Amazon Apparel Recommendations

[4.2] Data and Code:

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

[4.3] Overview of the data

In [78]:

```
#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 [3]:

```
# 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 [4]:

```
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 [5]:

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

Out[5]:

```
Index(['asin', 'author', 'availability', 'availability_type', 'brand', 'color',
       '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 ex: 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 [6]:

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

In [7]:

```
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[7]:

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
0	B016I2TS4W	FNC7C	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	Minions Como Superheroes Ironman Long Sleeve R...	None
1	B01N49AI08	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Izo Tunic	None
2	B01JDPCOHO	FIG Clothing	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	FIG Clothing Womens Won Top	None
3	B01N19U5H5	Focal18	None	https://images-na.ssl-images-amazon.com/images...	SHIRT	Focal18 Sailor Collar Bubble Sleeve Blouse Shi...	None
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	Featherlite Ladies' Long Sleeve Stain Resistan...	$26.26

[5.1] Missing data for various features.

Basic stats for the feature: product_type_name

In [8]:

```
# 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 [9]:

```
# 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 [10]:

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

Out[10]:

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

Basic stats for the feature: brand

In [11]:

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

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

```
count     182987
unique     10577
top         Zago
```

In [12]:

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

Out[12]:

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

Basic stats for the feature: color

In [13]:

```
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 [14]:

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

Out[14]:

```
[(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 [15]:

```
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
```

In [16]:

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

Out[16]:

```
[(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 [17]:

```
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 [0]:

```
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 which 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

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

In [0]:

```
data.to_pickle('pickels/28k_apparel_data')
```

In [0]:

```
# 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[0]:

```
"\nfrom PIL import Image\nimport requests\nfrom io import BytesIO\n\nfor index, row in
images.iterrows():\n        url = row['large_image_url']\n        response = requests.get(url)\n
img = Image.open(BytesIO(response.content))\n
img.save('workshop/images/28k_images/'+row['asin']+'.jpeg')\n\n\n"
```

[5.2] Remove near duplicate items

[5.2.1] Understand about duplicates.

In [20]:

```
# 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)

B00AQ4GMCK	B00AQ4GMTS
B00AQ4GMLQ	B00AQ4GN3I

These shirts exactly same except in color

B00G278GZ6	B00G278W6O
B00G278Z2A	B00G2786X8

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 [21]:

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

In [22]:

```
data.head()
```

Out[22]:

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	Featherlite Ladies' Long Sleeve Stain Resistan...	$26.26
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...	$9.99
11	B001LOUGE4	Fitness Etc.	Black	https://images-na.ssl-images-amazon.com/images...	SHIRT	Ladies Cotton Tank 2x1 Ribbed Tank Top	$11.99
15	B003BSRPB0	FeatherLite	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	FeatherLite Ladies' Moisture Free Mesh Sport S...	$20.54
21	B014ICEDNA	FNC7C	Purple	https://images-na.ssl-images-amazon.com/images...	SHIRT	Supernatural Chibis Sam Dean And Castiel Short...	$7.50

In [23]:

```
# 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 [24]:

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

Out[24]:

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
61973	B06Y1KZ2WB	Éclair	Black/Pink	https://images-na.ssl-images-amazon.com/images...	SHIRT	Éclair Women's Printed Thin Strap Blouse Black...	$24.99
133820	B010RV33VE	xiaoming	Pink	https://images-na.ssl-images-amazon.com/images...	SHIRT	xiaoming Womens Sleeveless Loose Long T-shirts...	$18.19

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
75995	B00X5LYO9Y	xiaoming	Red Anchors	https://images-na.ssl-images-amazon.com/images...	SHIRT	xiaoming Stripes Tank Patch/Bear Sleeve Anchor...	$15.91
151570	B00WPJG35K	xiaoming	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	xiaoming Sleeve Sheer Loose Tassel Kimono Woma...	$14.32

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 [25]:

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

In [26]:

```
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', 'Diam
onds', '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', 'The', 'Queen', 'of', '
Diamonds', 'Women's', 'Shirt', 'Small']
        b = data['title'].loc[indices[j]].split()
```

```
        # 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 t
hose two apperals are different
        # if the number of words in which both strings differ are < 2 , we are considering it as t
hose two apperals are same, hence we are ignoring them
        if (length - count) > 2: # number of words in which both sensences differ
            # if both strings are differ by more than 2 words we include the 1st string index
            stage1_dedupe_asins.append(data_sorted['asin'].loc[indices[i]])

            # 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 [27]:

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

We removed the dupliactes which differ only at the end.

In [28]:

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

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

In [0]:

```
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, we 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-Large
115042. UltraClub Ladies Classic Wrinkle-Free Long-Sleeve Oxford Light Blue XXL

TItles-2

120832. EVALY Women's New University Of UTAH 3/4-Sleeve Raglan Tshirt

In [29]:

```
data = pd.read_pickle('pickels/17k_apperal_data')
```

In [0]:

```
# 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', 'Diam
onds', '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 t
hose two apperals are same, hence we are ignoring them
        if (length - count) < 3:
            indices.remove(j)
```

In [0]:

```
# 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)]
```

In [0]:

```
print('Number of data points after stage two of dedupe: ',data.shape[0])
# from 17k apperals we reduced to 16k apperals
```

```
Number of data points after stage two of dedupe:  16042
```

In [0]:

```
data.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 [30]:

```
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 [31]:

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

In [32]:

```
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")
```

```
7.0601589 seconds
```

In [33]:

```
data.head()
```

Out[33]:

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
4	B004GSI2OS	FeatherLite	Onyx Black/ Stone	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies long sleeve stain resistant...	$26.26
6	B012YX2ZPI	HX-Kingdom Fashion T-shirts	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	womens unique 100 cotton special olympics wor...	$9.99
15	B003BSRPB0	FeatherLite	White	https://images-na.ssl-images-amazon.com/images...	SHIRT	featherlite ladies moisture free mesh sport sh...	$20.54
27	B014ICEJ1Q	FNC7C	Purple	https://images-na.ssl-images-amazon.com/images...	SHIRT	supernatural chibis sam dean castiel neck tshi...	$7.39
46	B01NACPBG2	Fifth Degree	Black	https://images-na.ssl-images-amazon.com/images...	SHIRT	fifth degree womens gold foil graphic tees jun...	$6.95

In [0]:

```
data.to_pickle('pickels/16k_apperal_data_preprocessed')
```

Stemming

In [34]:

```
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 [35]:

```
data = pd.read_pickle('pickels/16k_apperal_data_preprocessed')
data.head()
```

Out[35]:

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

	asin	brand	color	medium_image_url	product_type_name	title	formatted_price
46	B01NACPBG2	Fifth Degree	Black	https://images-na.ssl-images-amazon.com/images...	SHIRT	fifth degree womens gold foil graphic tees jun...	$6.95

In [36]:

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

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

        # 1st, ploting heat map that represents the count of commonly ocurred words in title2
        ax = plt.subplot(gs[0])
        # it displays a cell in white color if the word is intersection(lis of words of title1 and
list of words 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 contribute to the distance
between two title vec's
    intersection = set(vec1.keys()) & set(vec2.keys())
```

```
        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 model we are using
        # if model == 'bag of words': labels(i) = values(i)
        # if model == 'tfidf weighted bag of words':labels(i) = tfidf(keys(i))
        # if model == 'idf weighted bag of words':labels(i) = idf(keys(i))

    if model == 'bag_of_words':
        labels = values
    elif model == 'tfidf':
        labels = []
        for x in vec2.keys():
            # tfidf_title_vectorizer.vocabulary_ it contains all the words in the corpus
            # tfidf_title_features[doc_id, index_of_word_in_corpus] will give the tfidf value of w
rd in given document (doc_id)
            if x in  tfidf_title_vectorizer.vocabulary_:
                labels.append(tfidf_title_features[doc_id, tfidf_title_vectorizer.vocabulary_[x]])
            else:
                labels.append(0)
    elif model == 'idf':
        labels = []
        for x in vec2.keys():
            # idf_title_vectorizer.vocabulary_ it contains all the words in the corpus
            # idf_title_features[doc_id, index_of_word_in_corpus] will give the idf value of word
in given 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 = text.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 [37]:

```
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.
```

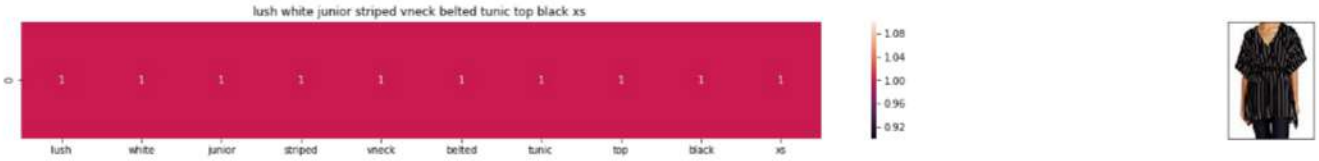
```
# the a sparase matrix of dimensions #data_points * #words_in_corpus

# What is a sparse vector?

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

Out[37]:

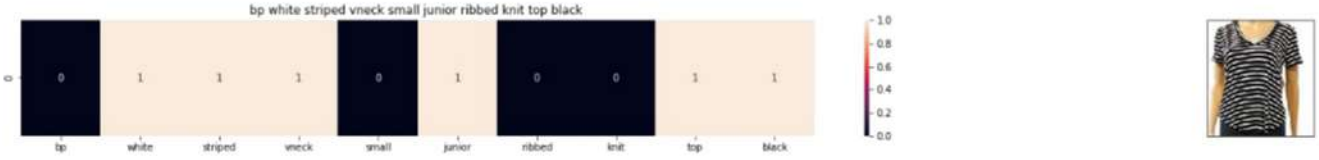
```
(16042, 12609)
```

In [39]:

```
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 remaining apparels
    # the metric we used here is cosine, the coside distance is mesured as K(X, Y) = <X, Y> / (||X
||*||Y||)
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(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]], d
ata['medium_image_url'].loc[df_indices[i]], 'bag_of_words')
        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(1345, 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
```

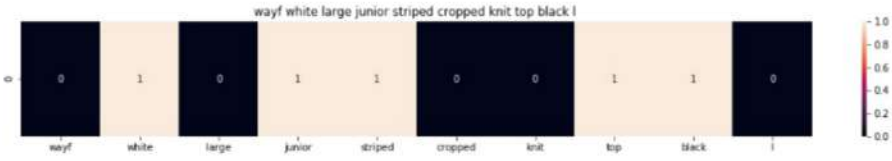



```
ASIN : B01M3YMFF7
Brand: Lush Clothing
Title: lush white junior striped vneck belted tunic top black xs
Euclidean similarity with the query image : 0.0
============================================================
```

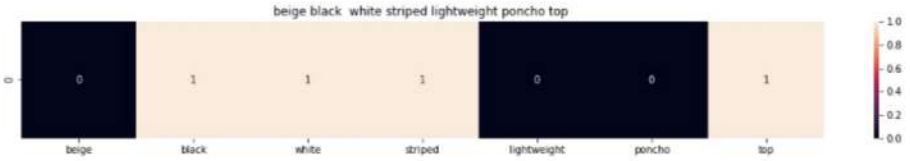



```
ASIN : B072PTJJ5Y
Brand: BP
Title: bp white striped vneck small junior ribbed knit top black
Euclidean similarity with the query image : 2.8284271247461903
```

ASIN : B06XVYC2CV
Brand: Alexis
Title: alexis sienne striped top xs
Euclidean similarity with the query image : 3.0
==========



ASIN : B01HD7LH0O
Brand: WAYF
Title: wayf white large junior striped cropped knit top black l
Euclidean similarity with the query image : 3.0
==========



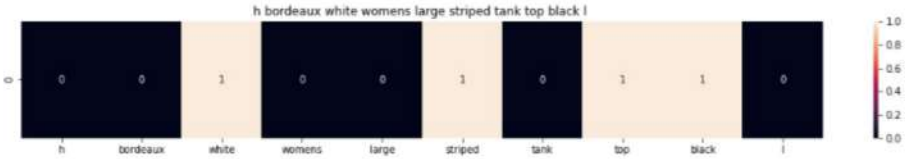
ASIN : B01EESHW3G
Brand: Luxury Divas
Title: beige black white striped lightweight poncho top
Euclidean similarity with the query image : 3.0
==========

ASIN : B071JJPPGH
Brand: Joe Boxer
Title: joe boxer black white striped pull top
Euclidean similarity with the query image : 3.0
==========

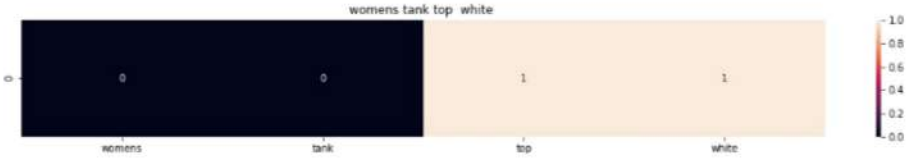
ASIN : B01J504G7I
Brand: Studio M
Title: studio navy vneck top xs
Euclidean similarity with the query image : 3.0
==========

ASIN : B06XQ4KLQL
Brand: One Clothing
Title: one clothing black white striped top size
Euclidean similarity with the query image : 3.0
==

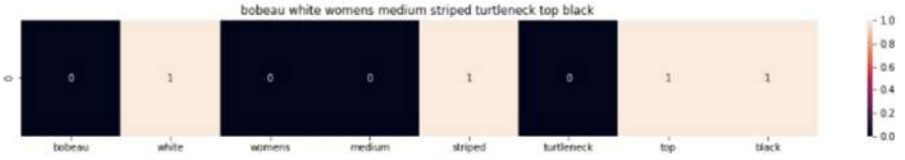
ASIN : B00CF4GDUA
Brand: ELAN
Title: elan bubble vneck top white medium
Euclidean similarity with the query image : 3.1622776601683795
==



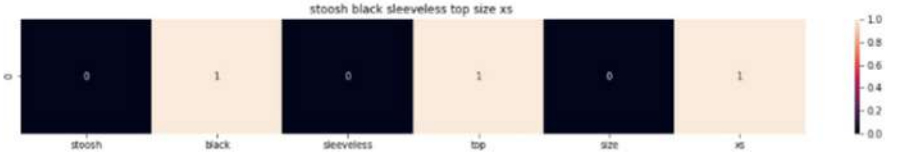
ASIN : B01MSH5UCH
Brand: H By Bordeaux
Title: h bordeaux white womens large striped tank top black l
Euclidean similarity with the query image : 3.1622776601683795
==



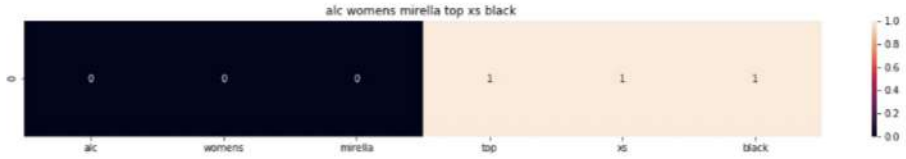
ASIN : B00JPOZ9GM
Brand: Sofra
Title: womens tank top white
Euclidean similarity with the query image : 3.1622776601683795
==



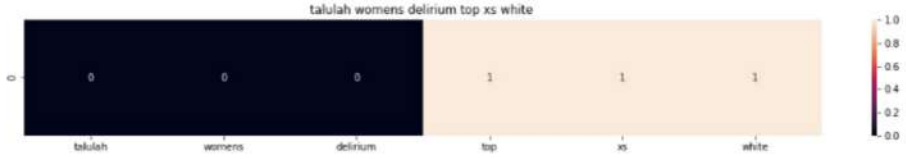
ASIN : B07336B8WY
Brand: Bobeau
Title: bobeau white womens medium striped turtleneck top black
Euclidean similarity with the query image : 3.1622776601683795
==



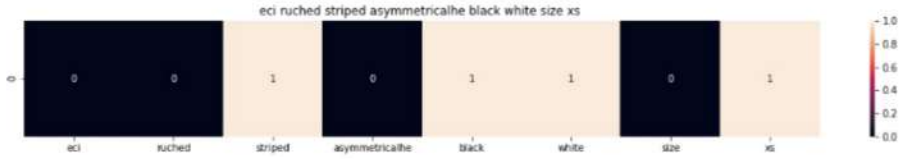
ASIN : B06XGPGWM8
Brand: Stoosh
Title: stoosh black sleeveless top size xs
Euclidean similarity with the query image : 3.1622776601683795



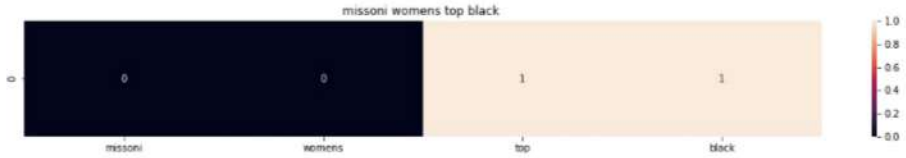
ASIN : B072N8CS7N
Brand: A.L.C.
Title: alc womens mirella top xs black
Euclidean similarity with the query image : 3.1622776601683795
==========



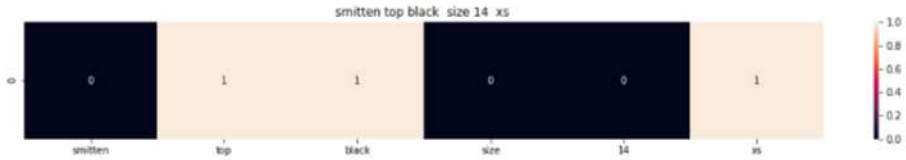
ASIN : B071KG15NM
Brand: Talulah
Title: talulah womens delirium top xs white
Euclidean similarity with the query image : 3.1622776601683795
==========



ASIN : B015OVZIIS
Brand: ECI
Title: eci ruched striped asymmetricalhe black white size xs
Euclidean similarity with the query image : 3.1622776601683795
==========



ASIN : B074TSFJHM
Brand: M Missoni
Title: missoni womens top black
Euclidean similarity with the query image : 3.1622776601683795
==========



ASIN : B01D0121J8
Brand: City Chic
Title: smitten top black size 14 xs
Euclidean similarity with the query image : 3.1622776601683795
==========

```
ASIN : B071HZXMF6
Brand: Brooks Brothers
Title: brooks brothers womens tunic xs white
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```


```
ASIN : B06XH7HQ2T
Brand: DKNY
Title: dkny ponte vneck ruffled top black
Euclidean similarity with the query image : 3.1622776601683795
============================================================
```

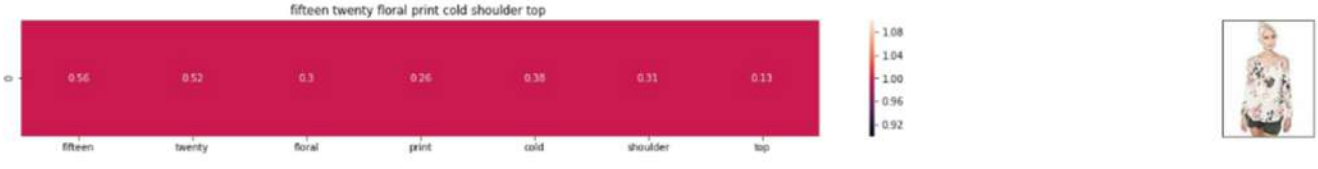
[8.5] TF-IDF based product similarity

In [40]:

```
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 dimensions #data_points
* #words_in_corpus
# tfidf_title_features[doc_id, index_of_word_in_corpus] = tfidf values of the word in given doc
```

In [41]:

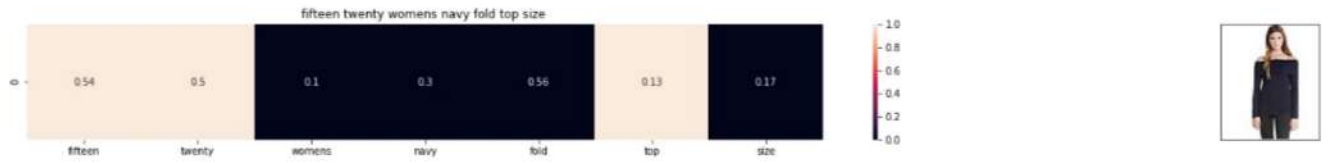
```
def tfidf_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

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

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

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

    for i in range(0,len(indices)):
        # 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(125, 20)
# in the output heat map each value represents the tfidf values of the label word, the color repre
sents the intersection with inputs title
```



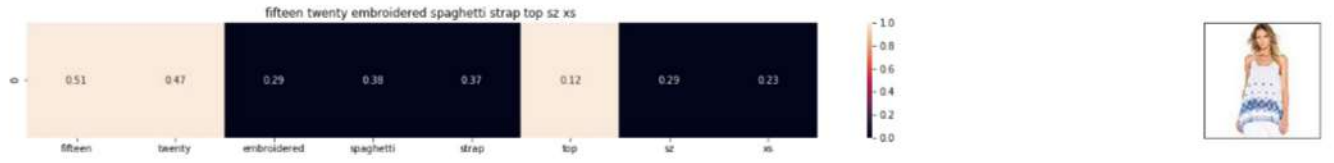
Eucliden distance from the given image : 0.0

ASIN : B074KT1R5Y
BRAND : FIFTEEN TWENTY
Eucliden distance from the given image : 0.7513763192537632

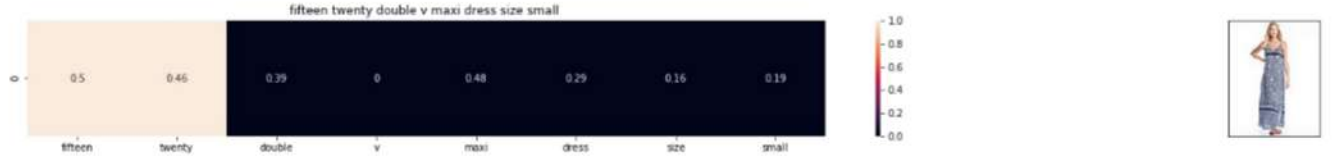
ASIN : B01IFYEVQG
BRAND : FIFTEEN TWENTY
Eucliden distance from the given image : 0.8778660847234199



ASIN : B074KRLG5F
BRAND : FIFTEEN TWENTY
Eucliden distance from the given image : 0.9233000469813402

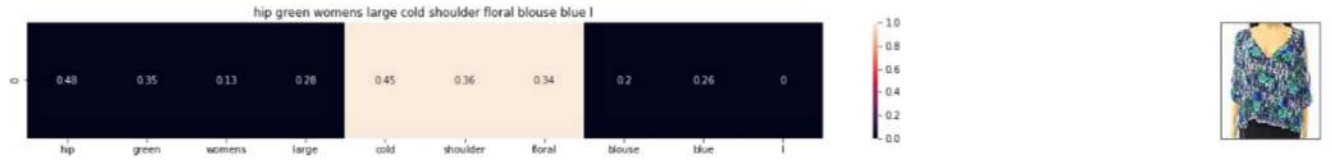


ASIN : B01I0NAIDM
BRAND : FIFTEEN TWENTY
Eucliden distance from the given image : 0.9528092363412269



ASIN : B01IG4CBE4
BRAND : FIFTEEN TWENTY
Eucliden distance from the given image : 0.9793303963833676

ASIN : B01IG2V2LY
BRAND : FIFTEEN TWENTY
Eucliden distance from the given image : 1.0308282103366617
==========

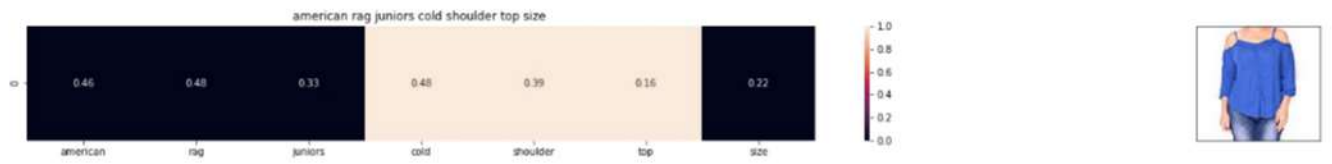


ASIN : B01KYMCMIG
BRAND : Hip
Eucliden distance from the given image : 1.1089736611777519
==========

ASIN : B06XP9VLYL
BRAND : ECI New York
Eucliden distance from the given image : 1.1232720835087358
==========

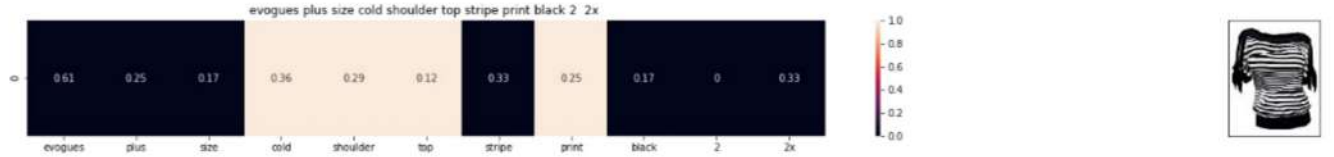
ASIN : B01N2HO9AV
BRAND : Style& Co.
Eucliden distance from the given image : 1.1512363644335064
==========

ASIN : B01ILGCQ9W
BRAND : Emerald
Eucliden distance from the given image : 1.1521612635840166
==========



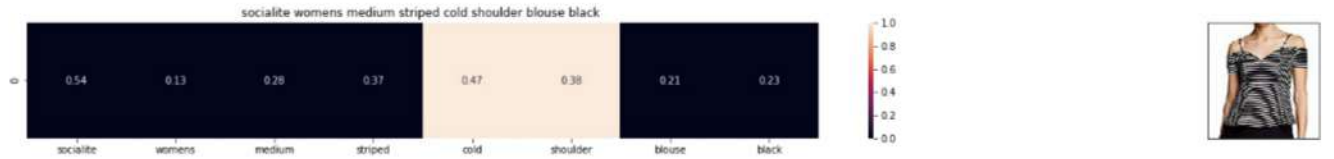
BRAND : American Rag
Eucliden distance from the given image : 1.1626150506396635
==========

ASIN : B071J6ZPSW
BRAND : iJeans by Buffalo
Eucliden distance from the given image : 1.172451718268551
==========



ASIN : B01CG9D5I6
BRAND : eVogues Apparel
Eucliden distance from the given image : 1.1741979973738197
==========

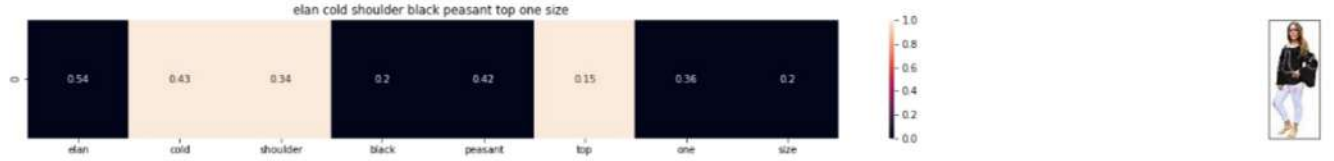
ASIN : B0721YF3GH
BRAND : Twenty Tees
Eucliden distance from the given image : 1.17531945918778
==========



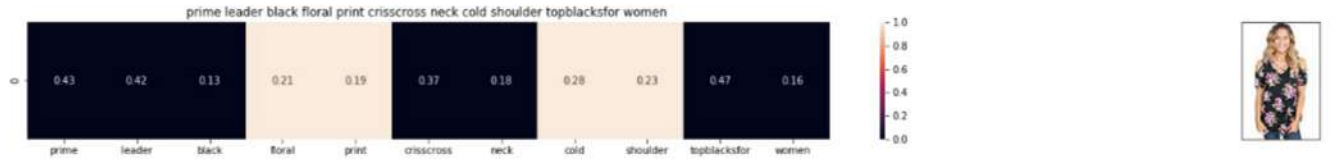
ASIN : B072XMZM5F
BRAND : Socialite
Eucliden distance from the given image : 1.182697831509685
==========

ASIN : B0758ZSF48
BRAND : ASