt2VWhCYXhMV3p4dTg)

[4.3] Overview of the data

In [1]:
```
#import all the necessary packages.

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")
```

In [2]:
```
# we have give a json file which consists of all information about
# the products
# loading the data using pandas' read_json file.
data = pd.read_json('tops_fashion.json')
```

In [3]:
```
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
```

Terminology:

What is a dataset?
Rows and columns
Data-point
Feature/variable

In [4]:
```
# each product/item has 19 features in the raw dataset.
data.columns # prints column-names or feature-names.
```

Out[4]:
```
Index(['asin', 'author', 'availability', 'availability_type', 'brand', 'colo
r',
       'editorial_reivew', 'editorial_review', 'formatted_price',
       'large_image_url', 'manufacturer', 'medium_image_url', 'model',
       'product_type_name', 'publisher', 'reviews', 'sku', 'small_image_url',
       'title'],
      dtype='object')
```

Of these 19 features, we will be using only 6 features in this workshop.

1. asin (Amazon standard identification number)
2. brand (brand to which the product belongs to)
3. color (Color information of apparel, it can contain many colors as a value e
x: red and black stripes)
4. product_type_name (type of the apperal, ex: SHIRT/TSHIRT)
5. medium_image_url (url of the image)
6. title (title of the product.)
7. formatted_price (price of the product)

In [5]:
```
data = data[['asin', 'brand', 'color', 'medium_image_url', 'product_type_name'
, 'title', 'formatted_price']]
```

In [6]:
```
print ('Number of data points : ', data.shape[0], \
       'Number of features:', data.shape[1])
data.head() # prints the top rows in the table.
```

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

Out[6]:

	asin	brand	color	medium_image_url	product_type_name	title	form
0	B016I2TS4W	FNC7C	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	Minions Como Superheroes Ironman Long Sleeve R...	
1	B01N49AI08	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Izo Tunic	
2	B01JDPCOHO	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Won Top	
3	B01N19U5H5	Focal18	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	Focal18 Sailor Collar Bubble Sleeve Blouse Shi...	
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	Featherlite Ladies' Long Sleeve Stain Resistan...	

[5.1] Missing data for various features.

Basic stats for the feature: product_type_name

In [7]:
```
# We have total 72 unique type of product_type_names
print(data['product_type_name'].describe())

# 91.62% (167794/183138) of the products are shirts,
```

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

In [8]:
```
# names of different product types
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']
```

In [9]:
```
# find the 10 most frequent product_type_names.
product_type_count = Counter(list(data['product_type_name']))
product_type_count.most_common(10)
```

Out[9]:
```
[('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)]
```

Basic stats for the feature: brand

In [10]:
```
# there are 10577 unique brands
print(data['brand'].describe())

# 183138 - 182987 = 151 missing values.
```

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

In [11]:
```
brand_count = Counter(list(data['brand']))
brand_count.most_common(10)
```

Out[11]:
```
[('Zago', 223),
 ('XQS', 222),
 ('Yayun', 215),
 ('YUNY', 198),
 ('XiaoTianXin-women clothes', 193),
 ('Generic', 192),
 ('Boohoo', 190),
 ('Alion', 188),
 ('TheMogan', 187),
 ('Abetteric', 187)]
```

Basic stats for the feature: color

In [12]:
```
print(data['color'].describe())


# we have 7380 unique colors
# 7.2% of products are black in color
# 64956 of 183138 products have brand information. That's approx 35.4%.
```

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

In [13]:
```
color_count = Counter(list(data['color']))
color_count.most_common(10)
```

Out[13]:
```
[(None, 118182),
 ('Black', 13207),
 ('White', 8616),
 ('Blue', 3570),
 ('Red', 2289),
 ('Pink', 1842),
 ('Grey', 1499),
 ('*', 1388),
 ('Green', 1258),
 ('Multi', 1203)]
```

Basic stats for the feature: formatted_price

In [14]:
```
print(data['formatted_price'].describe())

# Only 28,395 (15.5% of whole data) products with price information
```

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

In [15]:
```
price_count = Counter(list(data['formatted_price']))
price_count.most_common(10)
```

Out[15]:
```
[(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)]
```

Basic stats for the feature: title

In [16]:
```
print(data['title'].describe())

# All of the products have a title.
# Titles are fairly descriptive of what the product is.
# We use titles extensively in this workshop
# as they are short and informative.
```

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

In [17]:
```
data.to_pickle('pickels/180k_apparel_data')
```

We save data files at every major step in our processing in "pickle" files. If you are stuck anywhere (or) if some code takes too long to run on your laptop, you may use the pickle files we give you to speed things up.

In [18]:
```
# consider products which have price information
# data['formatted_price'].isnull() => gives the information
#about the dataframe row's which have null values price == None|Null
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
```

In [19]:
```
# consider products which have color information
# data['color'].isnull() => gives the information about the dataframe row's wh
ich have null values price == None|Null
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
```

We brought down the number of data points from 183K to 28K.

We are processing only 28K points so that most of the workshop participants can run this code on thier laptops in a reasonable amount of time.

For those of you who have powerful computers and some time to spare, you are recommended to use all of the 183K images.

In [20]:
```
data.to_pickle('pickels/28k_apparel_data')
```

In [21]:
```
# You can download all these 28k images using this code below.
# You do NOT need to run this code and hence it is commented.


'''
from PIL import Image
import requests
from io import BytesIO

for index, row in images.iterrows():
        url = row['large_image_url']
        response = requests.get(url)
        img = Image.open(BytesIO(response.content))
        img.save('images/28k_images/'+row['asin']+'.jpeg')


'''
```

Out[21]:
```
"\nfrom PIL import Image\nimport requests\nfrom io import BytesIO\n\nfor inde
x, row in images.iterrows():\n        url = row['large_image_url']\n        r
esponse = requests.get(url)\n        img = Image.open(BytesIO(response.conten
t))\n        img.save('images/28k_images/'+row['asin']+'.jpeg')\n\n\n"
```

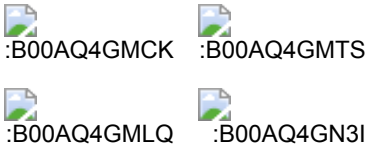
[5.2] Remove near duplicate items

[5.2.1] Understand about duplicates.

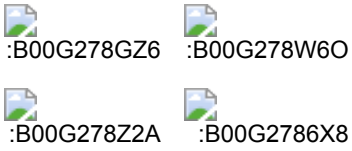
In [22]:
```
# read data from pickle file from previous stage
data = pd.read_pickle('pickels/28k_apparel_data')

# find number of products that have duplicate titles.
print(sum(data.duplicated('title')))
# we have 2325 products which have same title but different color
```

```
2325
```

These shirts are exactly same except in size (S, M,L,XL)



These shirts exactly same except in color



In our data there are many duplicate products like the above examples, we need to de-dupe them for better results.

[5.2.2] Remove duplicates : Part 1

In [23]:
```
# read data from pickle file from previous stage
data = pd.read_pickle('pickels/28k_apparel_data')
```

In [24]:
```
data.head()
```

Out[24]:

	asin	brand	color	medium_image_url	product_type_name	title	form
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	Featherlite Ladies' Long Sleeve Stain Resistan...	
6	B012YX2ZPI	HX-Kingdom Fashion T-shirts	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	Women's Unique 100% Cotton T - Special Olympic...	
11	B001LOUGE4	Fitness Etc.	Black	https://images-na.ssl-images-amazon.com/images...	SHIRT	Ladies Cotton Tank 2x1 Ribbed Tank Top	
15	B003BSRPB0	FeatherLite	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	FeatherLite Ladies' Moisture Free Mesh Sport S...	
21	B014ICEDNA	FNC7C	Purple	https://images-na.ssl-images-amazon.com/images...	SHIRT	Supernatural Chibis Sam Dean And Castiel Short...	

In [25]:
```
# Remove All products with very few words in title
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: 27949
```

In [26]:
```
# Sort the whole data based on title (alphabetical order of title)
data_sorted.sort_values('title',inplace=True, ascending=False)
data_sorted.head()
```

Out[26]:

	asin	brand	color	medium_image_url	product_type_name	title
61973	B06Y1KZ2WB	Éclair	Black/Pink	https://images-na.ssl-images-amazon.com/images...	SHIRT	Éclair Women's Printed Thin Strap Blouse Black...
133820	B010RV33VE	xiaoming	Pink	https://images-na.ssl-images-amazon.com/images...	SHIRT	xiaoming Womens Sleeveless Loose Long T-shirts...
81461	B01DDSDLNS	xiaoming	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	xiaoming Women's White Long Sleeve Single Brea...
75995	B00X5LYO9Y	xiaoming	Red Anchors	https://images-na.ssl-images-amazon.com/images...	SHIRT	xiaoming Stripes Tank Patch/Bear Sleeve Anchor...
151570	B00WPJG35K	xiaoming	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	xiaoming Sleeve Sheer Loose Tassel Kimono Woma...

Some examples of dupliacte titles that differ only in the last few words.

```
Titles 1:
16. woman's place is in the house and the senate shirts for Womens XXL White
17. woman's place is in the house and the senate shirts for Womens M Grey

Title 2:
25. tokidoki The Queen of Diamonds Women's Shirt X-Large
26. tokidoki The Queen of Diamonds Women's Shirt Small
27. tokidoki The Queen of Diamonds Women's Shirt Large

Title 3:
61. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow Animal Print
Head Shirt for woman Neon Wolf t-shirt
62. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow Animal Print
Head Shirt for woman Neon Wolf t-shirt
63. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow Animal Print
Head Shirt for woman Neon Wolf t-shirt
64. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow Animal Print
Head Shirt for woman Neon Wolf t-shirt
```

In [27]:
```
indices = []
for i,row in data_sorted.iterrows():
    indices.append(i)
```

In [28]:
```
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', 'Shirt', 'X-Large']
    a = data['title'].loc[indices[i]].split()

    # 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', 'Th
e', 'Queen', 'of', 'Diamonds', 'Women's', 'Shirt', 'Small']
        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 case of unequal strings
        # 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 apperals are different
        # if the number of words in which both strings differ are < 2 , we are
considering it as those two apperals are same, hence we are ignoring them
        if (length - count) > 2: # number of words in which both sensences dif
fer
            # if both strings are differ by more than 2 words we include the 1
st string index
            stage1_dedupe_asins.append(data_sorted['asin'].loc[indices[i]])

            # if the comaprision between is between num_data_points, num_data_
points-1 strings and they differ in more than 2 words we include both
            if j == num_data_points-1: stage1_dedupe_asins.append(data_sorted[
'asin'].loc[indices[j]])

            # start searching for similar apperals corresponds 2nd string
            i = j
            break
```

```
            else:
                j += 1
        if previous_i == i:
            break
```

In [29]:
```
data = data.loc[data['asin'].isin(stage1_dedupe_asins)]
```

We removed the dupliactes which differ only at the end.

In [30]:
```
print('Number of data points : ', data.shape[0])
```

```
Number of data points :  17593
```

In [31]:
```
data.to_pickle('pickels/17k_apperal_data')
```

[5.2.3] Remove duplicates : Part 2

```
In the previous cell, we sorted whole data in alphabetical order of  titles.Then, w
e removed titles which are adjacent and very similar title

But there are some products whose titles are not adjacent but very similar.

Examples:

Titles-1
86261.  UltraClub Women's Classic Wrinkle-Free Long Sleeve Oxford Shirt, Pink, XX-L
arge
115042. UltraClub Ladies Classic Wrinkle-Free Long-Sleeve Oxford Light Blue XXL

TItles-2
75004.  EVALY Women's Cool University Of UTAH 3/4 Sleeve Raglan Tee
109225. EVALY Women's Unique University Of UTAH 3/4 Sleeve Raglan Tees
120832. EVALY Women's New University Of UTAH 3/4-Sleeve Raglan Tshirt
```

In [32]:
```
data = pd.read_pickle('pickels/17k_apperal_data')
```

This code snippet takes significant amount of time. # O(n^2) time. # Takes about an hour to run on a decent computer. indices = [] for i,row in data.iterrows(): indices.append(i) stage2_dedupe_asins = [] while len(indices)!=0: i = indices.pop() stage2_dedupe_asins.append(data['asin'].loc[i]) # consider the first apperal's title a = data['title'].loc[i].split() # store the list of words of ith string in a, ex: a = ['tokidoki', 'The', 'Queen', 'of', 'Diamonds', 'Women's', 'Shirt', 'X-Large'] for j in indices: b = data['title'].loc[j].split() # store the list of words of jth string in b, ex: b = ['tokidoki', 'The', 'Queen', 'of', 'Diamonds', 'Women's', 'Shirt', 'X-Large'] 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 case of unequal strings # 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 < 3 , we are considering it as those two apperals are same, hence we are ignoring them if (length - count) < 3: indices.remove(j)# from whole previous products we will consider only # the products that are found in previous cell data = data.loc[data['asin'].isin(stage2_dedupe_asins)]print('Number of data points after stage two of dedupe: ',data.shape[0]) # from 17k apperals we reduced to 16k apperalsdata.to_pickle('pickels/16k_apperal_data') # Storing these products in a pickle file # candidates who wants to download these files instead # of 180K they can download and use them from the Google Drive folder.

6. Text pre-processing

In [33]:
```
data = pd.read_pickle('pickels/16k_apperal_data')

# NLTK download stop words. [RUN ONLY ONCE]
# goto Terminal (Linux/Mac) or Command-Prompt (Window)
# In the temrinal, type these commands
# $python3
# $import nltk
# $nltk.download()
```

In [34]:
```
# we use the list of stop words that are downloaded from nltk lib.
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: {'those', "needn't", 're', 'don', 'hasn', "she's", 'has',
'in', 'nor', "it's", 'few', 'because', 'her', 'themselves', 'couldn', 'down',
'these', 'was', 'herself', 'not', 'have', "couldn't", 'with', 'more', 'does
n', 'hadn', 'any', 'again', 'that', 'didn', 'weren', "hasn't", "aren't", 'whi
le', 'all', 'most', 'there', 'after', 'their', 'won', 'they', 'against', "had
n't", 'so', 'over', "you're", 'be', 's', 'through', "that'll", 'mightn', 'onc
e', "you'll", 'whom', 'now', 'haven', 'been', 'when', 'isn', 'wasn', 'are',
'hers', 'just', 'yourselves', 'having', 'before', 'he', 'shan', 'between', 's
houldn', 'at', 'his', 'out', 'y', "you've", 'which', 'himself', "wouldn't",
"won't", 'into', 'we', 'but', 'did', "isn't", 'ain', 'ma', 'other', 'doing',
'then', 't', "mightn't", 'ours', 'me', 'what', 'itself', 'below', 'too', 'dur
ing', "weren't", "haven't", 'why', 'o', 'am', "mustn't", 'how', 'about', 'm',
'll', 'my', 'as', 'will', 'who', "should've", "doesn't", 'yours', 'from',
'd', 'under', 'this', 'some', 'mustn', 'own', 'same', 'very', 'aren', 'or',
"you'd", 'further', 'does', "don't", "shan't", 'yourself', 'than', 'of', 'ha
d', 'here', 've', 'wouldn', 'needn', 'were', 'for', 'she', 'an', 'your', 't
o', 'him', 'up', 'off', "wasn't", 'being', 'do', 'where', 'myself', 'both',
'each', 'you', 'it', 'should', 'them', 'a', 'such', 'ourselves', 'our', 'if',
'above', 'is', 'its', 'by', 'until', 'can', 'i', 'theirs', 'on', 'no', 'onl
y', 'the', "didn't", "shouldn't", 'and'}
```

In [35]:
```
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")
```

```
7.405771000000001 seconds
```

In [36]:
```
data.head()
```

Out[36]:

	asin	brand	color	medium_image_url	product_type_name	title	form
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies long sleeve stain resistant...	
6	B012YX2ZPI	HX-Kingdom Fashion T-shirts	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	womens unique 100 cotton special olympics wor...	
15	B003BSRPB0	FeatherLite	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies moisture free mesh sport sh...	
27	B014ICEJ1Q	FNC7C	Purple	https://images-na.ssl-images-amazon.com/images...	SHIRT	supernatural chibis sam dean castiel neck tshi...	
46	B01NACPBG2	Fifth Degree	Black	https://images-na.ssl-images-amazon.com/images...	SHIRT	fifth degree womens gold foil graphic tees jun...	

In [37]:
```
data.to_pickle('pickels/16k_apperal_data_preprocessed')
```

Stemming

In [38]:
```
from nltk.stem.porter import *
stemmer = PorterStemmer()
print(stemmer.stem('arguing'))
print(stemmer.stem('fishing'))


# We tried using stemming on our titles and it didnot work very well.
```

```
argu
fish
```

[8] Text based product similarity

In [39]:
```
data = pd.read_pickle('pickels/16k_apperal_data_preprocessed')
data.head()
```

Out[39]:

	asin	brand	color	medium_image_url	product_type_name	title	form
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies long sleeve stain resistant...	
6	B012YX2ZPI	HX-Kingdom Fashion T-shirts	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	womens unique 100 cotton special olympics wor...	
15	B003BSRPB0	FeatherLite	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies moisture free mesh sport sh...	
27	B014ICEJ1Q	FNC7C	Purple	https://images-na.ssl-images-amazon.com/images...	SHIRT	supernatural chibis sam dean castiel neck tshi...	
46	B01NACPBG2	Fifth Degree	Black	https://images-na.ssl-images-amazon.com/images...	SHIRT	fifth degree womens gold foil graphic tees jun...	

In [40]:
```
# Utility Functions which we will use through the rest of the workshop.


#Display an image
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 occurenc
e of the word keys(i)
        # labels: len(labels) == len(keys), the values of labels depends on th
e 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 of title2), in black if not
        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 contri
bute to the distance between two title vec's
    intersection = set(vec1.keys()) & set(vec2.keys())

    # we set the values of non intersecting words to zero, this is just to sho
w 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 word in title2 else values(i)=0
    values = [vec2[x] for x in vec2.keys()]

    # labels: len(labels) == len(keys), the values of labels depends on the mo
del 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 document (doc_id)
            if x in  tfidf_title_vectorizer.vocabulary_:
                labels.append(tfidf_title_features[doc_id, tfidf_title_vectori
zer.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 th
e corpus
            # idf_title_features[doc_id, index_of_word_in_corpus] will give th
e idf value of word in given document (doc_id)
            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 = tex
t.split()' this will also gives same result
    return Counter(words) # Counter counts the occurence of each word in list,
it returns dict type object {word1:count}



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)
```

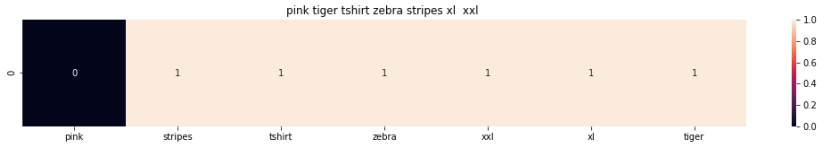
[8.2] Bag of Words (BoW) on product titles.

In [41]:
```
from sklearn.feature_extraction.text import CountVectorizer
title_vectorizer = CountVectorizer()
title_features   = title_vectorizer.fit_transform(data['title'])
title_features.get_shape() # get number of rows and columns in feature matrix.
# title_features.shape = #data_points * #words_in_corpus
# CountVectorizer().fit_transform(corpus) returns
# the a sparase matrix of dimensions #data_points * #words_in_corpus

# What is a sparse vector?

# title_features[doc_id, index_of_word_in_corpus] = number of times the word o
ccured in that doc
```

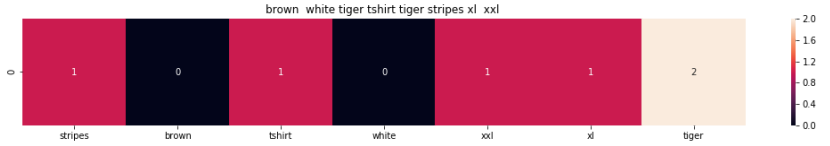
Out[41]: (16042, 12609)

In [42]:
```
def bag_of_words_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 re
maining 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(title_features,title_features[doc_id])

    # np.argsort will return indices of the smallest distances
    indices = np.argsort(pairwise_dist.flatten())[0:num_results]
    #pdists will store the 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)):
        # 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_image_url'].loc[df_indices[i]], 'bag_of_word
s')
        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)

#call the bag-of-words model for a product to get similar products.
bag_of_words_model(12566, 20) # change the index if you want to.
# In the output heat map each value represents the count value
# of the label word, the color represents the intersection
# with inputs title.

#try 12566
#try 931
```

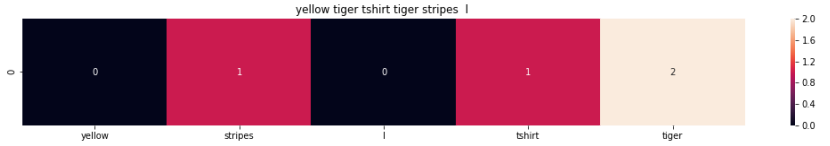
ASIN : B00JXQB5FQ
Brand: Si Row
Title: burnt umber tiger tshirt zebra stripes xl xxl
Euclidean similarity with the query image : 0.0
==



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

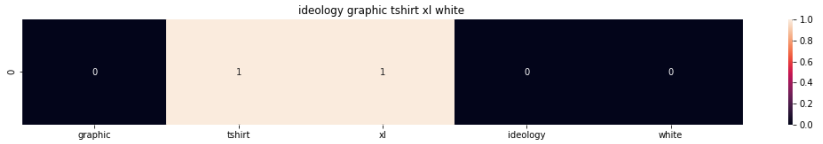


ASIN : B00JXQCWTO
Brand: Si Row
Title: brown white tiger tshirt tiger stripes xl xxl
Euclidean similarity with the query image : 2.449489742783178
==

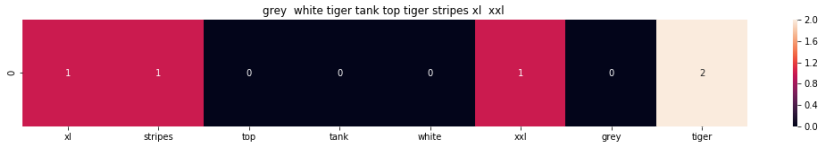


ASIN : B00JXQCUIC
Brand: Si Row
Title: yellow tiger tshirt tiger stripes l
Euclidean similarity with the query image : 2.6457513110645907
==

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

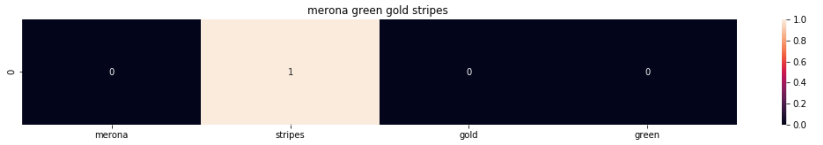


ASIN : B01NB0NKRO
Brand: Ideology
Title: ideology graphic tshirt xl white
Euclidean similarity with the query image : 3.0
==



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

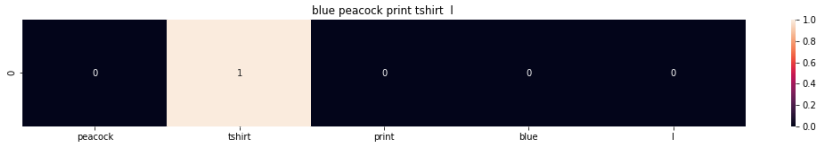
ASIN : B01CLS8LMW
Brand: Awake
Title: morning person tshirt troll picture xl
Euclidean similarity with the query image : 3.1622776601683795
==



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
==

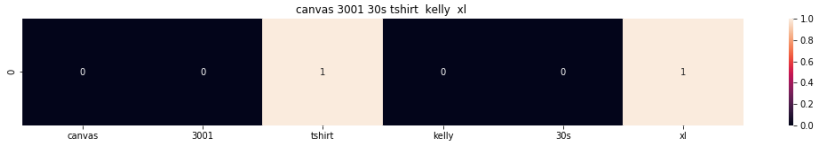
ASIN : B012VQLT6Y
Brand: KM T-shirt
Title: km tiger printed sleeveless vest tshirt
Euclidean similarity with the query image : 3.1622776601683795
==========



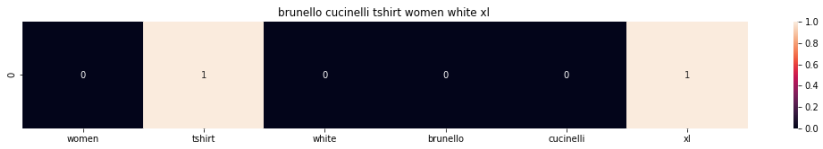
ASIN : B00JXQC8L6
Brand: Si Row
Title: blue peacock print tshirt l
Euclidean similarity with the query image : 3.1622776601683795
==========

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
==========

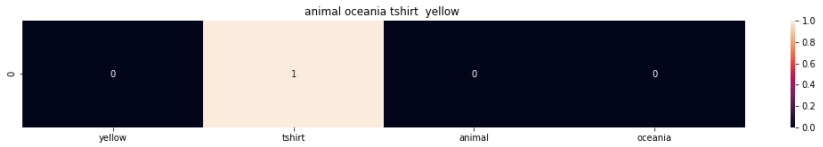


ASIN : B0088PN0LA
Brand: Red House
Title: canvas 3001 30s tshirt kelly xl
Euclidean similarity with the query image : 3.1622776601683795
==========



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
==========

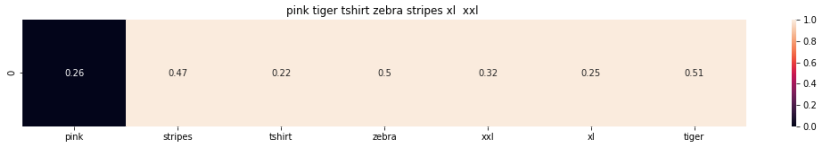
ASIN : B00IAA4JIQ
Brand: I Love Lucy
Title: juniors love lucywaaaaahhhh tshirt size xl
Euclidean similarity with the query image : 3.1622776601683795
==========

[8.5] TF-IDF based product similarity

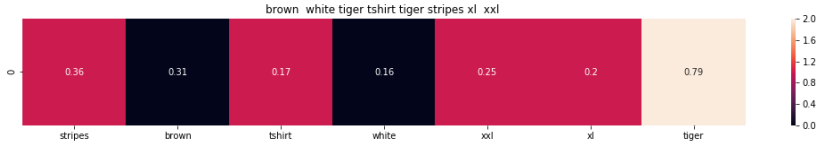
In [43]:
```
tfidf_title_vectorizer = TfidfVectorizer(min_df = 0)
tfidf_title_features = tfidf_title_vectorizer.fit_transform(data['title'])
# tfidf_title_features.shape = #data_points * #words_in_corpus
# CountVectorizer().fit_transform(courpus) returns the a sparase matrix of dim
ensions #data_points * #words_in_corpus
# tfidf_title_features[doc_id, index_of_word_in_corpus] = tfidf values of the
 word in given doc
```

In [44]:
```
def tfidf_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 re
maining 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(tfidf_title_features,tfidf_title_featur
es[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)):
        # 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_image_url'].loc[df_indices[i]], 'tfidf')
        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)
# in the output heat map each value represents the tfidf values of the label w
ord, the color represents the intersection with inputs title
```

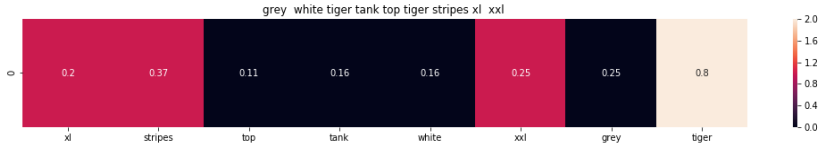
ASIN : B00JXQB5FQ
BRAND : Si Row
Eucliden distance from the given image : 0.0
==========
==========



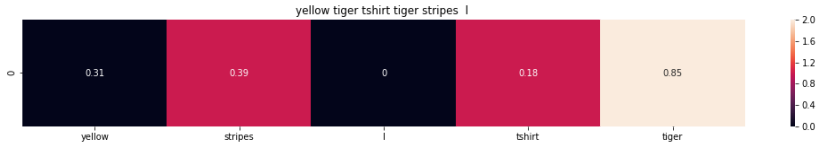
ASIN : B00JXQASS6
BRAND : Si Row
Eucliden distance from the given image : 0.7536331912451363
==========
==========



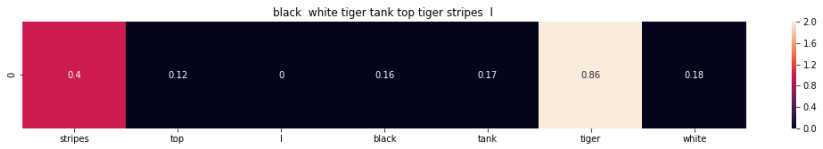
ASIN : B00JXQCWTO
BRAND : Si Row
Eucliden distance from the given image : 0.9357643943769647
==========
==========



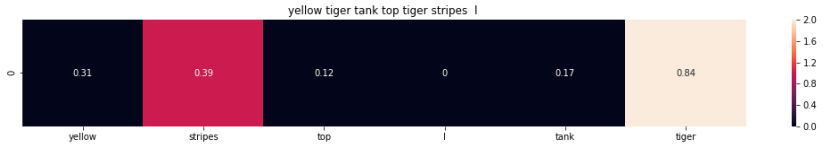
ASIN : B00JXQAFZ2
BRAND : Si Row
Eucliden distance from the given image : 0.9586153524200749
==========
==========



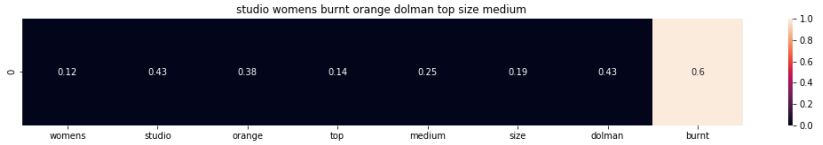
ASIN : B00JXQCUIC
BRAND : Si Row
Eucliden distance from the given image : 1.000074961446881
==========
==========



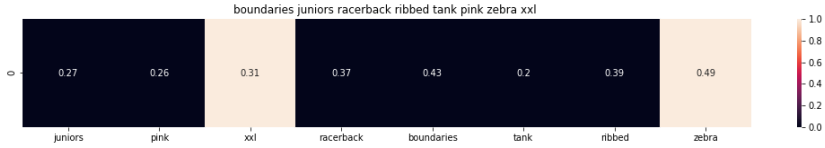
ASIN : B00JXQAO94
BRAND : Si Row
Eucliden distance from the given image : 1.023215552457452
==========
==========



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
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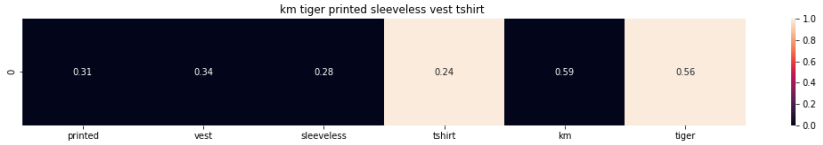
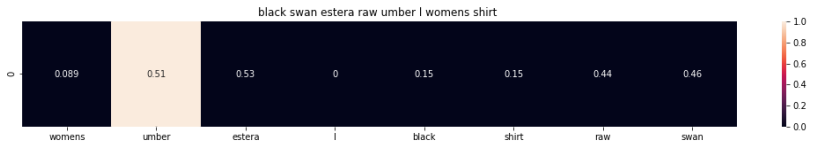
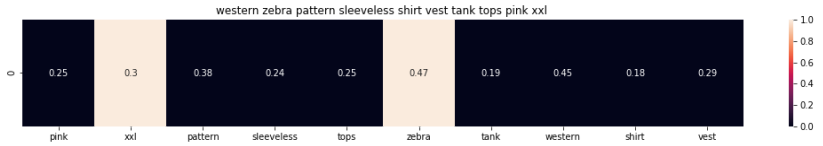


ASIN : B012VQLT6Y
BRAND : KM T-shirt
Eucliden distance from the given image : 1.219790640280982
==========
==========

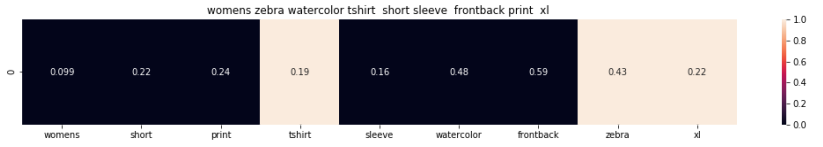


ASIN : B06Y1VN8WQ
BRAND : Black Swan
Eucliden distance from the given image : 1.2206849659998316

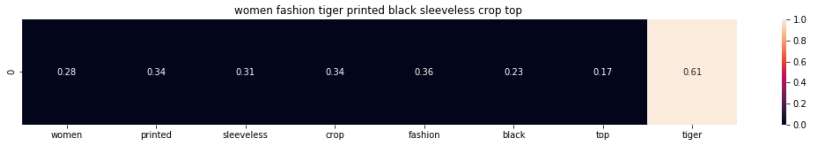


ASIN : B00Z6HEXWI
BRAND : Black Temptation
Eucliden distance from the given image : 1.221281392120943

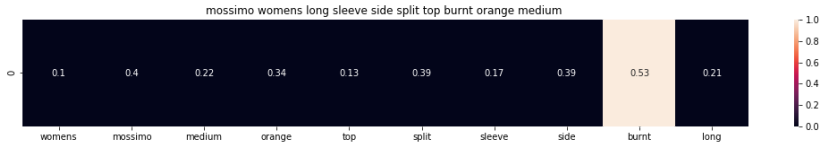
ASIN : B074TR12BH
BRAND : Ultra Flirt
Eucliden distance from the given image : 1.2313364094597743



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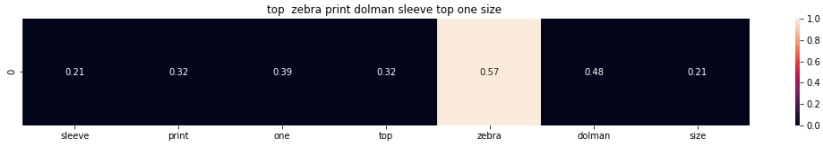
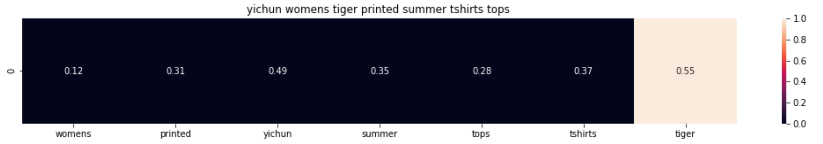
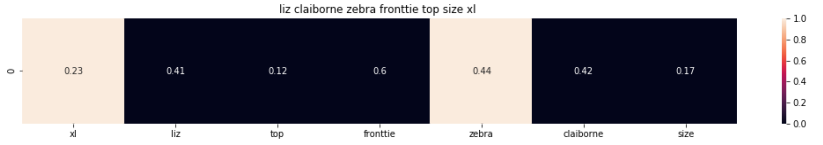


ASIN : B00H8A6ZLI
BRAND : Vivian's Fashions
Eucliden distance from the given image : 1.24996155052848
==========
==========



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



ASIN : B06XBY5QXL
BRAND : Liz Claiborne
Eucliden distance from the given image : 1.2538832938357722
==========
==========

[8.5] IDF based product similarity

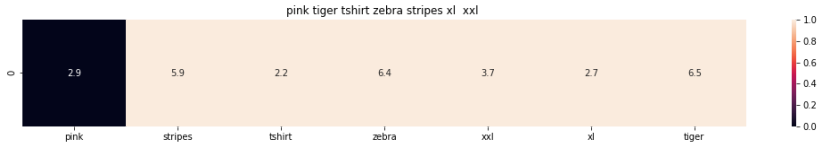
In [45]:
```
idf_title_vectorizer = CountVectorizer()
idf_title_features = idf_title_vectorizer.fit_transform(data['title'])

# idf_title_features.shape = #data_points * #words_in_corpus
# CountVectorizer().fit_transform(courpus) returns the a sparase matrix of dim
ensions #data_points * #words_in_corpus
# idf_title_features[doc_id, index_of_word_in_corpus] = number of times the wo
rd occured in that doc
```

In [46]:
```
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)))
```

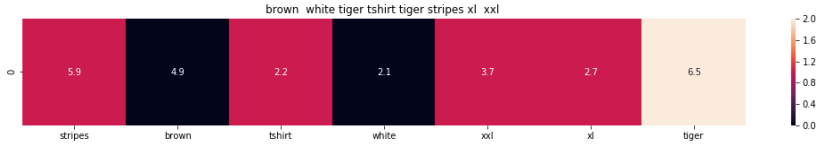
In [47]:
```
# we need to convert the values into float
idf_title_features  = idf_title_features.astype(np.float)

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 the word i present
    for j in idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzer
o()[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
```

In [48]:
```
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 re
maining 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[d
oc_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_image_url'].loc[df_indices[i]], 'idf')
        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)
# in the output heat map each value represents the idf values of the label wor
d, the color represents the intersection with inputs title
```

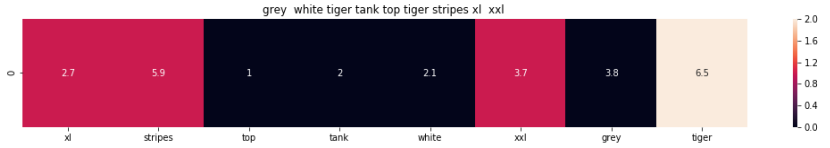
ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from the given image : 0.0
==========
==========



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
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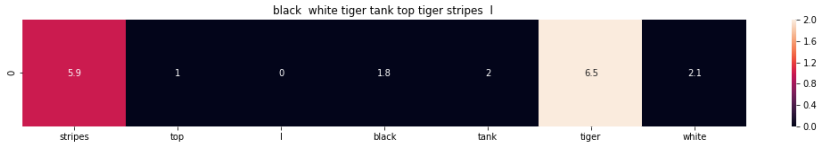

ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from the given image : 14.833392966672909
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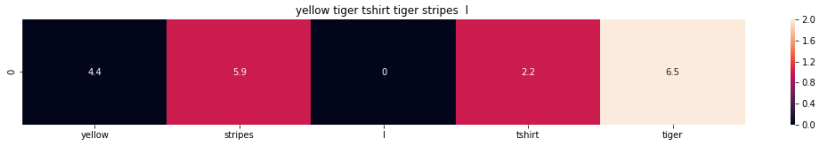
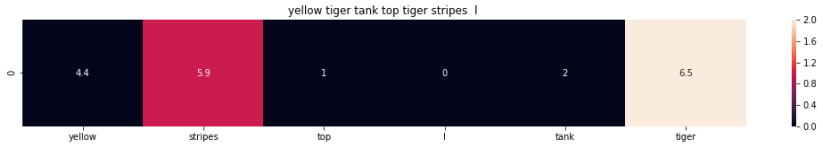
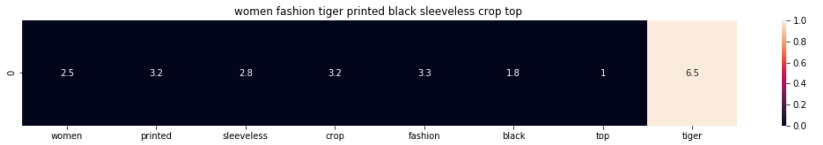


ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from the given image : 14.898744516719225
==========
==========



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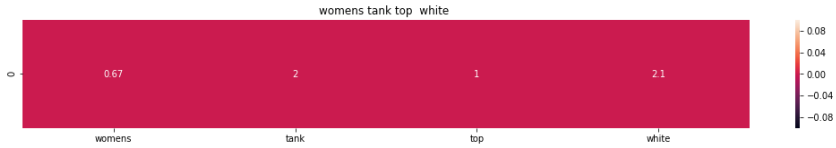

ASIN : B00JPOZ9GM
Brand : Sofra
euclidean distance from the given image : 17.153215337562703
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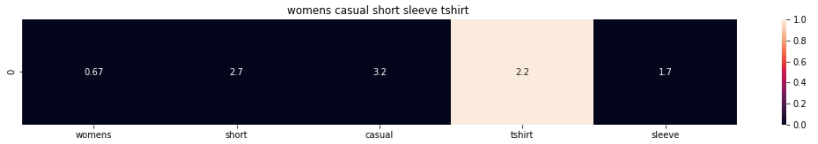
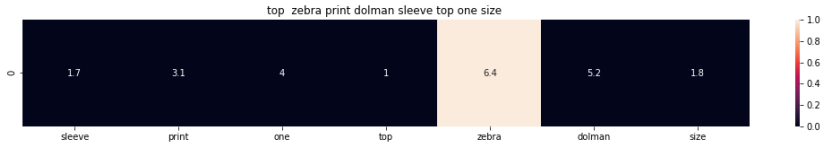
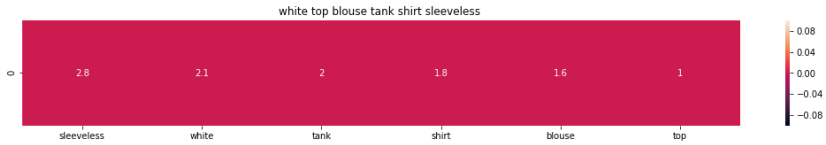


ASIN : B074T9KG9Q
Brand : Rain
euclidean distance from the given image : 17.33671523874989
==========
==========



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
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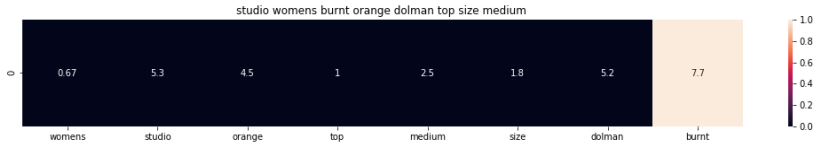

ASIN : B06XSCVFT5
Brand : Studio M
euclidean distance from the given image : 17.61275854366134
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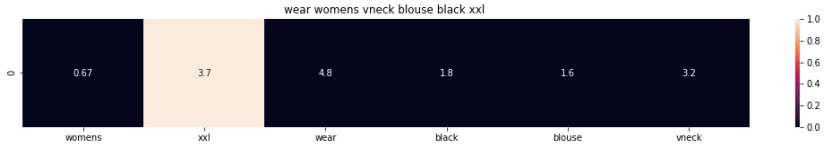

ASIN : B06Y6FH453
Brand : Who What Wear
euclidean distance from the given image : 17.623745282500135
==========
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ASIN : B074V45DCX
Brand : Rain
euclidean distance from the given image : 17.634342496835046
==========
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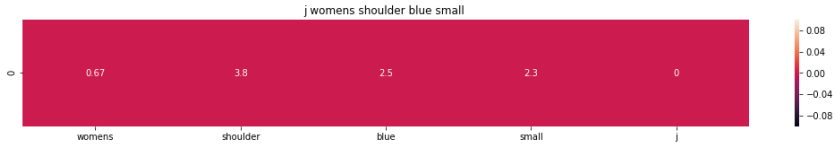

ASIN : B07583CQFT
Brand : Very J
euclidean distance from the given image : 17.63753712743611
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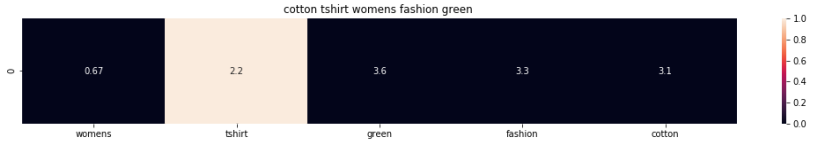

ASIN : B073GJGVBN
Brand : Ivan Levi
euclidean distance from the given image : 17.7230738913371
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==========

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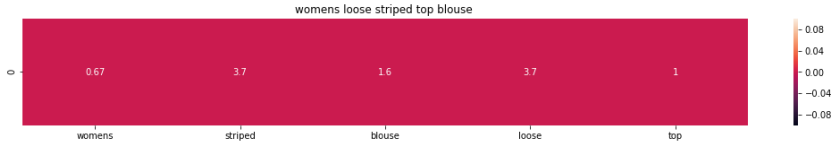


ASIN : B00ZZMYBRG
Brand : HP-LEISURE
euclidean distance from the given image : 17.779536864674238
==========
==========

[9] Text Semantics based product similarity

In [49]:
```
# credits: https://www.kaggle.com/c/word2vec-nlp-tutorial#part-2-word-vectors
# Custom Word2Vec using your own text data.
# Do NOT RUN this code.
# It is meant as a reference to build your own Word2Vec when you have
# lots of data.

'''
# Set values for various parameters
num_features = 300    # Word vector dimensionality
min_word_count = 1    # Minimum word count
num_workers = 4       # Number of threads to run in parallel
context = 10          # Context window size
downsampling = 1e-3   # Downsample setting for frequent words

# Initialize and train the model (this will take some time)
from gensim.models import word2vec
print ("Training model...")
model = word2vec.Word2Vec(sen_corpus, workers=num_workers, \
            size=num_features, min_count = min_word_count, \
            window = context)

'''
```

Out[49]:
```
'\n# Set values for various parameters\nnum_features = 300    # Word vector d
imensionality                    \nmin_word_count = 1    # Minimum word cou
nt                          \nnum_workers = 4       # Number of threads to run
in parallel\ncontext = 10          # Context window size
\ndownsampling = 1e-3   # Downsample setting for frequent words\n\n# Initiali
ze and train the model (this will take some time)\nfrom gensim.models import
word2vec\nprint ("Training model...")\nmodel = word2vec.Word2Vec(sen_corpus,
workers=num_workers,            size=num_features, min_count = min_word_coun
t,            window = context)\n    \n'
```

In [50]:
```
from gensim.models import Word2Vec
from gensim.models import KeyedVectors
import pickle

# in this project we are using a pretrained model by google
# its 3.3G file, once you load this into your memory
# it occupies ~9Gb, so please do this step only if you have >12G of ram
# we will provide a pickle file wich contains a dict ,
# and it contains all our courpus words as keys and  model[word] as values
# To use this code-snippet, download "GoogleNews-vectors-negative300.bin"
# from https://drive.google.com/file/d/0B7XkCwpI5KDYNlNUTTlSS21pQmM/edit
# it's 1.9GB in size.

'''
model = KeyedVectors.load_word2vec_format('GoogleNews-vectors-negative300.bi
n', binary=True)
'''

#if you do NOT have RAM >= 12GB, use the code below.
with open('word2vec_model', 'rb') as handle:
    model = pickle.load(handle)
```

In [51]:
```
# Utility functions

def get_word_vec(sentence, doc_id, m_name):
    # sentence : title of the apparel
    # doc_id: document id in our corpus
    # m_name: model information it will take two values
        # if  m_name == 'avg', we will append the model[i], w2v representation
of word i
        # if m_name == 'weighted', we will multiply each w2v[word] with the id
f(word)
    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.voc
abulary_[i]] * model[i])
            elif m_name == 'avg':
                vec.append(model[i])
        else:
            # if the word in our courpus is not there in the google word2vec c
orpus, we are just ignoring it
            vec.append(np.zeros(shape=(300,)))
    # we will return a numpy array of shape (#number of words in title * 300 )
300 = len(w2v_model[word])
    # each row represents the word2vec representation of each word (weighted/a
vg) in given sentance
    return  np.array(vec)

def get_distance(vec1, vec2):
    # vec1 = np.array(#number_of_words_title1 * 300), each row is a vector of
 length 300 corresponds to each word in give title
    # vec2 = np.array(#number_of_words_title2 * 300), each row is a vector of
 length 300 corresponds to each word in give title

    final_dist = []
    # for each vector in vec1 we caluclate the distance(euclidean) to all vect
ors in vec2
    for i in vec1:
        dist = []
        for j in vec2:
            # np.linalg.norm(i-j) will result the euclidean distance between v
ectors i, j
            dist.append(np.linalg.norm(i-j))
        final_dist.append(np.array(dist))
    # final_dist = np.array(#number of words in title1 * #number of words in t
itle2)
    # final_dist[i,j] = euclidean distance between vectors i, j
    return np.array(final_dist)


def heat_map_w2v(sentence1, sentence2, url, doc_id1, doc_id2, model):
    # sentance1 : title1, input apparel
    # sentance2 : title2, recommended apparel
    # url: apparel image url
    # doc_id1: document id of input apparel
```

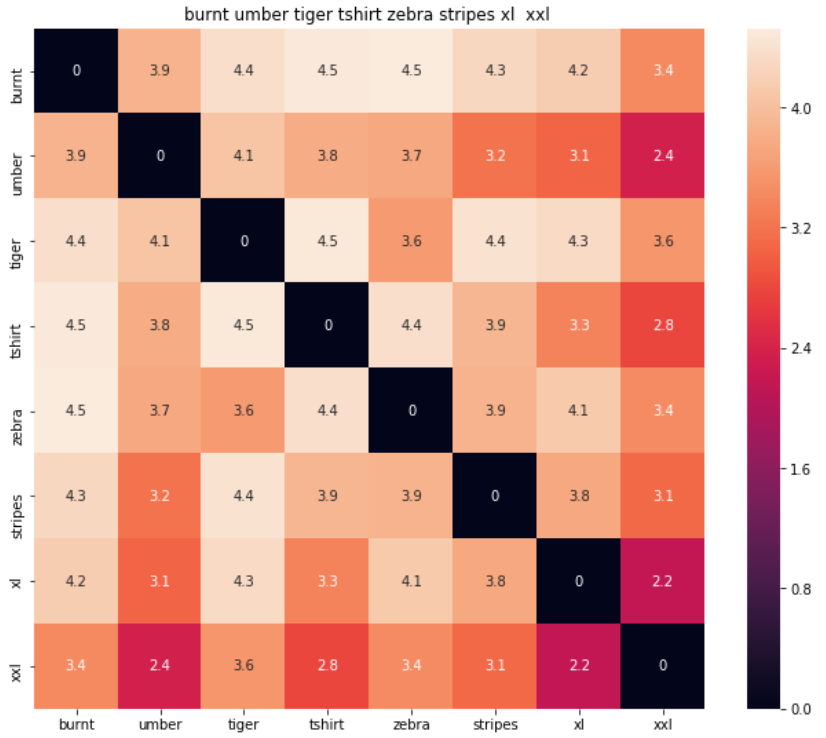
```
    # doc_id2: document id of recommended apparel
    # model: it can have two values, 1. avg 2. weighted

    #s1_vec = np.array(#number_of_words_title1 * 300), each row is a vector(we
ighted/avg) of length 300 corresponds to each word in give title
    s1_vec = get_word_vec(sentence1, doc_id1, model)
    #s2_vec = np.array(#number_of_words_title1 * 300), each row is a vector(we
ighted/avg) of length 300 corresponds to each word in give title
    s2_vec = get_word_vec(sentence2, doc_id2, model)

    # s1_s2_dist = np.array(#number of words in title1 * #number of words in t
itle2)
    # s1_s2_dist[i,j] = euclidean distance between words i, j
    s1_s2_dist = get_distance(s1_vec, s2_vec)



    # devide whole figure into 2 parts 1st part displays heatmap 2nd part disp
lays image of apparel
    gs = gridspec.GridSpec(2, 2, width_ratios=[4,1],height_ratios=[2,1])
    fig = plt.figure(figsize=(15,15))

    ax = plt.subplot(gs[0])
    # ploting the heap map based on the pairwise distances
    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()
```

In [52]:
```
# vocab = stores all the words that are there in google w2v model
# vocab = model.wv.vocab.keys() # if you are using Google word2Vec

vocab = model.keys()
# this function will add the vectors of each word and returns the avg vector o
f given sentance
def build_avg_vec(sentence, num_features, doc_id, m_name):
    # sentace: its title of the apparel
    # num_features: the lenght of word2vec vector, its values = 300
    # m_name: model information it will take two values
        # if  m_name == 'avg', we will append the model[i], w2v representation
of word i
        # if m_name == 'weighted', we will multiply each w2v[word] with the id
f(word)

    featureVec = np.zeros((num_features,), dtype="float32")
    # we will intialize a vector of size 300 with all zeros
    # we add each word2vec(wordi) to this fetureVec
    nwords = 0

    for word in sentence.split():
        nwords += 1
        if word in vocab:
            if m_name == 'weighted' and word in  idf_title_vectorizer.vocabula
ry_:
                featureVec = np.add(featureVec, idf_title_features[doc_id, idf
_title_vectorizer.vocabulary_[word]] * model[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
```

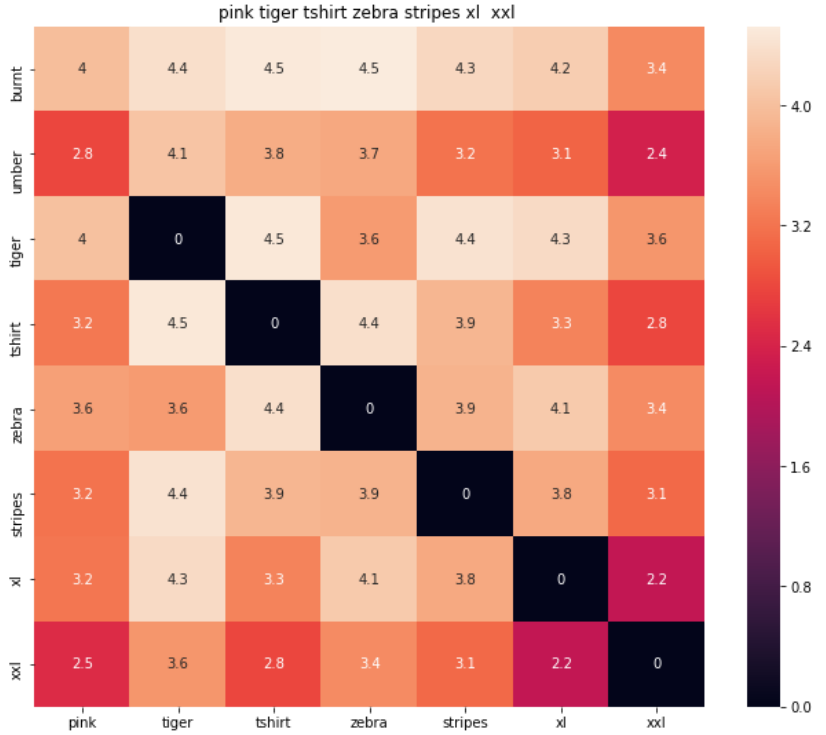
[9.2] Average Word2Vec product similarity.

In [53]:
```
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)
```

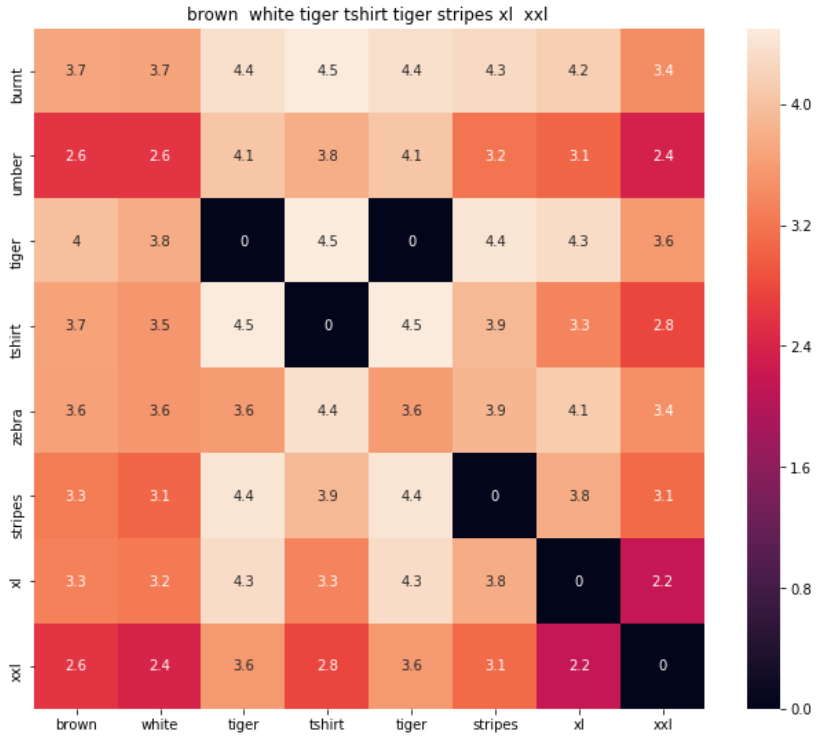
In [54]:
```
def avg_w2v_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

    # 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_ind
ices[i]], data['medium_image_url'].loc[df_indices[i]], indices[0], indices[i],
'avg')
        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)
# in the give heat map, each cell contains the euclidean distance between word
s i, j
```



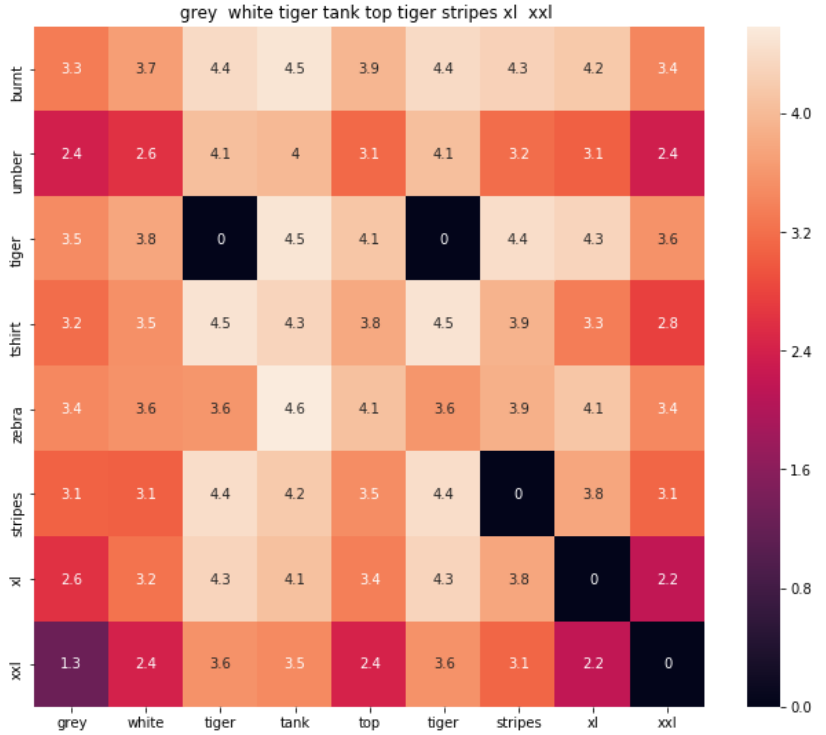
ASIN : B00JXQB5FQ
BRAND : Si Row
euclidean distance from given input image : 0.0
==========
==========



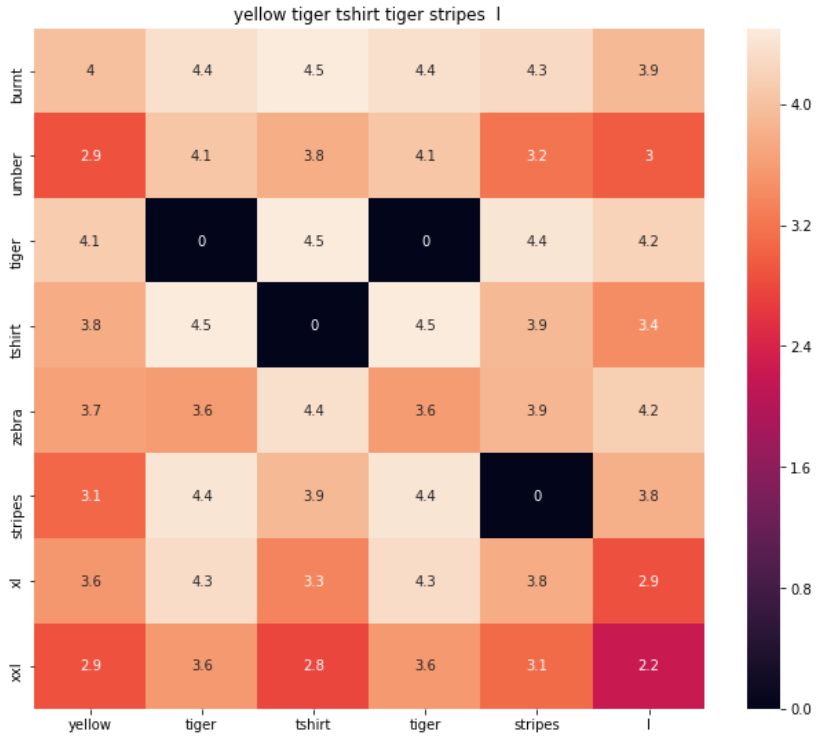
ASIN : B00JXQASS6
BRAND : Si Row
euclidean distance from given input image : 0.5891926
==========
==========



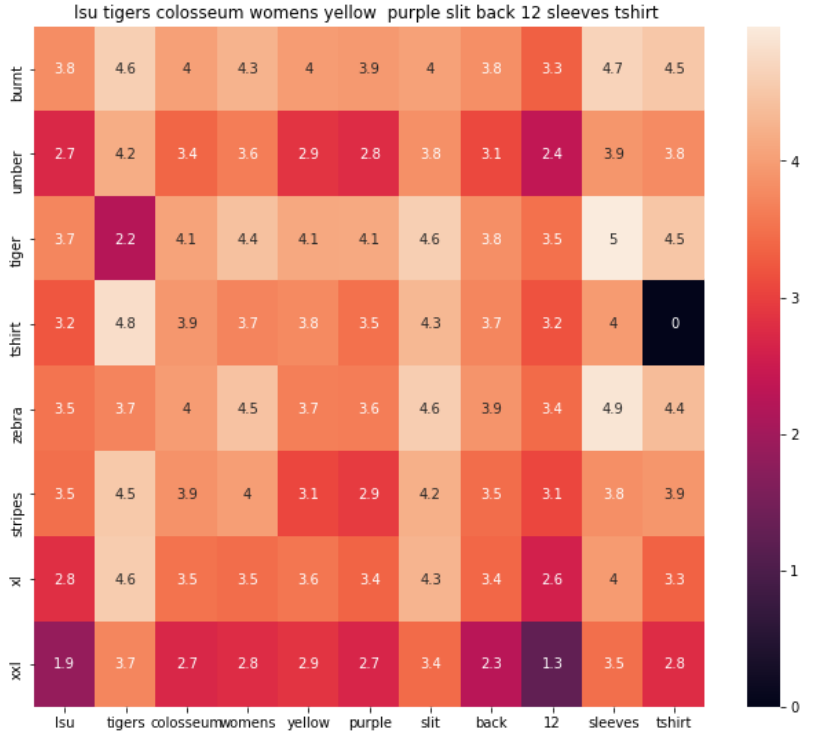
ASIN : B00JXQCWTO
BRAND : Si Row
euclidean distance from given input image : 0.7003438
==========
==========



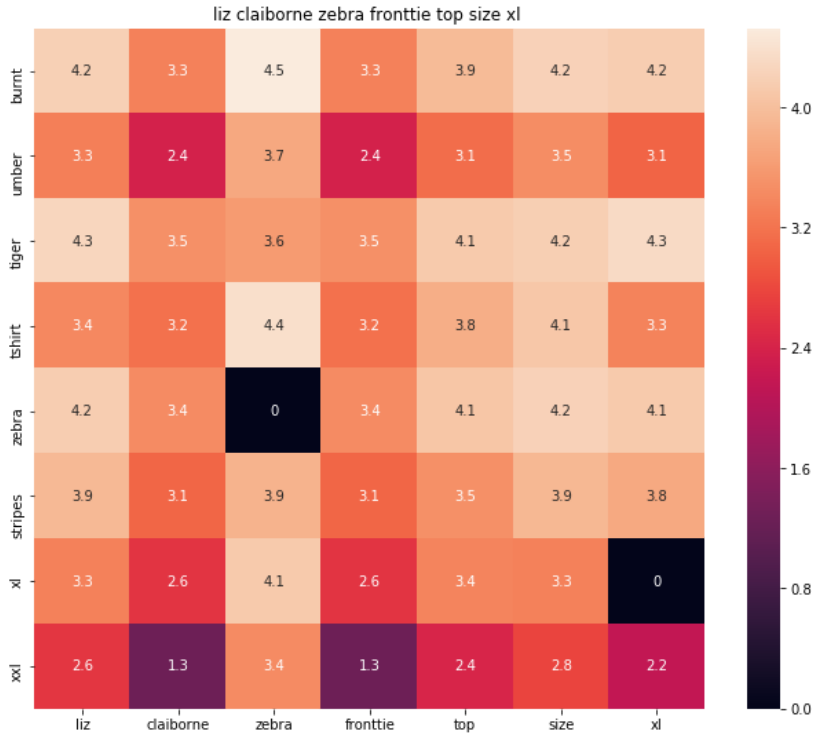
ASIN : B00JXQAFZ2
BRAND : Si Row
euclidean distance from given input image : 0.89283955
==========
==========



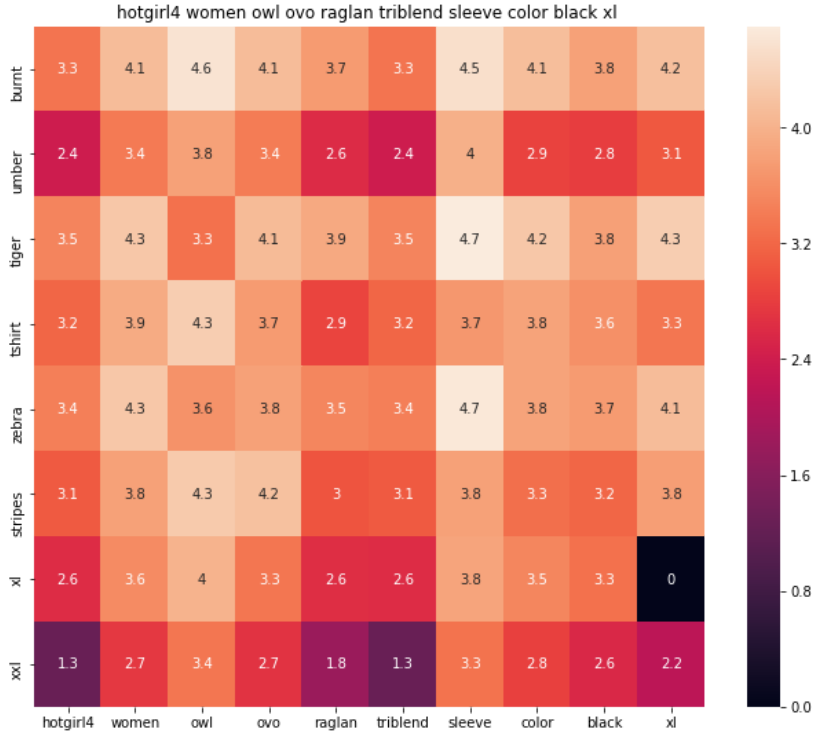
ASIN : B00JXQCUIC
BRAND : Si Row
euclidean distance from given input image : 0.95601255
==========
==========



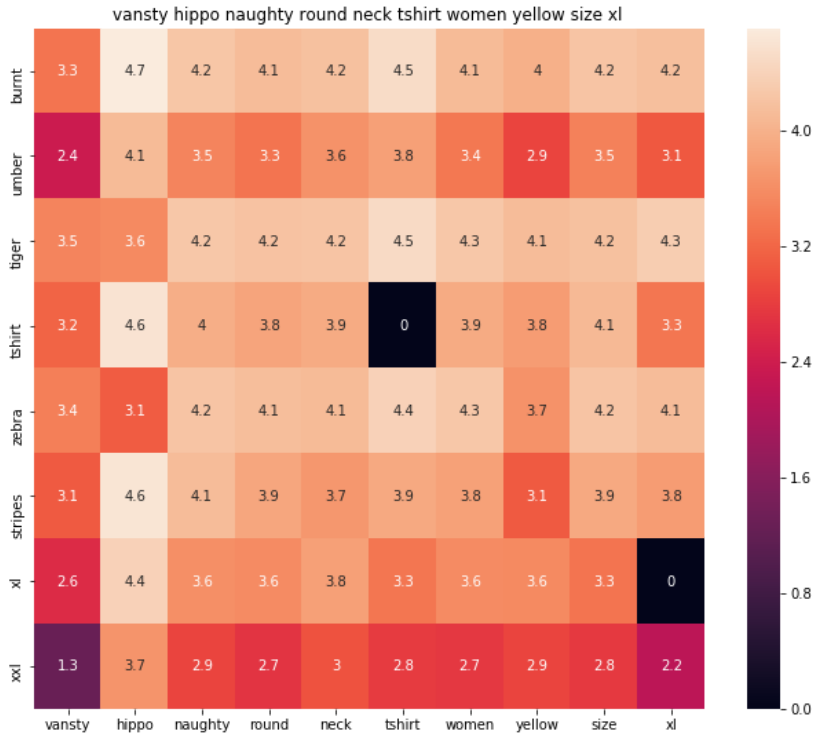
ASIN : B073R5Q8HD
BRAND : Colosseum
euclidean distance from given input image : 1.022969
==========
==========



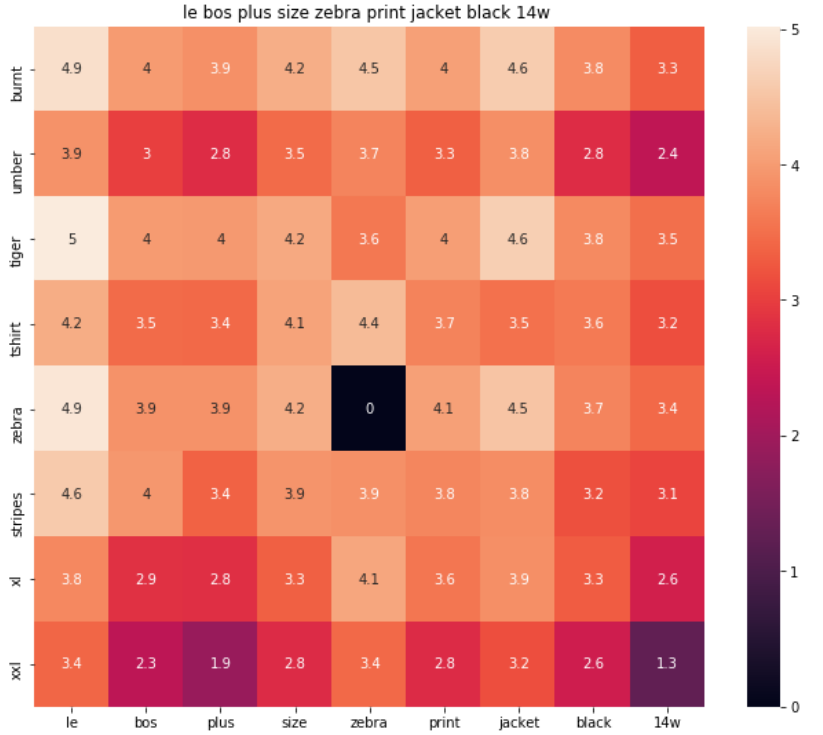
ASIN : B06XBY5QXL
BRAND : Liz Claiborne
euclidean distance from given input image : 1.0669324
==========
==========



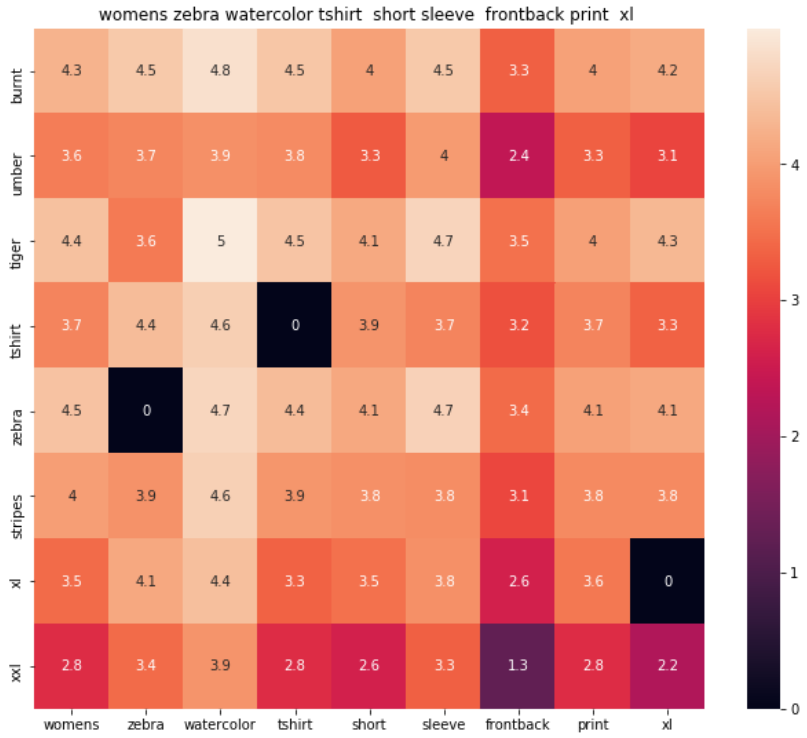
ASIN : B01L8L73M2
BRAND : Hotgirl4 Raglan Design
euclidean distance from given input image : 1.0731405
==========
==========



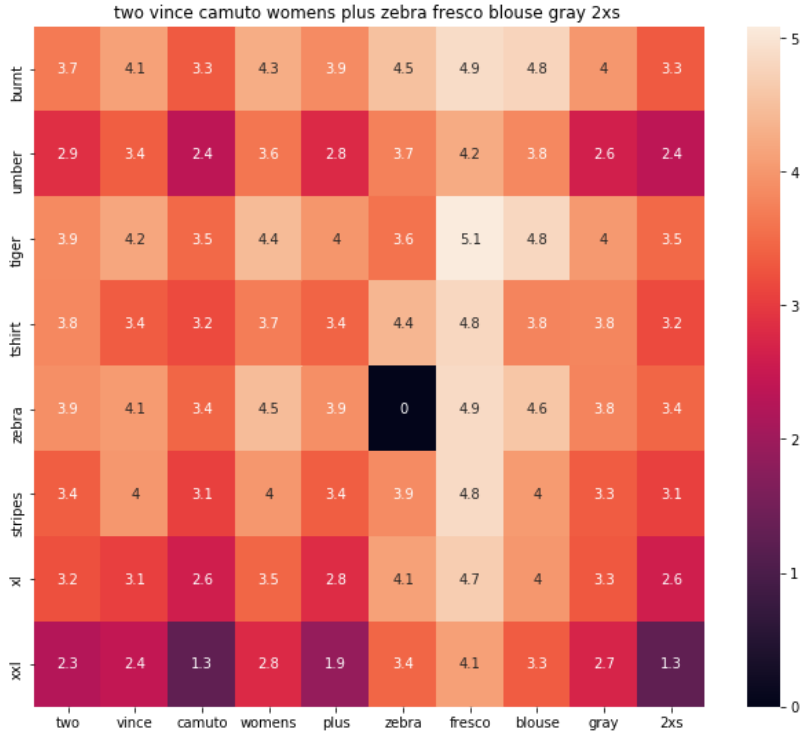
ASIN : B01EJS5H06
BRAND : Vansty
euclidean distance from given input image : 1.075719
==========
==========



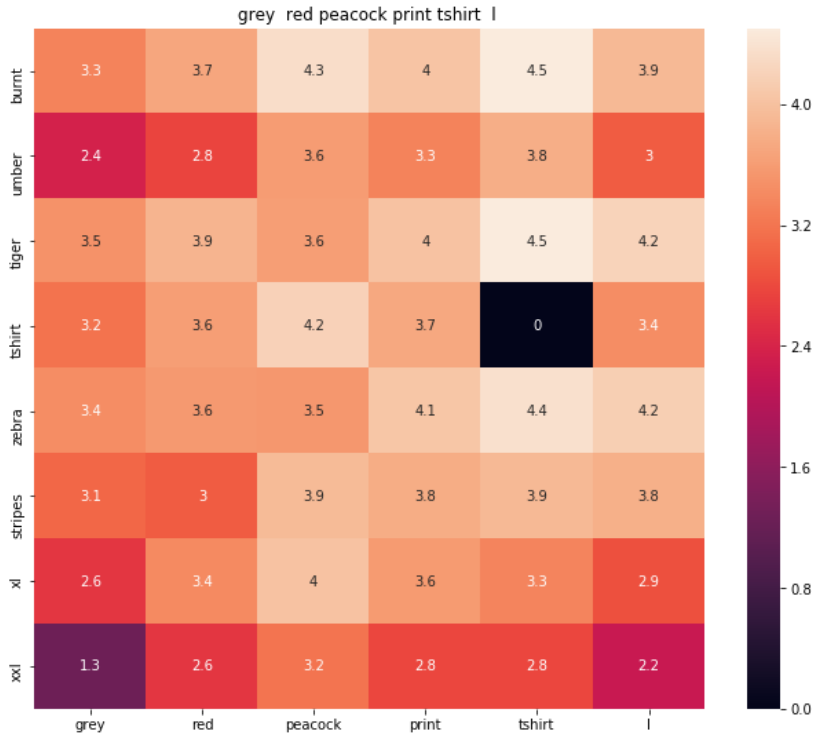
ASIN : B01BO1XRK8
BRAND : Le Bos
euclidean distance from given input image : 1.0839964
==========
==========



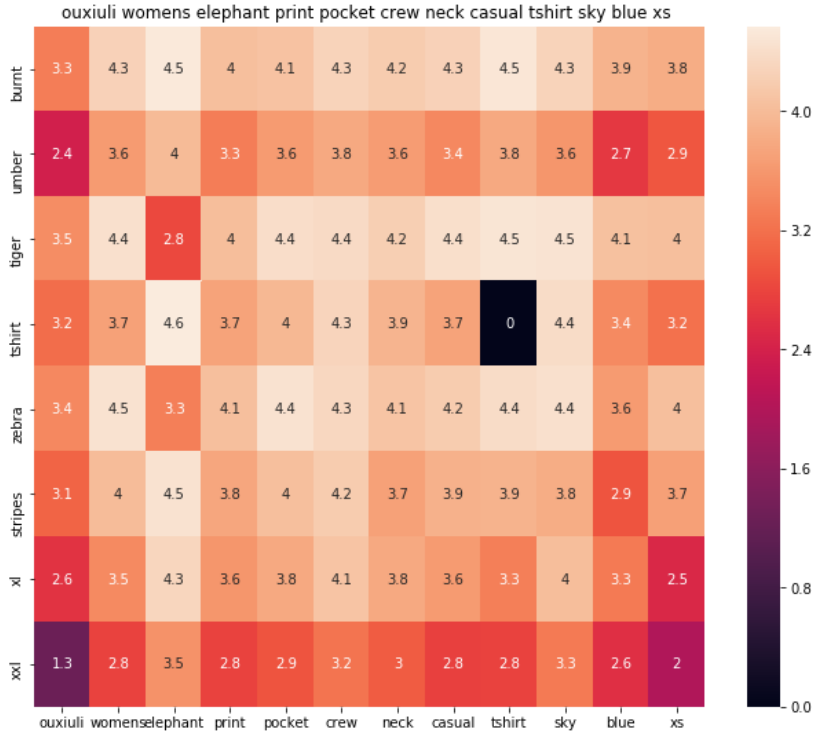
ASIN : B072R2JXKW
BRAND : WHAT ON EARTH
euclidean distance from given input image : 1.0842218
==========
==========



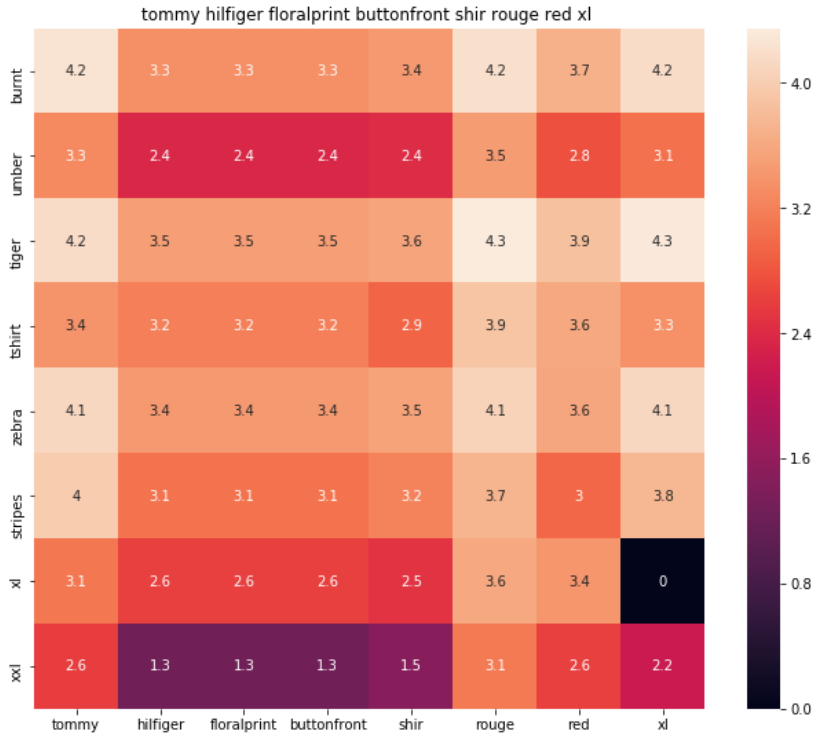
ASIN : B074MJRGW6
BRAND : Two by Vince Camuto
euclidean distance from given input image : 1.0895038
==========
==========



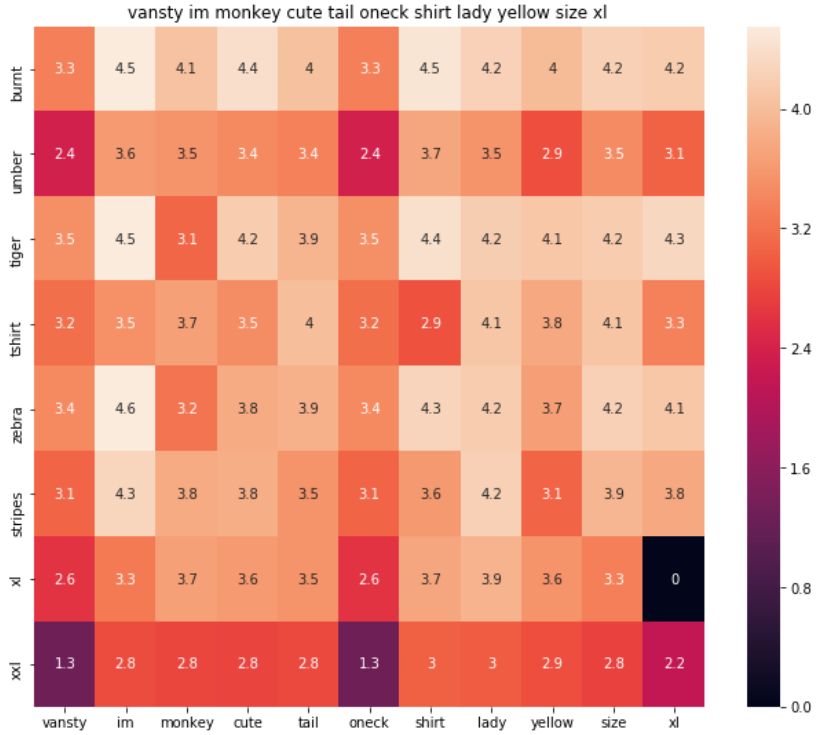
ASIN : B00JXQCFRS
BRAND : Si Row
euclidean distance from given input image : 1.0900588
==========
==========



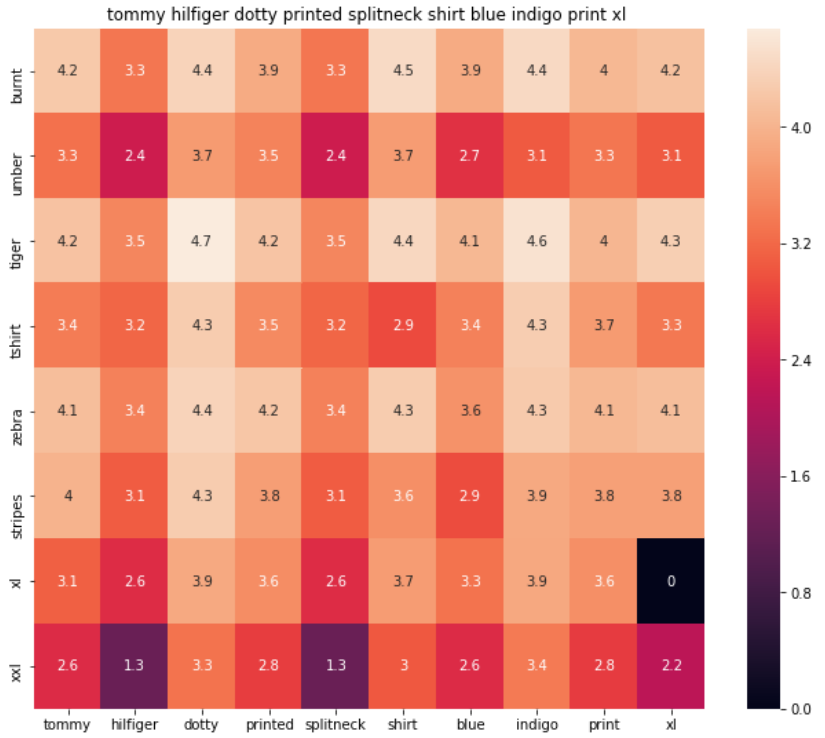
ASIN : B01I53HU6K
BRAND : ouxiuli
euclidean distance from given input image : 1.0920111
==========
==========



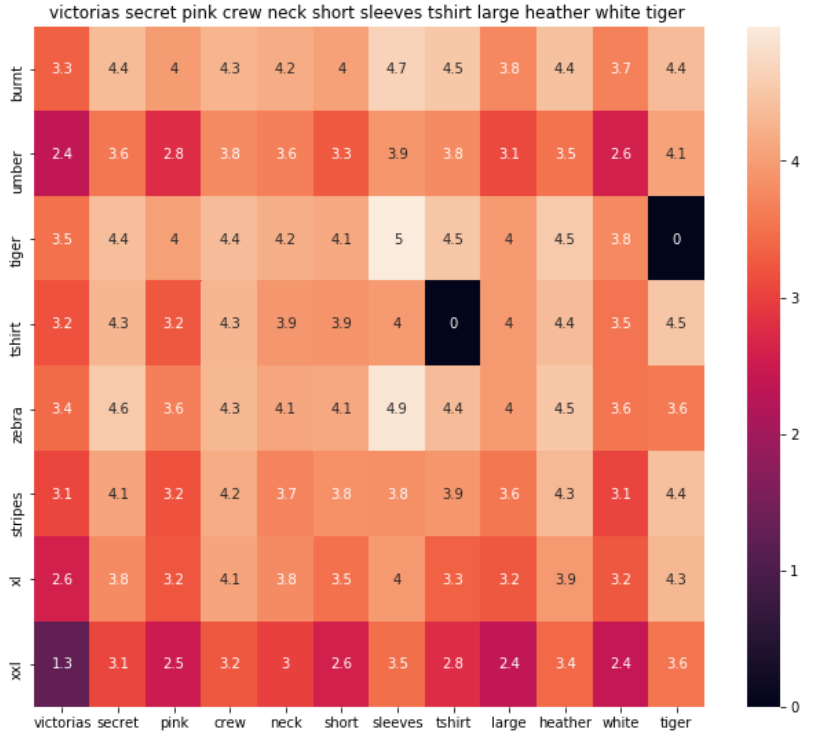
ASIN : B0711NGTQM
BRAND : THILFIGER RTW
euclidean distance from given input image : 1.0923415
==========
==========



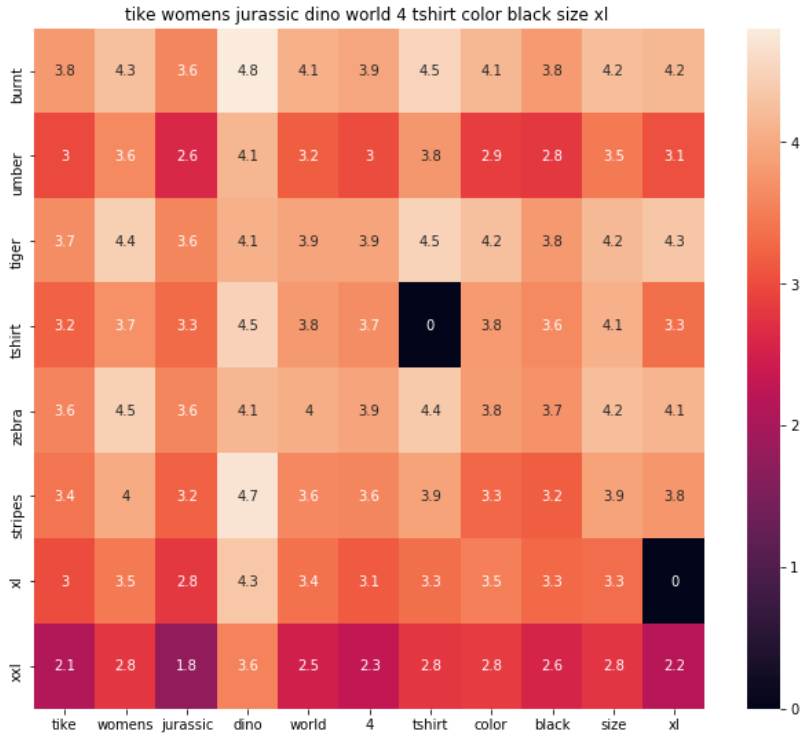
ASIN : B01EFSLO8Y
BRAND : Vansty
euclidean distance from given input image : 1.0934004
==========
==========



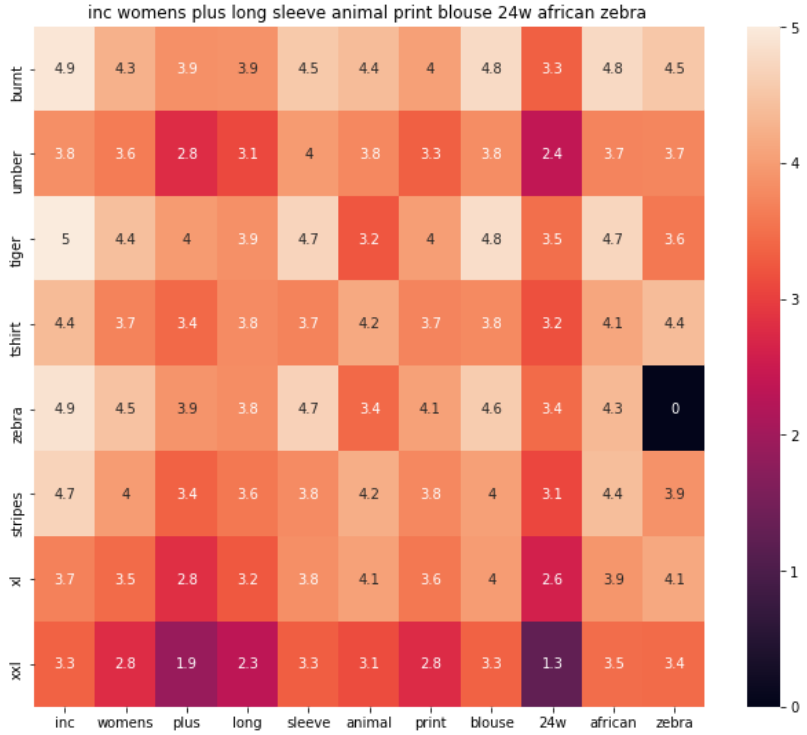
ASIN : B0716TVWQ4
BRAND : THILFIGER RTW
euclidean distance from given input image : 1.0942024
==========
==========



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
==========

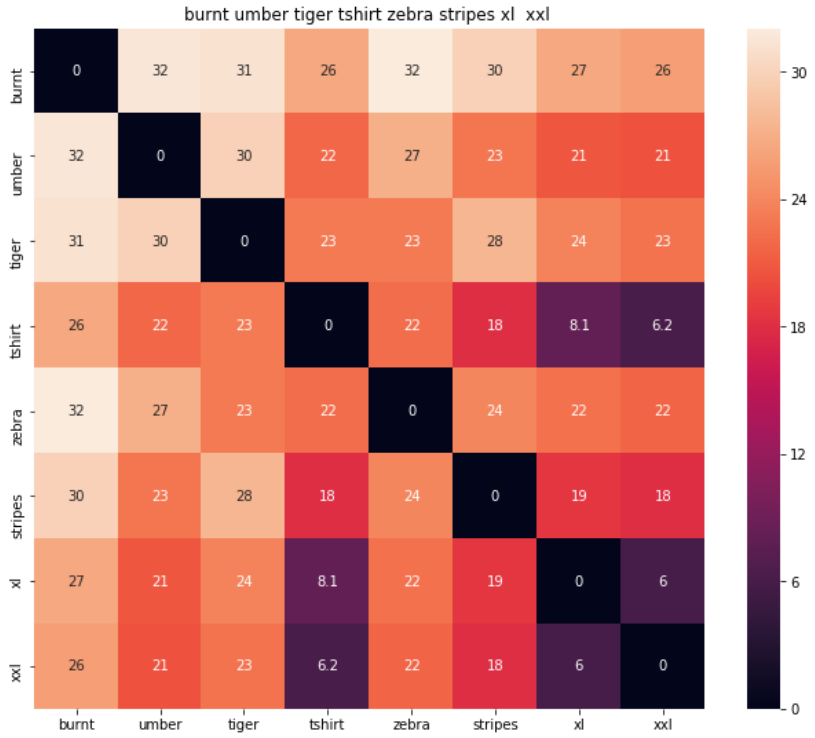


ASIN : B018WDJCUA
BRAND : INC - International Concepts Woman
euclidean distance from given input image : 1.0966892
==========

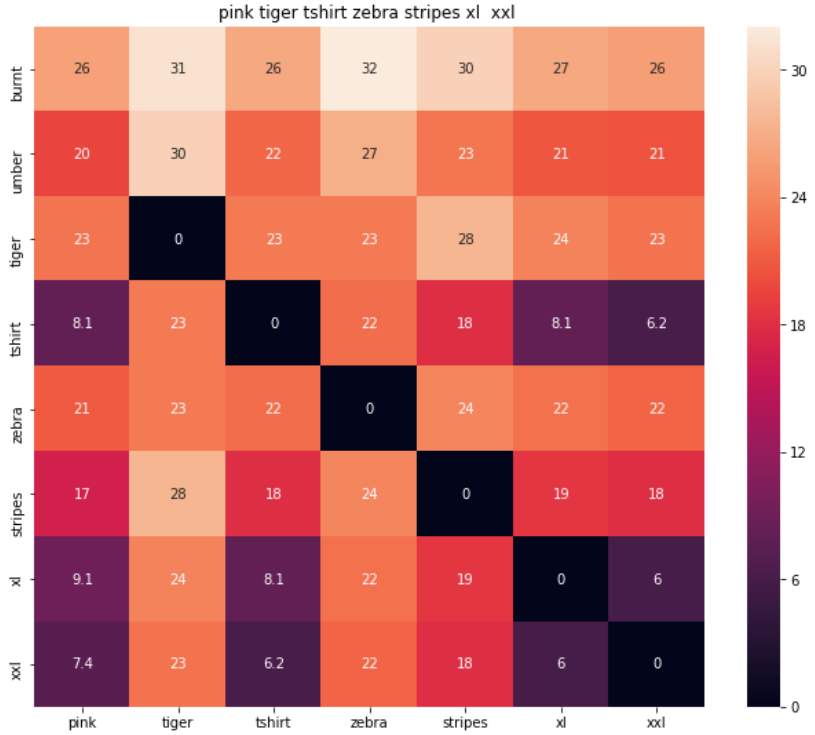
[9.4] IDF weighted Word2Vec for product similarity

In [55]:
```
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)
```

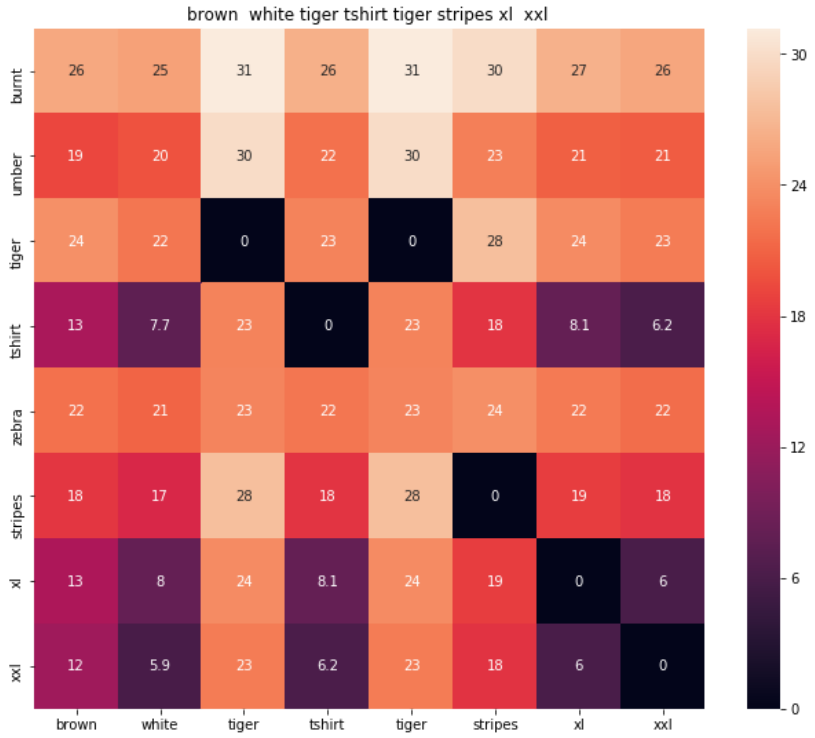
In [56]:
```
def weighted_w2v_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

    # pairwise_dist will store the distance from given input apparel to all re
maining 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(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_ind
ices[i]], data['medium_image_url'].loc[df_indices[i]], indices[0], indices[i],
'weighted')
        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)
#931
#12566
# in the give heat map, each cell contains the euclidean distance between word
s i, j
```



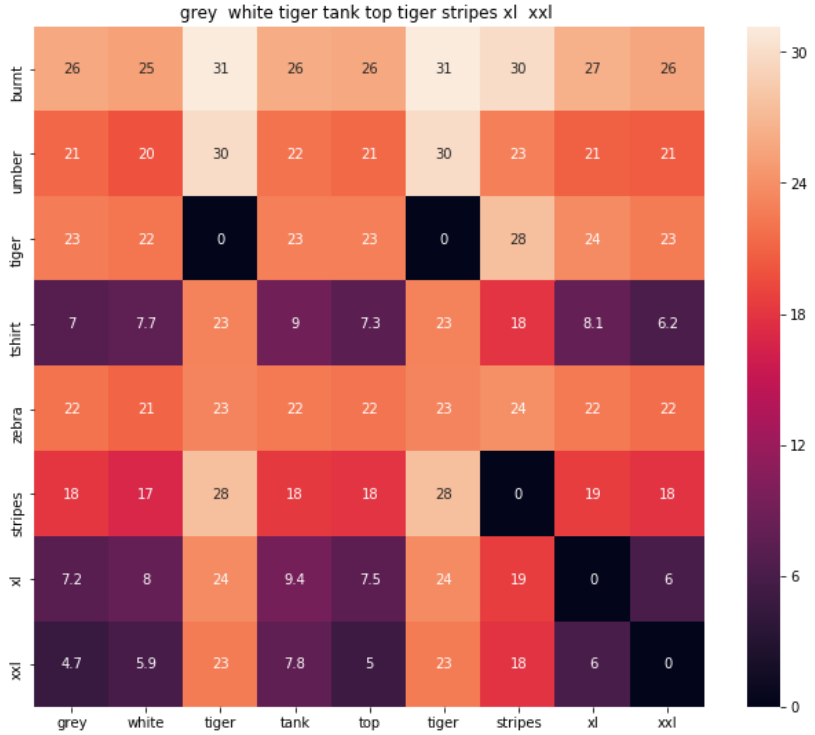
ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from input : 0.0
==========
==========



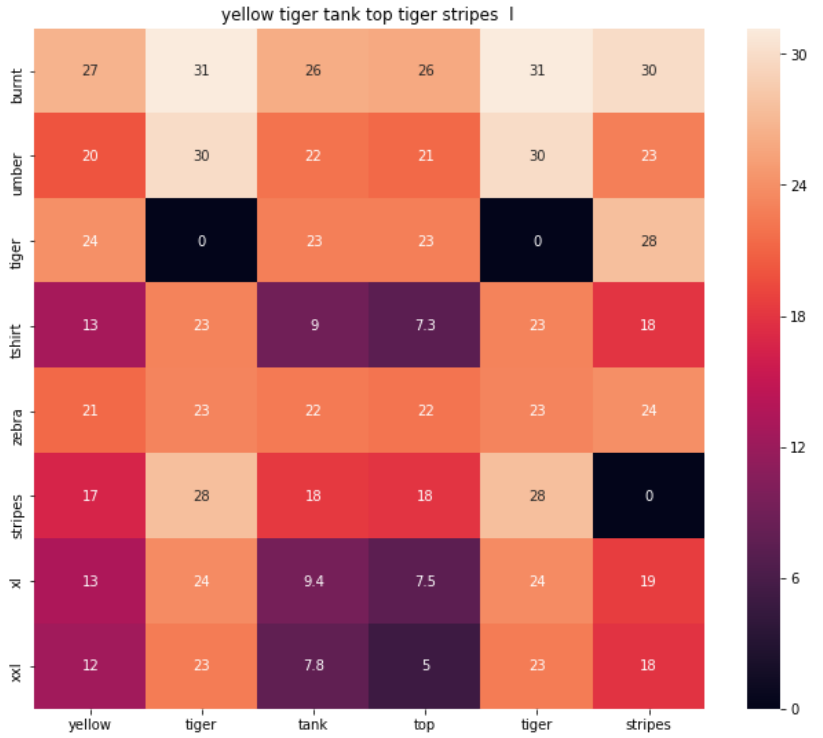
ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from input : 4.0638866
==========
==========



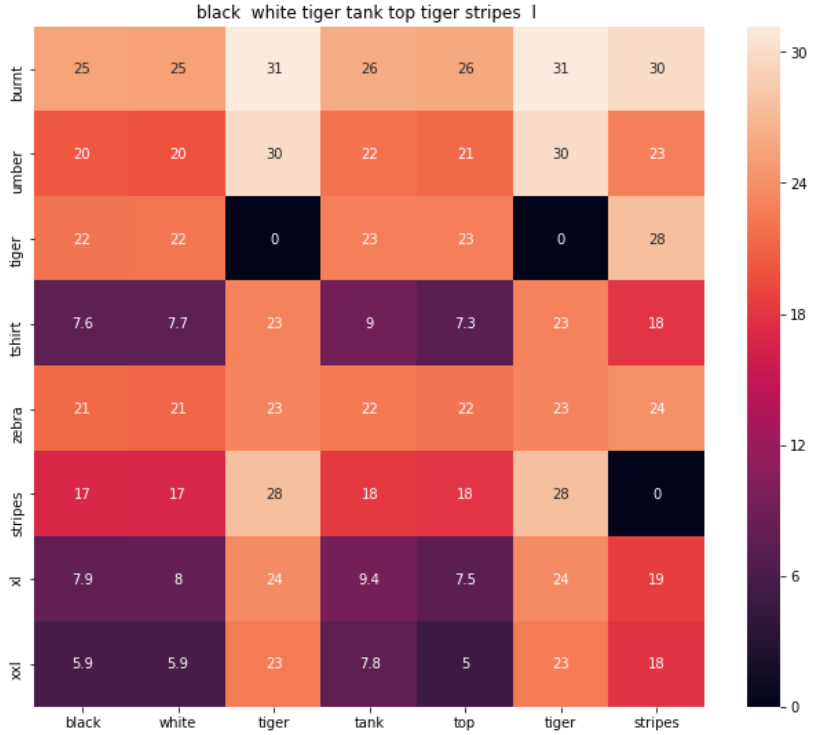
ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from input : 4.7709413
==========
==========



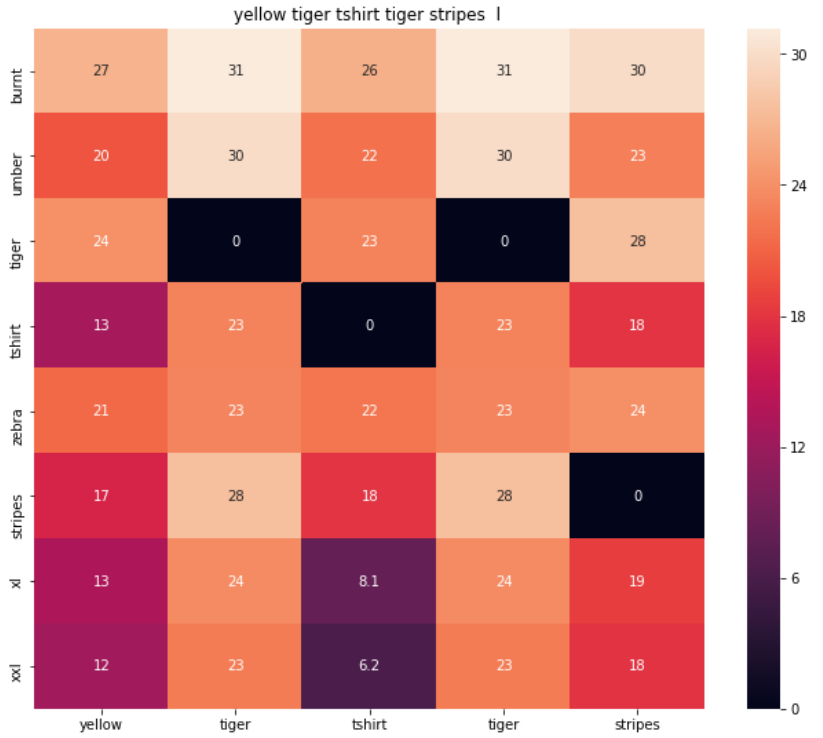
ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from input : 5.3601604
==========
==========



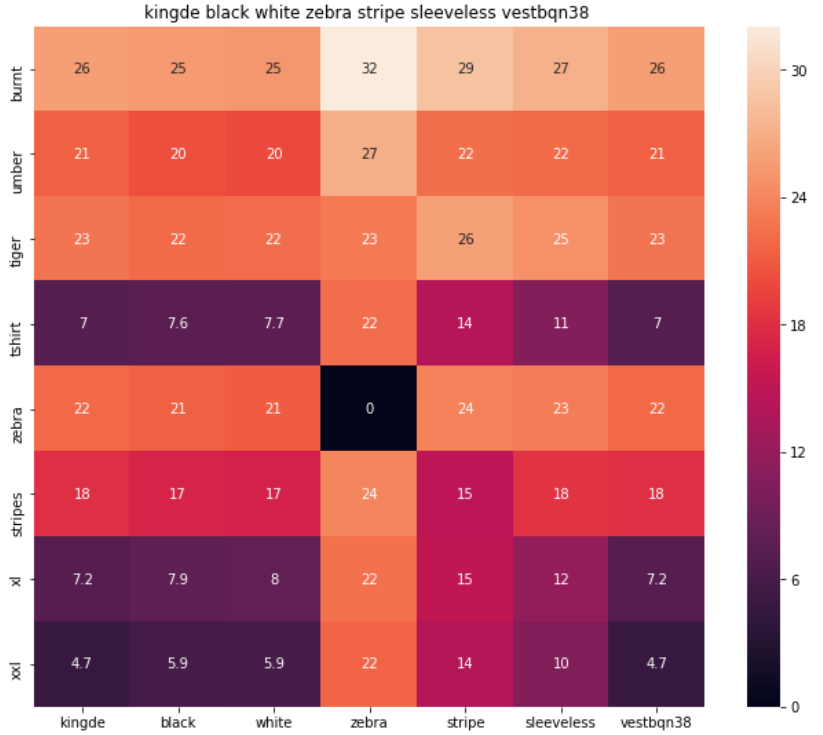
ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from input : 5.6895227
==========
==========



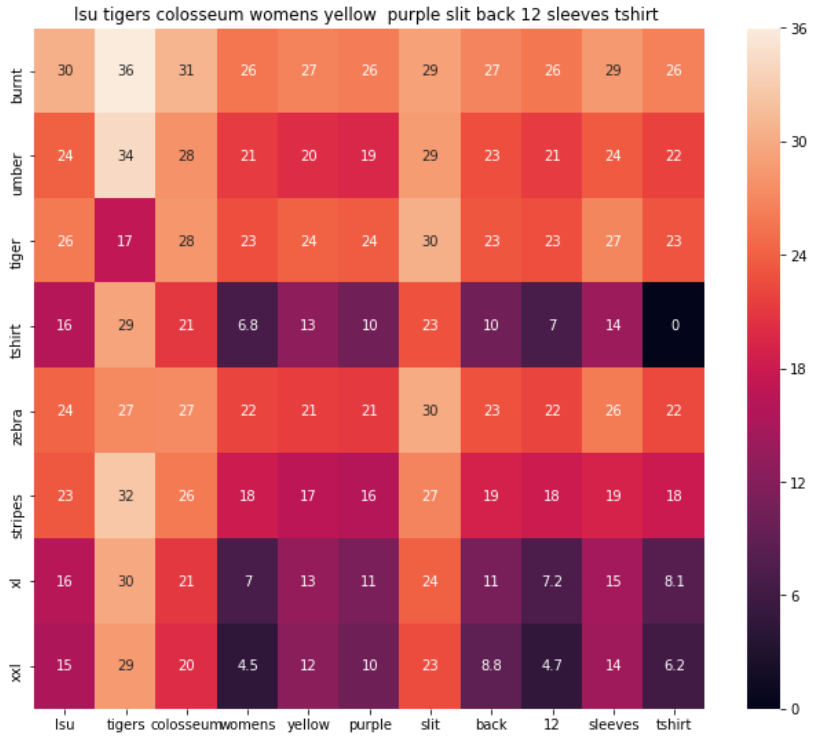
ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from input : 5.693021
==========
==========



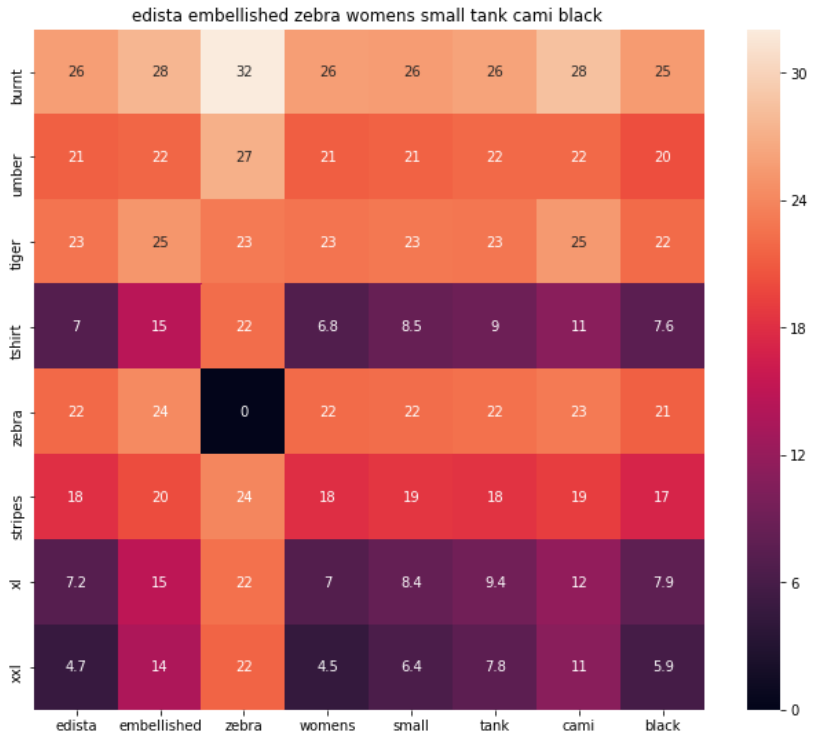
ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from input : 5.893442
==========
==========



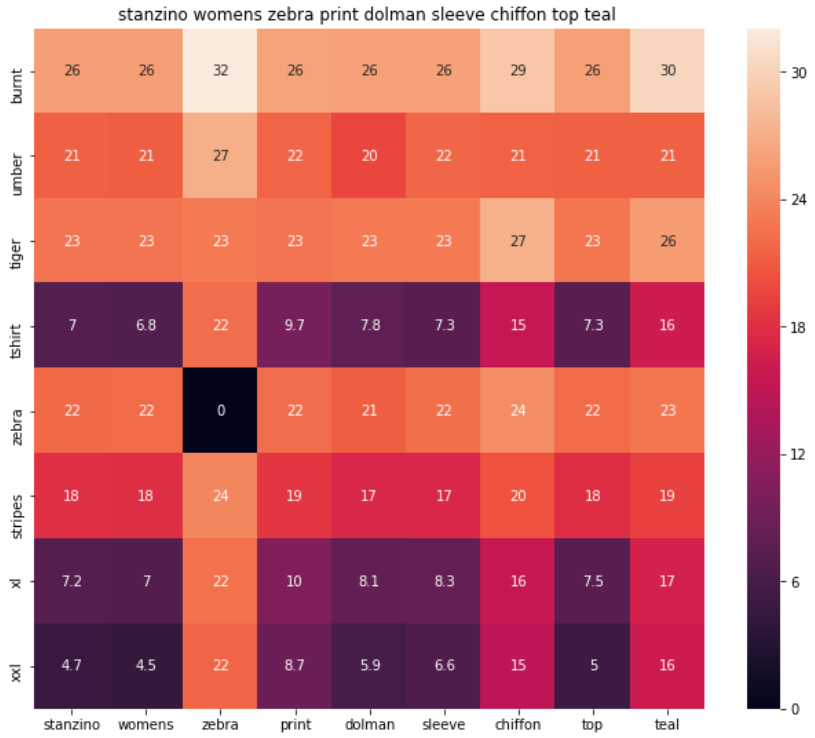
ASIN : B015H41F6G
Brand : KINGDE
euclidean distance from input : 6.1329894
==========
==========



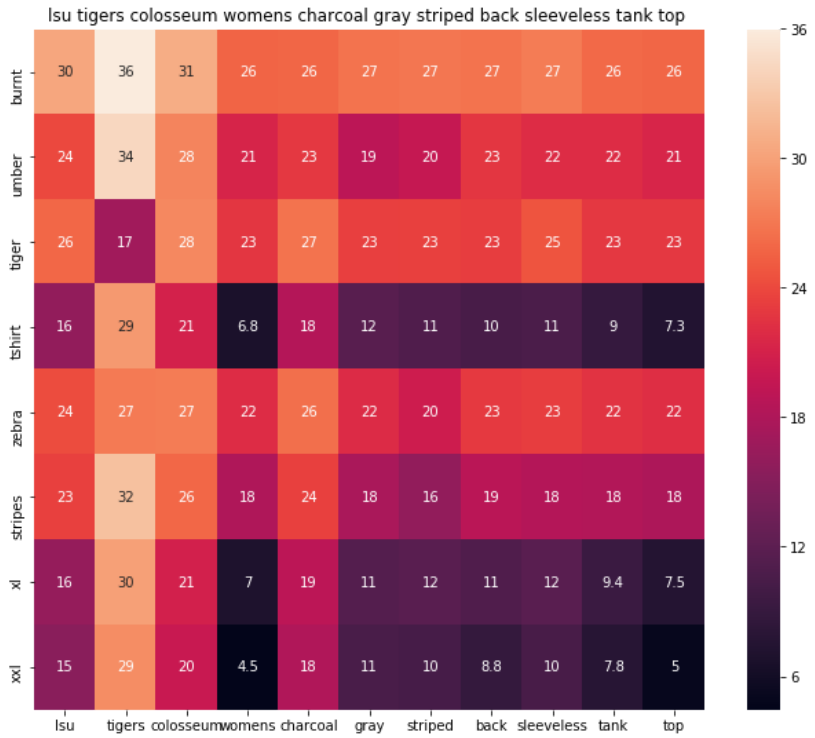
ASIN : B073R5Q8HD
Brand : Colosseum
euclidean distance from input : 6.2567053
==========
==========



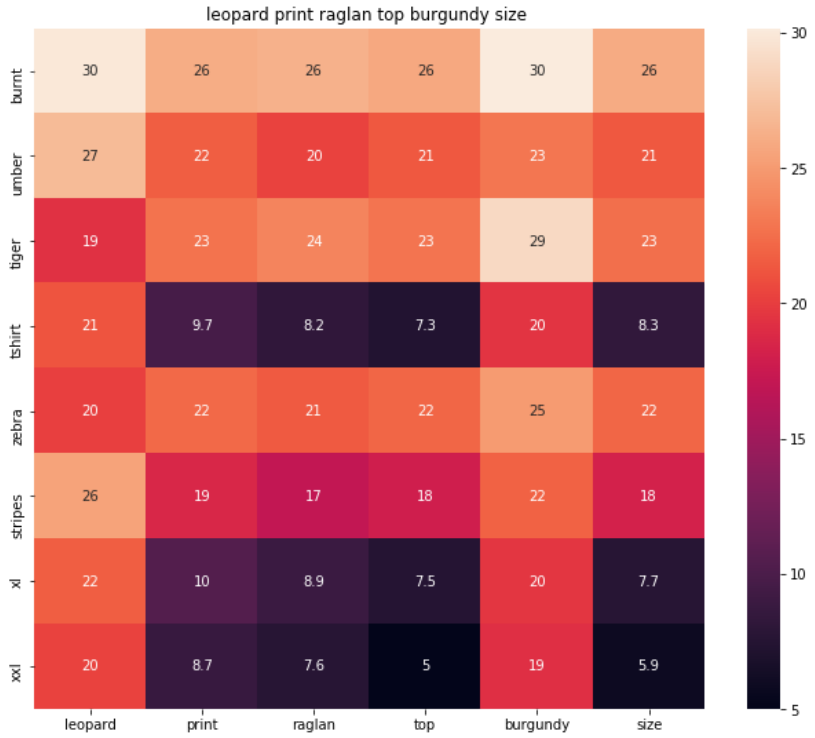
ASIN : B074P8MD22
Brand : Edista
euclidean distance from input : 6.3922033
==========
==========



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



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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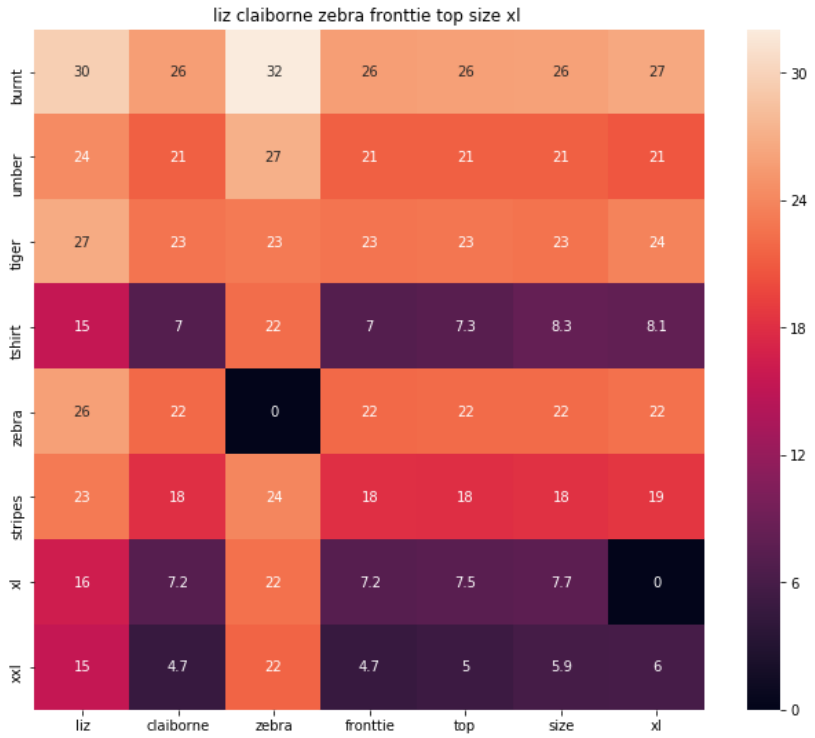
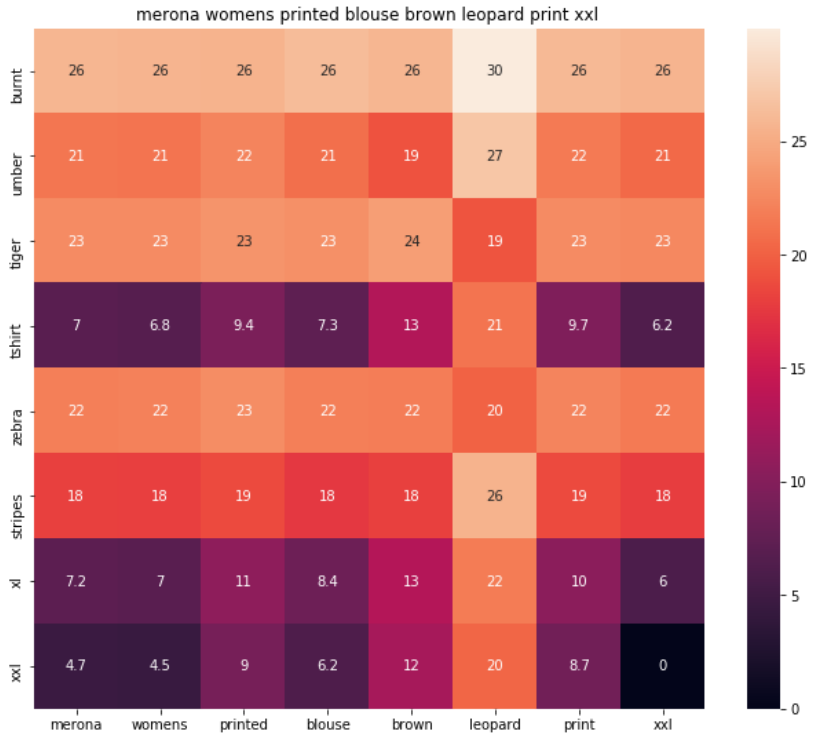


ASIN : B06XBY5QXL
Brand : Liz Claiborne
euclidean distance from input : 6.5392227
==========
==========



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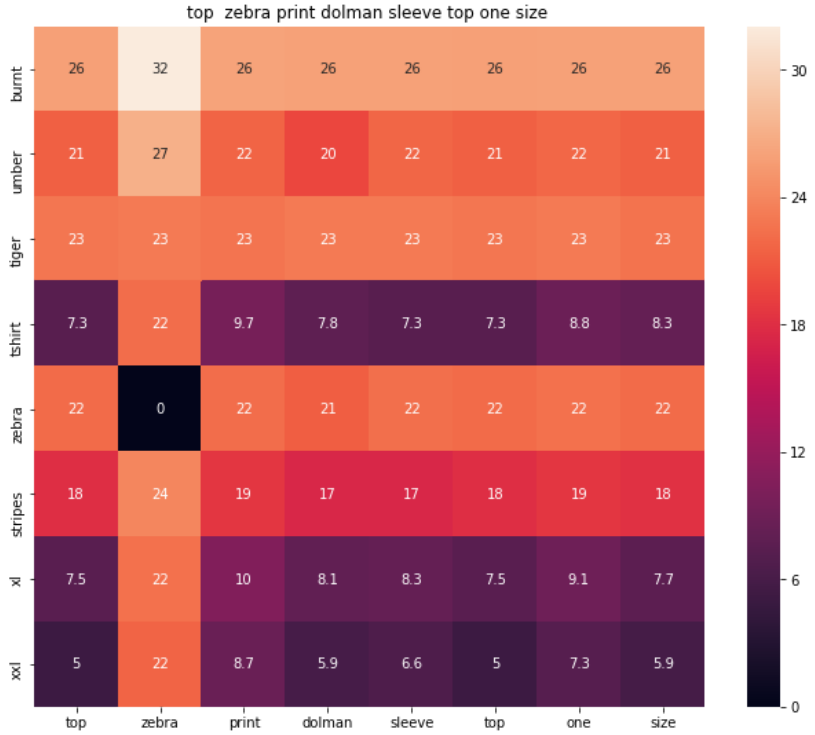

ASIN : B00H8A6ZLI
Brand : Vivian's Fashions
euclidean distance from input : 6.6382146
==========
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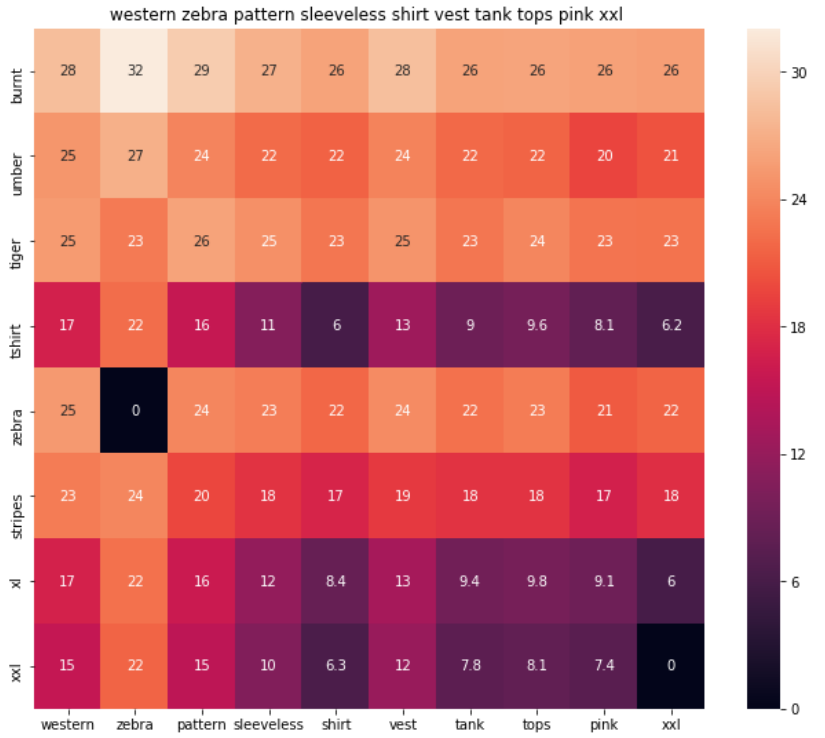

ASIN : B00Z6HEXWI
Brand : Black Temptation
euclidean distance from input : 6.6607366
==========
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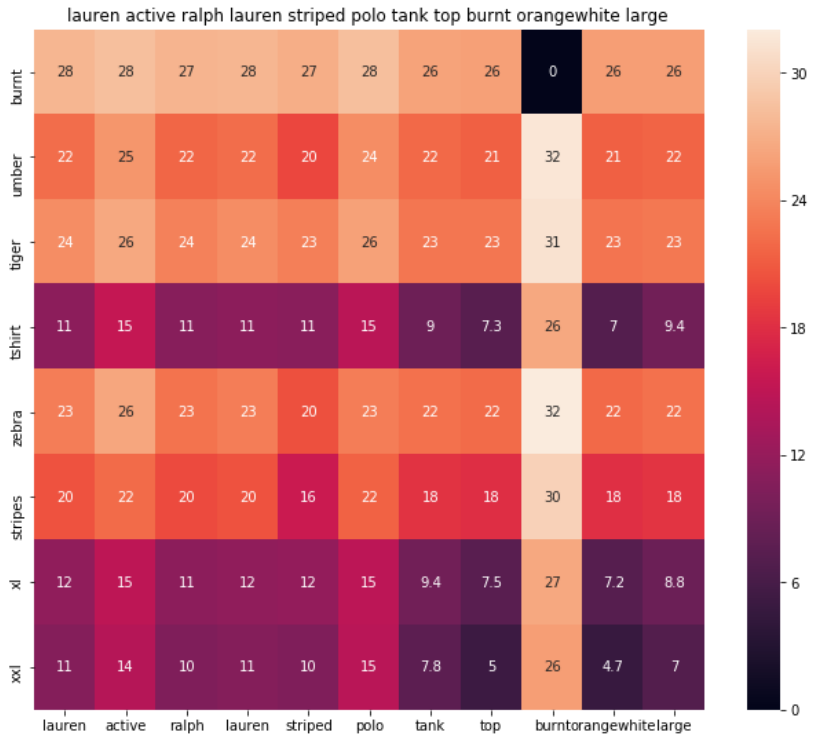

ASIN : B00ILGH5OY
Brand : Ralph Lauren Active
euclidean distance from input : 6.6839046
==========
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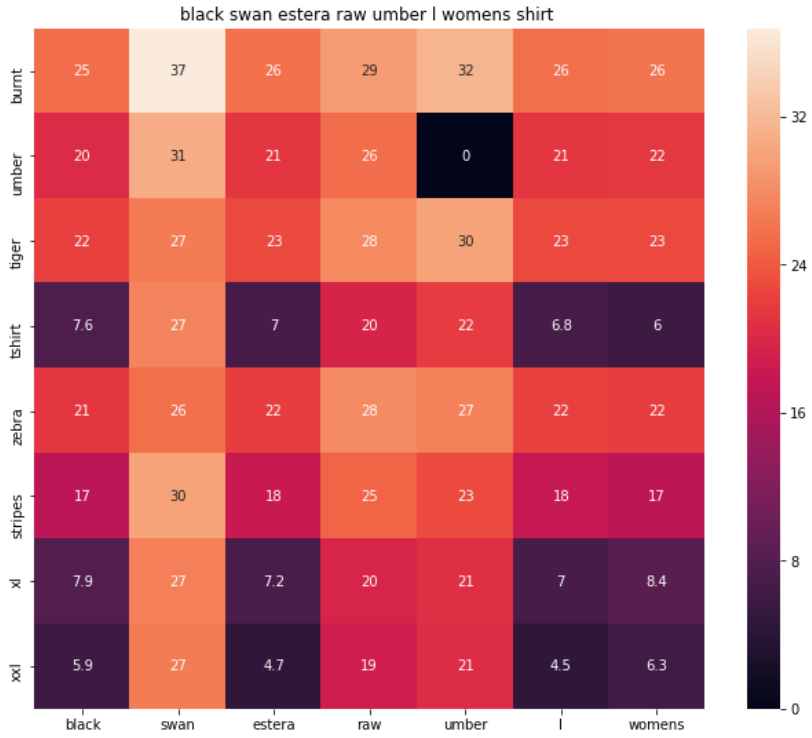

ASIN : B06Y1VN8WQ
Brand : Black Swan
euclidean distance from input : 6.705763
==========
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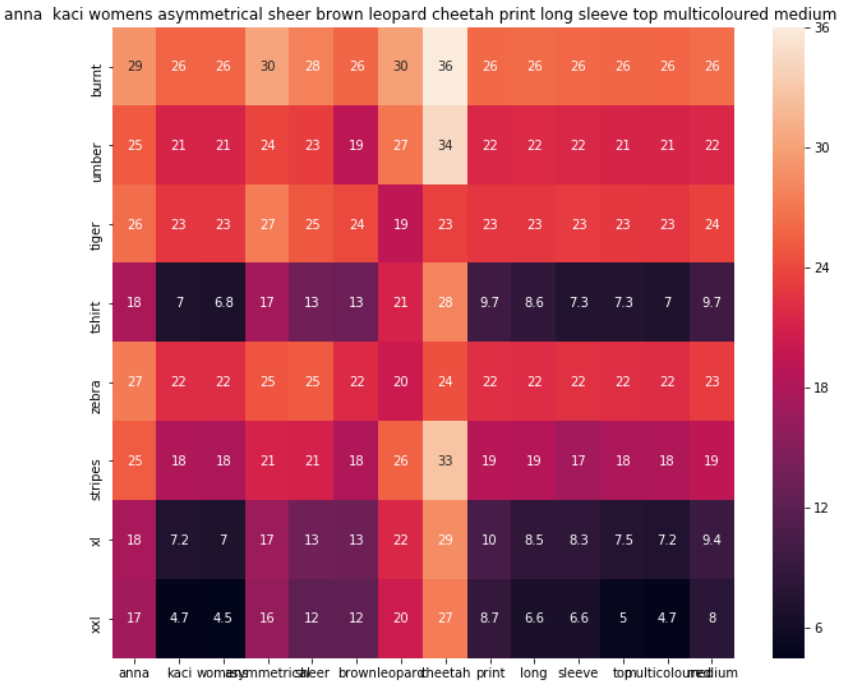


ASIN : B00KSNTY7Y
Brand : Anna-Kaci
euclidean distance from input : 6.7061243
==========
==========

[9.6] Weighted similarity using brand and color.

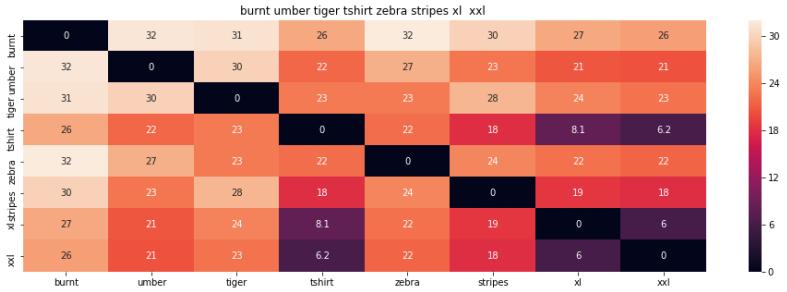
In [57]:
```
# some of the brand values are empty.
# Need to replace Null with string "NULL"
data['brand'].fillna(value="Not given", inplace=True )

# 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
()
```

In [58]:
```
def heat_map_w2v_brand(sentance1, sentance2, url, doc_id1, doc_id2, df_id1, df
_id2, model):

    # sentance1 : title1, input apparel
    # sentance2 : title2, recommended apparel
    # url: apparel image url
    # doc_id1: document id of input apparel
    # doc_id2: document id of recommended apparel
    # df_id1: index of document1 in the data frame
    # df_id2: index of document2 in the data frame
    # model: it can have two values, 1. avg 2. weighted

    #s1_vec = np.array(#number_of_words_title1 * 300), each row is a vector(we
ighted/avg) of length 300 corresponds to each word in give title
    s1_vec = get_word_vec(sentance1, doc_id1, model)
    #s2_vec = np.array(#number_of_words_title2 * 300), each row is a vector(we
ighted/avg) of length 300 corresponds to each word in give title
    s2_vec = get_word_vec(sentance2, doc_id2, model)

    # s1_s2_dist = np.array(#number of words in title1 * #number of words in t
itle2)
    # s1_s2_dist[i,j] = euclidean distance between words i, j
    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], typ
es[doc_id1]], # input apparel's features
                   [data['asin'].loc[df_id2],brands[doc_id2], colors[doc_id2], typ
es[doc_id2]]] # recommonded apparel's features

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

    # we create a table with the data_matrix
    table = ff.create_table(data_matrix, index=True, colorscale=colorscale)
    # plot it with plotly
    plotly.offline.iplot(table, filename='simple_table')

    # devide whole figure space into 25 * 1:10 grids
    gs = gridspec.GridSpec(25, 15)
    fig = plt.figure(figsize=(25,5))

    # in first 25*10 grids we plot heatmap
    ax1 = plt.subplot(gs[:, :-5])
    # ploting the heap map based on the pairwise distances
    ax1 = sns.heatmap(np.round(s1_s2_dist,6), annot=True)
    # set the x axis labels as recommended apparels title
    ax1.set_xticklabels(sentance2.split())
    # set the y axis labels as input apparels title
    ax1.set_yticklabels(sentance1.split())
    # set title as recommended apparels title
    ax1.set_title(sentance2)

    # in last 25 * 10:15 grids we display image
    ax2 = plt.subplot(gs[:, 10:16])
    # we dont display grid lins and axis labels to images
```

```
    ax2.grid(False)
    ax2.set_xticks([])
    ax2.set_yticks([])

    # pass the url it display it
    display_img(url, ax2, fig)

    plt.show()
```

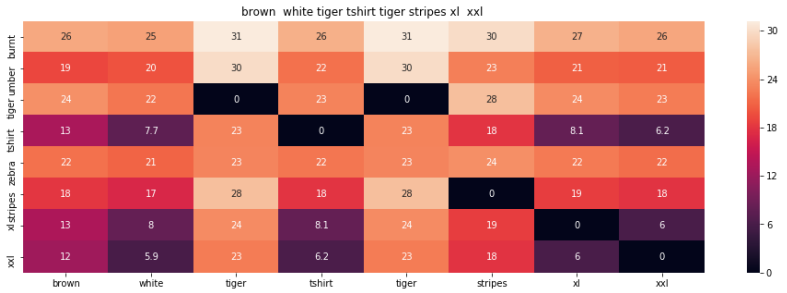
In [59]:
```
def idf_w2v_brand(doc_id, w1, w2, num_results):
    # doc_id: apparel's id in given corpus
    # w1: weight for  w2v features
    # w2: weight for brand and color features

    # pairwise_dist will store the distance from given input apparel to all re
maining 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
    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)

    # 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_brand(data['title'].loc[df_indices[0]],data['title'].loc[
df_indices[i]], data['medium_image_url'].loc[df_indices[i]], indices[0], indic
es[i],df_indices[0], df_indices[i], 'weighted')
        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)
# in the give heat map, each cell contains the euclidean distance between word
s i, j
```

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



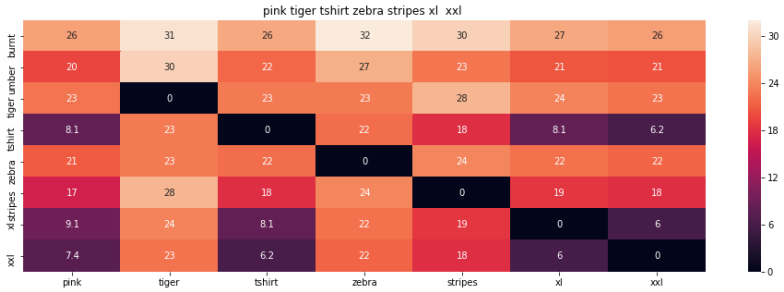
ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from input : 0.0
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



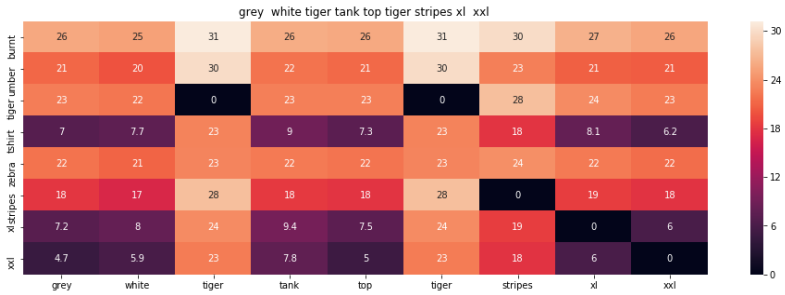
ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from input : 2.3854705810546877
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



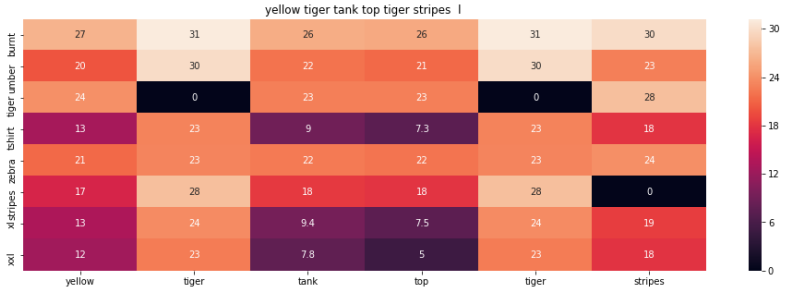
ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from input : 2.739050102414575
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



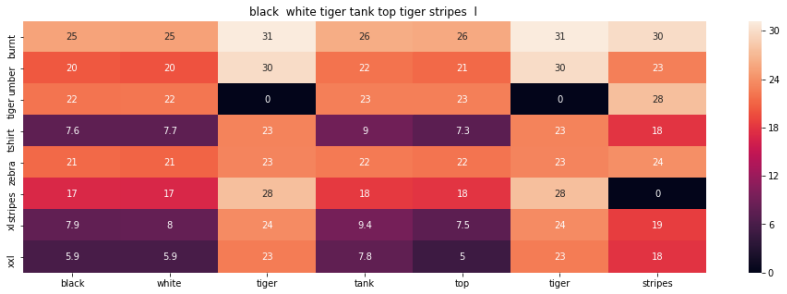
ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from input : 3.387187004270044
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



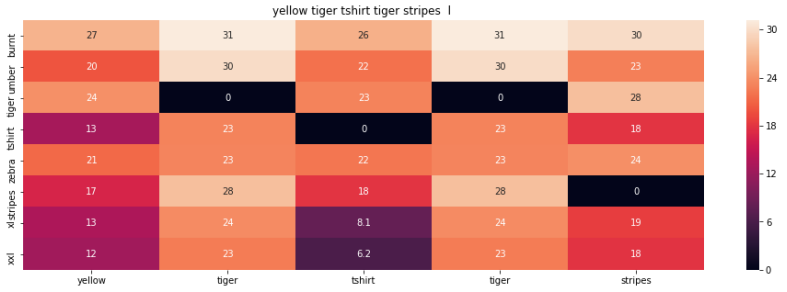
ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from input : 3.5518680574316646
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



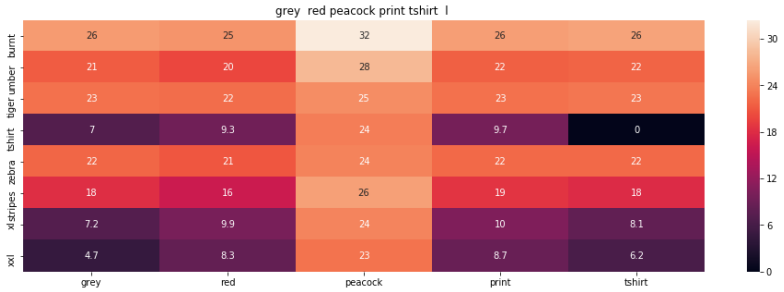
ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from input : 3.5536170961279536
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



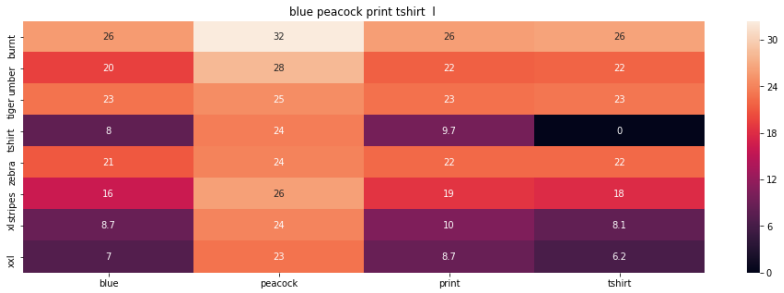
ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from input : 3.6538278581518795
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



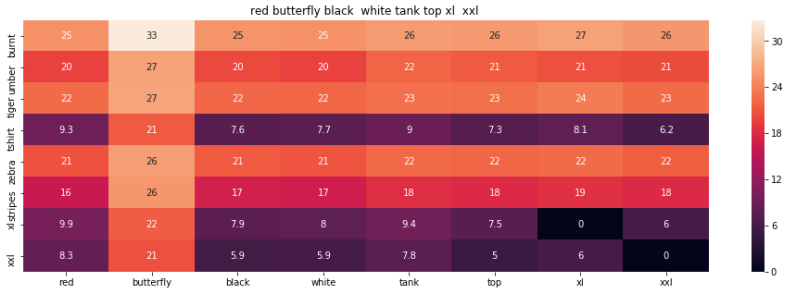
ASIN : B00JXQCFRS
Brand : Si Row
euclidean distance from input : 4.128811264218774
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



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

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



ASIN : B00JV63CW2
Brand : Si Row
euclidean distance from input : 4.286586380185571
==========
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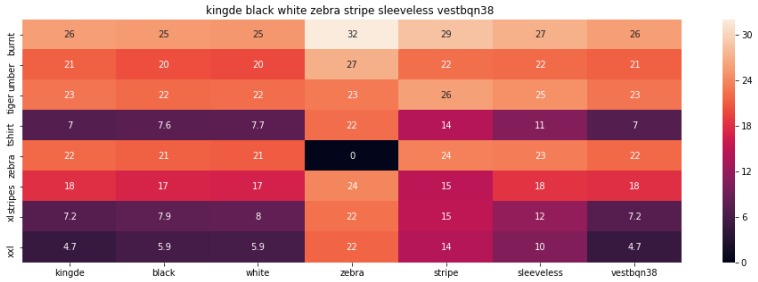
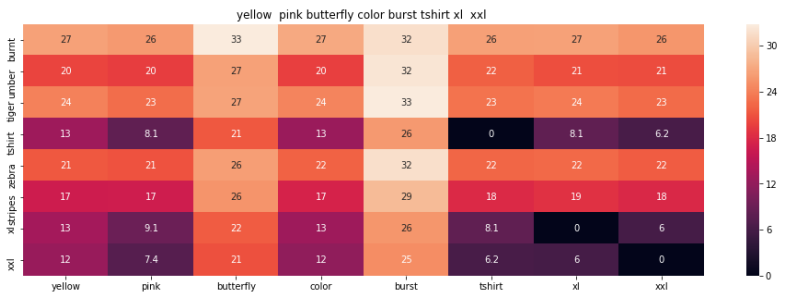
Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



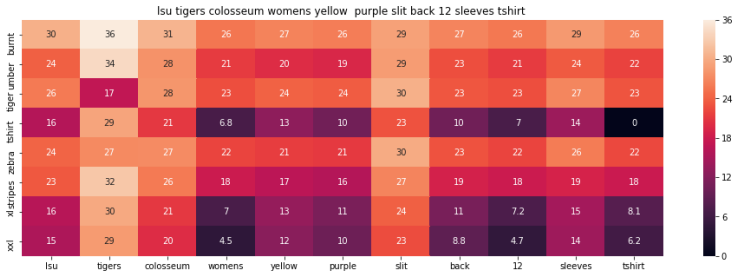
ASIN : B015H41F6G
Brand : KINGDE
euclidean distance from input : 4.389370406508858
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



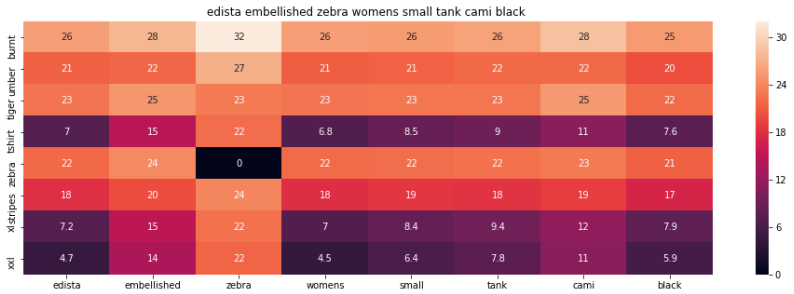
ASIN : B00JXQBBMI
Brand : Si Row
euclidean distance from input : 4.397909927548852
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



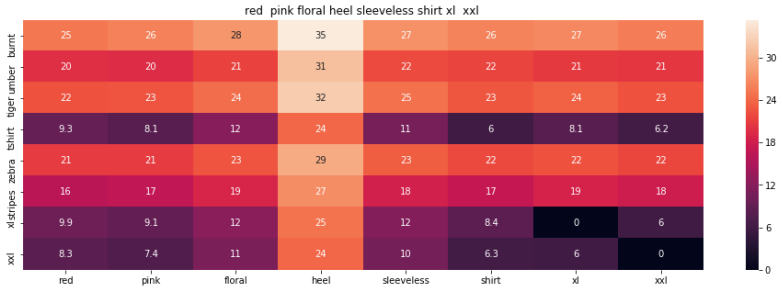
ASIN : B073R5Q8HD
Brand : Colosseum
euclidean distance from input : 4.451228392959053
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



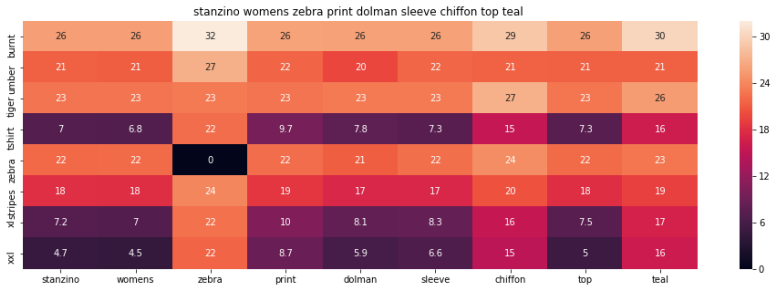
ASIN : B074P8MD22
Brand : Edista
euclidean distance from input : 4.518977416396553
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



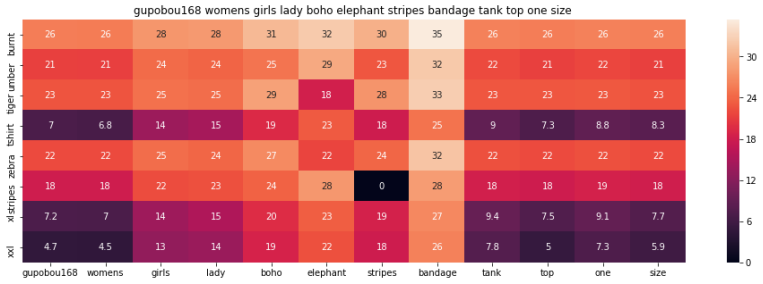
ASIN : B00JV63QQE
Brand : Si Row
euclidean distance from input : 4.529374695004907
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



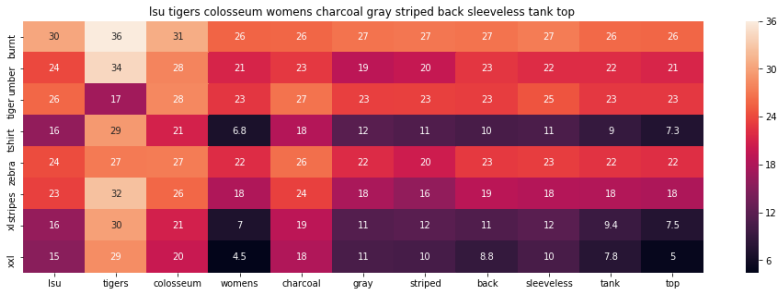
ASIN : B00C0I3U3E
Brand : Stanzino
euclidean distance from input : 4.530325759292061
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



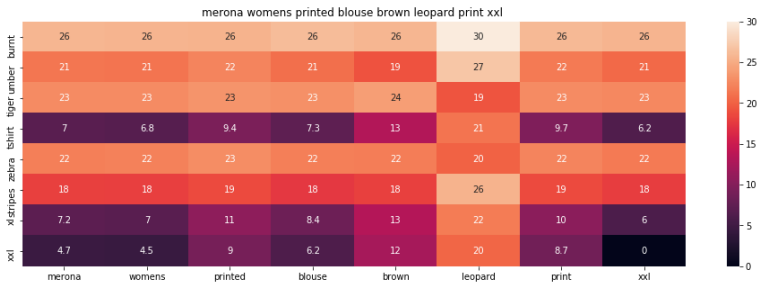
ASIN : B01ER184O6
Brand : GuPoBoU168
euclidean distance from input : 4.546816642558488
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



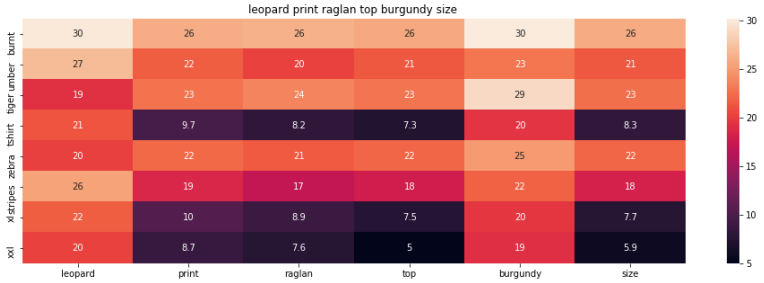
ASIN : B073R4ZM7Y
Brand : Colosseum
euclidean distance from input : 4.548355162978584
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



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

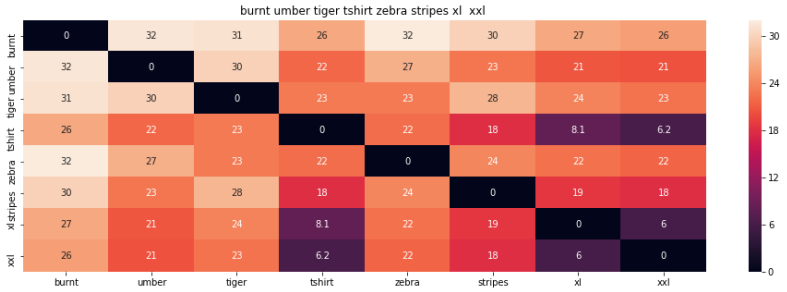
Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



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

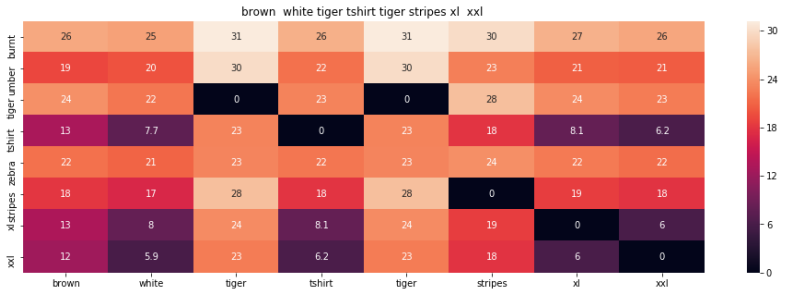
In [60]:
```
# brand and color weight =50
# title vector weight = 5

idf_w2v_brand(12566, 5, 50, 20)
```

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



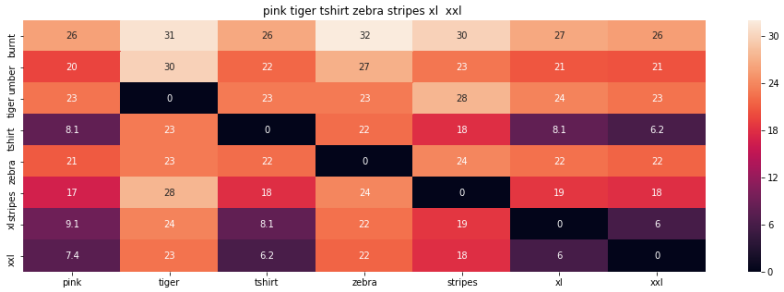
ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from input : 0.0
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



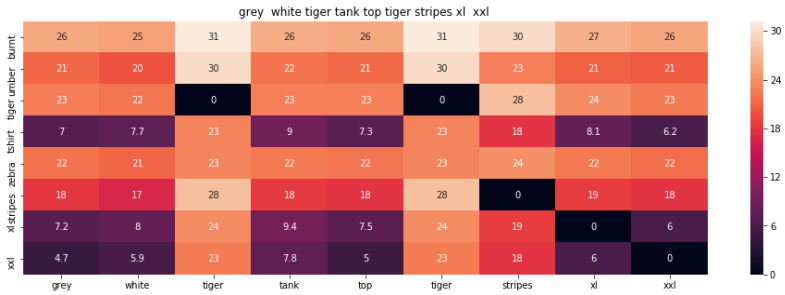
ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from input : 0.433721923828125
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



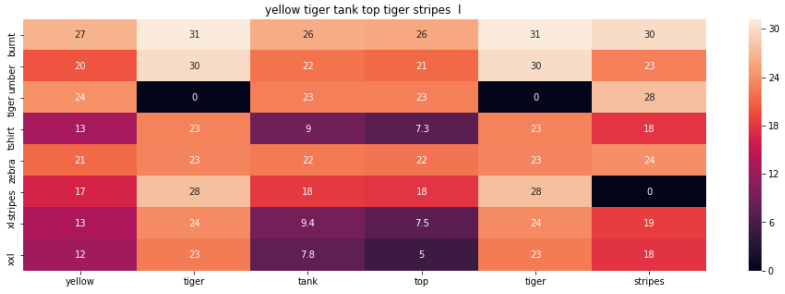
ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from input : 1.6550929332897277
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



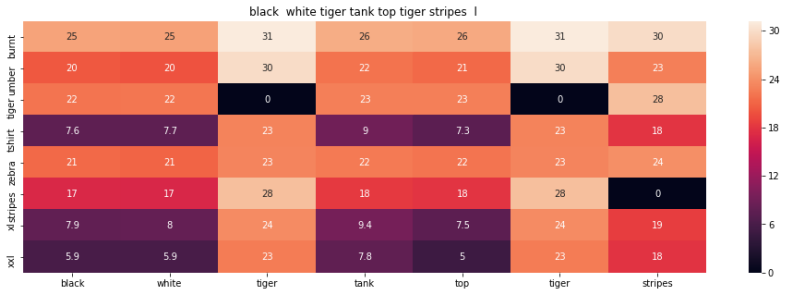
ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from input : 1.7729360063543584
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



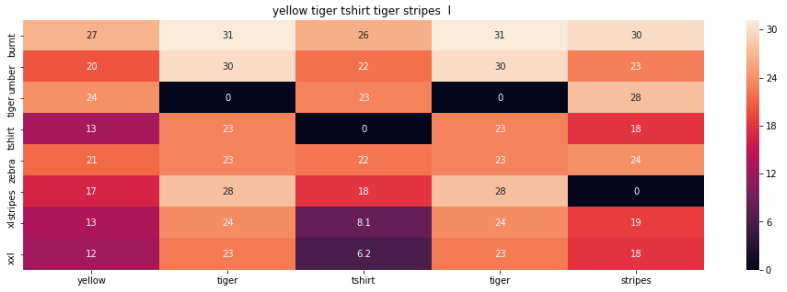
ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from input : 1.8028780160201077
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



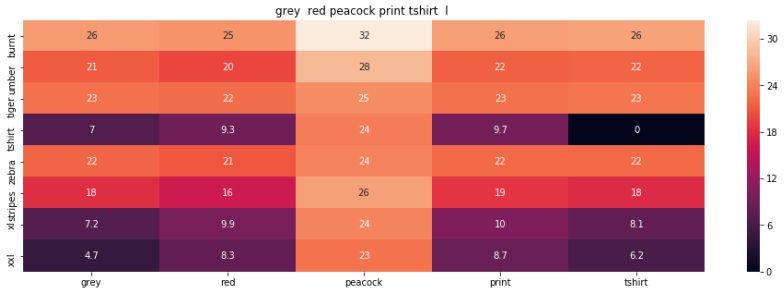
ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from input : 1.8031960230557966
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



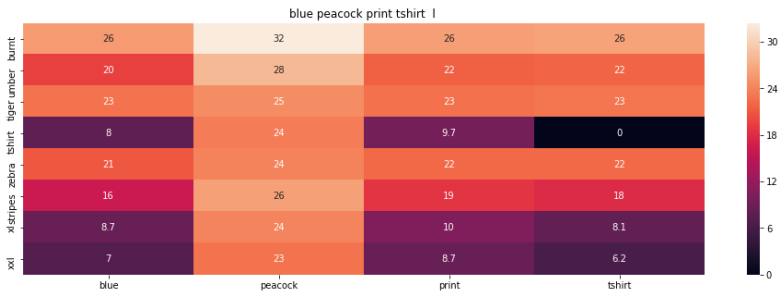
ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from input : 1.8214161616056013
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



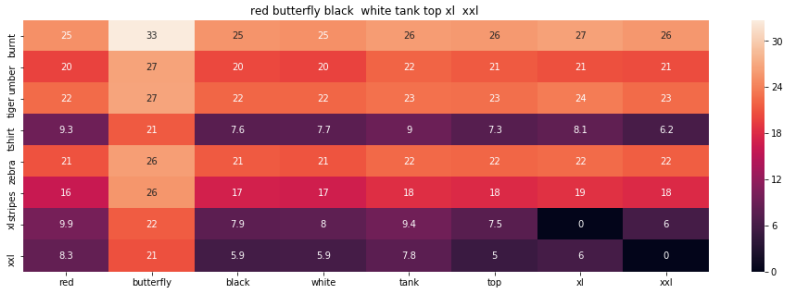
ASIN : B00JXQCFRS
Brand : Si Row
euclidean distance from input : 1.9077767808904913
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



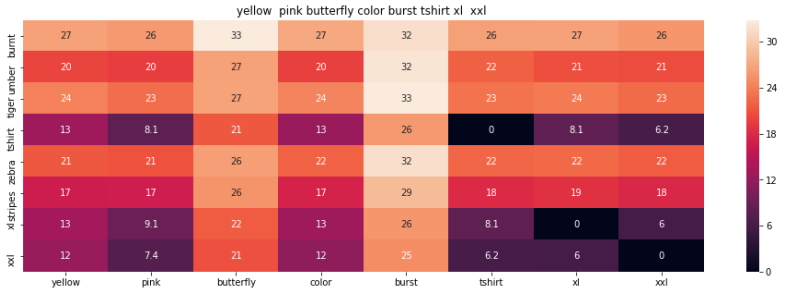
ASIN : B00JXQC8L6
Brand : Si Row
euclidean distance from input : 1.9214293049716347
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



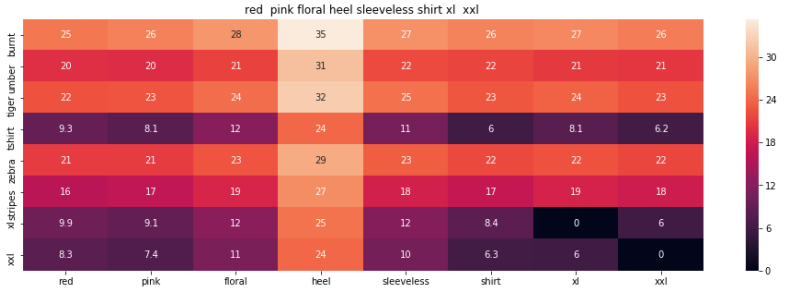
ASIN : B00JV63CW2
Brand : Si Row
euclidean distance from input : 1.936463165611727
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



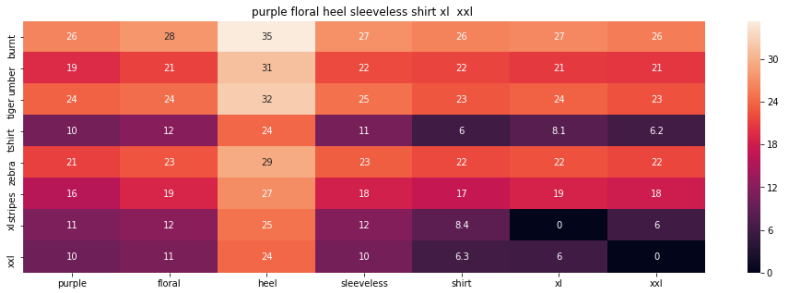
ASIN : B00JXQBBMI
Brand : Si Row
euclidean distance from input : 1.956703810586869
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



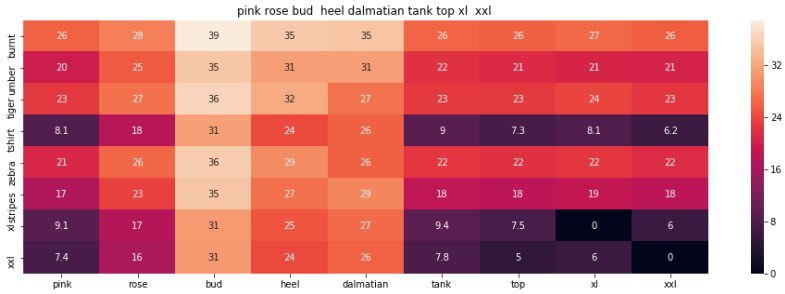
ASIN : B00JV63QQE
Brand : Si Row
euclidean distance from input : 1.9806064955788791
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



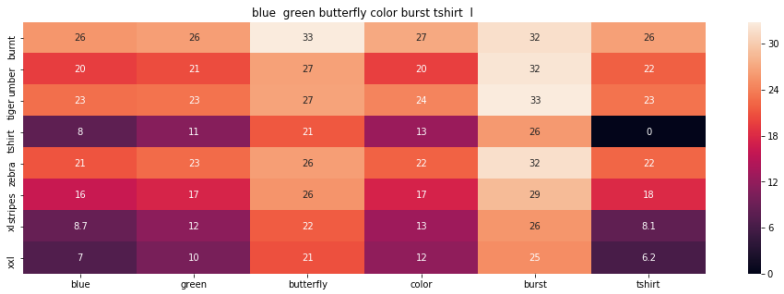
ASIN : B00JV63VC8
Brand : Si Row
euclidean distance from input : 2.012185530557572
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



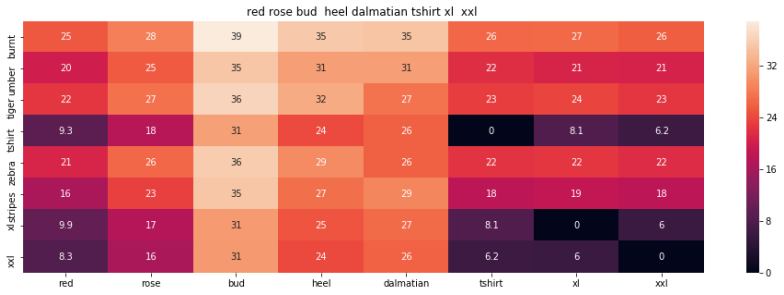
ASIN : B00JXQAX2C
Brand : Si Row
euclidean distance from input : 2.01335171819074
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



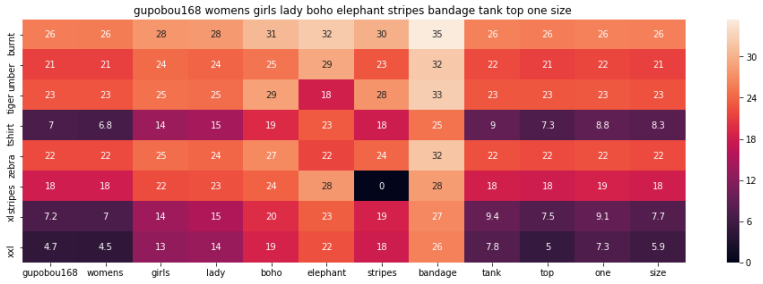
ASIN : B00JXQC0C8
Brand : Si Row
euclidean distance from input : 2.0138832789151717
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



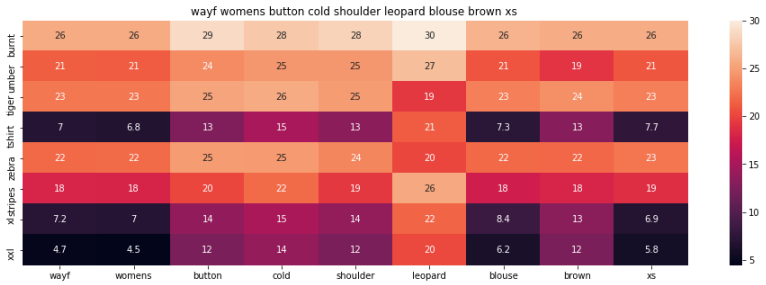
ASIN : B00JXQABB0
Brand : Si Row
euclidean distance from input : 2.0367257554998663
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



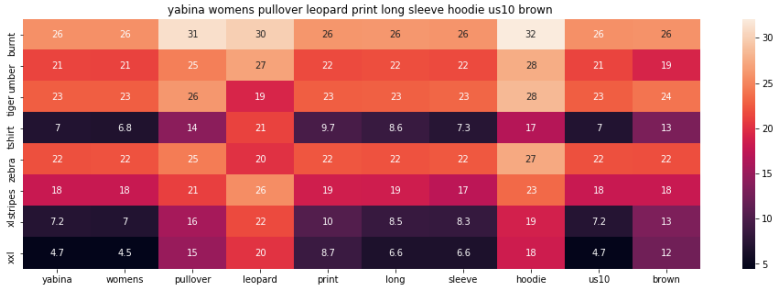
ASIN : B01ER184O6
Brand : GuPoBoU168
euclidean distance from input : 2.656204098419553
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



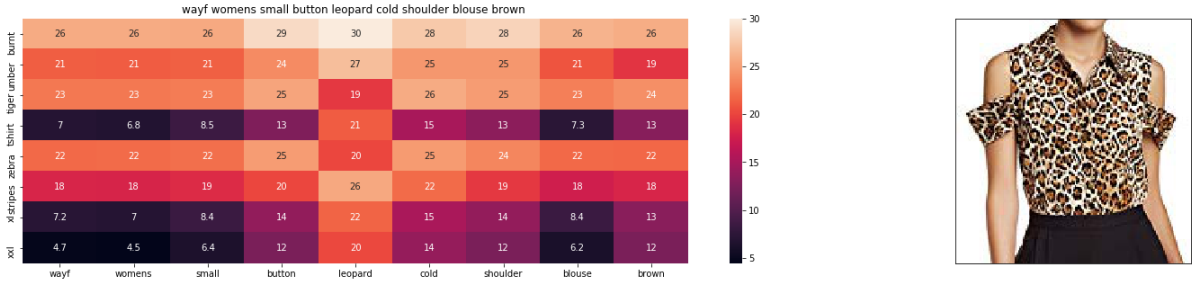
ASIN : B01LZ7BQ4H
Brand : WAYF
euclidean distance from input : 2.6849067129437008
==========
==========

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown



```
ASIN : B01KJUM6JI
Brand : YABINA
euclidean distance from input : 2.6858381232997024
================================================================================
================================================
```

Asin	Brand	Color
B00JXQB5FQ	Si-Row	Brown




```
ASIN : B01M06V4X1
Brand : WAYF
euclidean distance from input : 2.694761948650377
================================================================================
================================================
```

[10.2] Keras and Tensorflow to extract features

In [5]:
```
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
```

```
Using TensorFlow backend.
```

In [62]:
```
# https://gist.github.com/fchollet/f35fbc80e066a49d65f1688a7e99f069
# Code reference: https://blog.keras.io/building-powerful-image-classification
-models-using-very-little-data.html



# This code takes 40 minutes to run on a modern GPU (graphics card)
# like Nvidia  1050.
# GPU (NVidia 1050): 0.175 seconds per image

# This codse takes 160 minutes to run on a high end i7 CPU
# CPU (i7): 0.615 seconds per image.

#Do NOT run this code unless you want to wait a few hours for it to generate o
utput

# each image is converted into 25088 length dense-vector


'''
# dimensions of our images.
img_width, img_height = 224, 224

top_model_weights_path = 'bottleneck_fc_model.h5'
train_data_dir = 'images2/'
nb_train_samples = 16042
epochs = 50
batch_size = 1


def save_bottlebeck_features():

    #Function to compute VGG-16 CNN for image feature extraction.

    asins = []
    datagen = ImageDataGenerator(rescale=1. / 255)

    # build the VGG16 network
    model = applications.VGG16(include_top=False, weights='imagenet')
    generator = datagen.flow_from_directory(
        train_data_dir,
        target_size=(img_width, img_height),
        batch_size=batch_size,
        class_mode=None,
        shuffle=False)

    for i in generator.filenames:
        asins.append(i[2:-5])

    bottleneck_features_train = model.predict_generator(generator, nb_train_sa
mples // batch_size)
    bottleneck_features_train = bottleneck_features_train.reshape((16042,2508
8))

    np.save(open('16k_data_cnn_features.npy', 'wb'), bottleneck_features_trai
n)
```

```
    np.save(open('16k_data_cnn_feature_asins.npy', 'wb'), np.array(asins))


save_bottlebeck_features()

'''
```

Out[62]:
```
"\n# dimensions of our images.\nimg_width, img_height = 224, 224\n\ntop_model
_weights_path = 'bottleneck_fc_model.h5'\ntrain_data_dir = 'images2/'\nnb_tra
in_samples = 16042\nepochs = 50\nbatch_size = 1\n\n\ndef save_bottlebeck_feat
ures():\n    \n    #Function to compute VGG-16 CNN for image feature extracti
on.\n    \n    asins = []\n    datagen = ImageDataGenerator(rescale=1. / 255)
\n    \n    # build the VGG16 network\n    model = applications.VGG16(include
_top=False, weights='imagenet')\n    generator = datagen.flow_from_directory
(\n        train_data_dir,\n        target_size=(img_width, img_height),\n
batch_size=batch_size,\n        class_mode=None,\n        shuffle=False)\n\n
for i in generator.filenames:\n        asins.append(i[2:-5])\n\n    bottlenec
k_features_train = model.predict_generator(generator, nb_train_samples // bat
ch_size)\n    bottleneck_features_train = bottleneck_features_train.reshape
((16042,25088))\n    \n    np.save(open('16k_data_cnn_features.npy', 'wb'), b
ottleneck_features_train)\n    np.save(open('16k_data_cnn_feature_asins.npy',
'wb'), np.array(asins))\n    \n\nsave_bottlebeck_features()\n\n"
```

[10.3] Visual features based product similarity.

In [63]:
```
#load the features and corresponding ASINS info.
bottleneck_features_train = np.load('16k_data_cnn_features.npy')
asins = np.load('16k_data_cnn_feature_asins.npy')
asins = list(asins)

# load the original 16K dataset
data = pd.read_pickle('pickels/16k_apperal_data_preprocessed')
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_f
eatures_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[indi
ces[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 shadowpe
ach
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 shi
rt large
Euclidean Distance from input image: 48.265686
Amazon Url: www.amzon.com/dp/B01CR57YY0

Product Title: kawaii cotton pastel tops tees peach pink cactus design
Euclidean Distance from input image: 48.362602
Amazon Url: www.amzon.com/dp/B071WYLBZS

Product Title: chicago chicago 18 shirt women pink
Euclidean Distance from input image: 48.383606
Amazon Url: www.amzon.com/dp/B01GXAZTRY

Product Title: yichun womens tiger printed summer tshirts tops
Euclidean Distance from input image: 48.449356
Amazon Url: www.amzon.com/dp/B010NN9RXO

Product Title: nancy lopez whimsy short sleeve whiteblacklemon drop xs
Euclidean Distance from input image: 48.47889
Amazon Url: www.amzon.com/dp/B01MPX6IDX

Product Title: womens tops tees pastel peach ice cream cone print
Euclidean Distance from input image: 48.557957
Amazon Url: www.amzon.com/dp/B0734GRKZL

Product Title: uswomens mary j blige without tshirts shirt
Euclidean Distance from input image: 48.614372
Amazon Url: www.amzon.com/dp/B01M0XXFKK

Weighted Euclidean-distance based similarity

In [2]:
```
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
from IPython.display import display, Image, SVG, Math, YouTubeVideo
```

```
Using TensorFlow backend.
```

Creating Brand, color and image features

In [3]:
```
data = pd.read_pickle('pickels/16k_apperal_data_preprocessed')
data.head()

# some of the brand values are empty.
# Need to replace Null with string "NULL"
data['brand'].fillna(value="Not given", inplace=True )

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

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

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

image_features = np.load('16k_data_cnn_features.npy')
```

Creating IDF vocabulary

In [4]:
```
idf_title_vectorizer = CountVectorizer()
idf_title_features = idf_title_vectorizer.fit_transform(data['title'])

# idf_title_features.shape = #data_points * #words_in_corpus
# CountVectorizer().fit_transform(courpus) returns the a sparase matrix of dim
ensions #data_points * #words_in_corpus
# idf_title_features[doc_id, index_of_word_in_corpus] = number of times the wo
rd occured in that doc
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)))

# we need to convert the values into float
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 the word i present
    for j in idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzer
o()[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
```

Creating title features using IDF weighted w2v

In [5]:
```
with open('word2vec_model', 'rb') as handle:
    model = pickle.load(handle)

# vocab = stores all the words that are there in google w2v model
# vocab = model.wv.vocab.keys() # if you are using Google word2Vec

vocab = model.keys()
# this function will add the vectors of each word and returns the avg vector o
f given sentance
def build_avg_vec(sentence, num_features, doc_id, m_name):
    # sentace: its title of the apparel
    # num_features: the lenght of word2vec vector, its values = 300
    # m_name: model information it will take two values
        # if  m_name == 'avg', we will append the model[i], w2v representation
of word i
        # if m_name == 'weighted', we will multiply each w2v[word] with the id
f(word)

    featureVec = np.zeros((num_features,), dtype="float32")
    # we will intialize a vector of size 300 with all zeros
    # we add each word2vec(wordi) to this fetureVec
    nwords = 0

    for word in sentence.split():
        nwords += 1
        if word in vocab:
            if m_name == 'weighted' and word in  idf_title_vectorizer.vocabula
ry_:
                featureVec = np.add(featureVec, idf_title_features[doc_id, idf
_title_vectorizer.vocabulary_[word]] * model[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

doc_id = 0
title_features = []
# for every title we build a avg vector representation
for i in data['title']:
    title_features.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
title_features = np.array(title_features)
```

In [6]:
```
def IDF_w2v(doc_id, num_results, W_title, W_brand, W_color, W_image):
    # doc_id: apparel's id in given corpus

    # pairwise_dist will store the distance from given input apparel to all re
maining 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
    title_dist = pairwise_distances(title_features, title_features[doc_id].res
hape(1,-1))
    brand_dist = pairwise_distances(brand_features, brand_features[doc_id])
    color_dist = pairwise_distances(color_features, color_features[doc_id])
    image_dist = pairwise_distances(image_features, image_features[doc_id].res
hape(1,-1))

    eucl_dist   = (W_title * title_dist +  W_brand * brand_dist + W_color * co
lor_dist + W_image * image_dist)\
                        /float(W_title + W_brand + W_color + W_image)

    # np.argsort will return indices of 9 smallest distances
    indices = np.argsort(eucl_dist.flatten())[0:num_results]
    #pdists will store the 9 smallest distances
    pdists  = np.sort(eucl_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)):
        display(Image(url=data['medium_image_url'].loc[df_indices[i]], embed=T
rue))
        print('ASIN : ',data['asin'].loc[df_indices[i]])
        print('TITLE : ',data['title'].loc[df_indices[i]])
        print('BRAND : ',data['brand'].loc[df_indices[i]])
        print('COLOR : ',data['color'].loc[df_indices[i]])
        print('Euclidean Distance from input is  :',pdists[i])
        print('='*125)


#931
#12566
# in the give heat map, each cell contains the euclidean distance between word
s i, j
```

In [10]:
```
IDF_w2v(12566, 20,50,1,1,1)
```

ASIN : B00JXQB5FQ
TITLE : burnt umber tiger tshirt zebra stripes xl xxl
BRAND : Si Row
COLOR : Brown
Euclidean Distance from input is : 1.416837530653212e-07
==========
==========

ASIN : B00JXQASS6
TITLE : pink tiger tshirt zebra stripes xl xxl
BRAND : Si Row
COLOR : Pink
Euclidean Distance from input is : 4.775818130212081
==========
==========

ASIN : B00JXQCWTO
TITLE : brown white tiger tshirt tiger stripes xl xxl
BRAND : Si Row
COLOR : Brown
Euclidean Distance from input is : 5.548960487797575
==========
==========

ASIN : B00JXQAFZ2
TITLE : grey white tiger tank top tiger stripes xl xxl
BRAND : Si Row
COLOR : Grey
Euclidean Distance from input is : 6.100921746026866
==========
==========

ASIN : B00JXQAUWA
TITLE : yellow tiger tank top tiger stripes l
BRAND : Si Row
COLOR : Yellow
Euclidean Distance from input is : 6.403193247100163
==========
==========

ASIN : B00JXQAO94
TITLE : black white tiger tank top tiger stripes l
BRAND : Si Row
COLOR : White
Euclidean Distance from input is : 6.439519961381929
==========
==========

ASIN : B00JXQCUIC
TITLE : yellow tiger tshirt tiger stripes l
BRAND : Si Row
COLOR : Yellow
Euclidean Distance from input is : 6.571007465873196
==========
==========

ASIN : B073R5Q8HD
TITLE : lsu tigers colosseum womens yellow purple slit back 12 sleeves tshi
rt
BRAND : Colosseum
COLOR : Yellow
Euclidean Distance from input is : 6.896308346657956
==========
==========

ASIN : B015H41F6G
TITLE : kingde black white zebra stripe sleeveless vestbqn38
BRAND : KINGDE
COLOR : White
Euclidean Distance from input is : 7.033048689283988
==========
==========

ASIN : B00C0I3U3E
TITLE : stanzino womens zebra print dolman sleeve chiffon top teal
BRAND : Stanzino
COLOR : Teal
Euclidean Distance from input is : 7.175993025221488
==========
==========

ASIN : B074P8MD22
TITLE : edista embellished zebra womens small tank cami black
BRAND : Edista
COLOR : Black
Euclidean Distance from input is : 7.177087195557942
==========
==========

ASIN : B01C6ORLDQ
TITLE : leopard print raglan top burgundy size
BRAND : 1 Mad Fit
COLOR : Burgundy
Euclidean Distance from input is : 7.179966735846662
==========
==========

ASIN : B073R4ZM7Y
TITLE : lsu tigers colosseum womens charcoal gray striped back sleeveless ta
nk top
BRAND : Colosseum
COLOR : Gray
Euclidean Distance from input is : 7.251415636098184
==========
==========

ASIN : B06XBY5QXL
TITLE : liz claiborne zebra fronttie top size xl
BRAND : Liz Claiborne
COLOR : Crema Multi/Black
Euclidean Distance from input is : 7.305180315701467
==========
==========

ASIN : B071YF3WDD
TITLE : merona womens printed blouse brown leopard print xxl
BRAND : Merona
COLOR : , Brown Leopard Print
Euclidean Distance from input is : 7.311708581816049
==========
==========

ASIN : B00H8A6ZLI
TITLE : top zebra print dolman sleeve top one size
BRAND : Vivian's Fashions
COLOR : Black
Euclidean Distance from input is : 7.3558892016209105
==========
==========

ASIN : B01IPV1SFQ
TITLE : daniel rainn orange pink ivory white print chiffon tank top 68 white ivory xl
BRAND : Daniel Rainn
COLOR : White Ivory
Euclidean Distance from input is : 7.362010144424391
==========
==========

ASIN : B06Y1VN8WQ
TITLE : black swan estera raw umber l womens shirt
BRAND : Black Swan
COLOR : Raw Umber
Euclidean Distance from input is : 7.3872998598854025
==========
==========

```
ASIN :  B00KSNTY7Y
TITLE :  anna  kaci womens asymmetrical sheer brown leopard cheetah print lon
g sleeve top multicoloured medium
BRAND :  Anna-Kaci
COLOR :  Multicoloured
Euclidean Distance from input is  : 7.3936295851289815
================================================================================
================================================
```

```
ASIN :  B00Z6HEXWI
TITLE :  western zebra pattern sleeveless shirt vest tank tops pink xxl
BRAND :  Black Temptation
COLOR :  Multicolored
Euclidean Distance from input is  : 7.434551642082843
================================================================================
================================================
```

Conclusion:

1.The final model uses IDF-w2v for product title, VGG-16 CNN for images and one-hot encoding for both brand and color.

2.This model has the added advantage of choosing the weightage for the required features.

In [ ]: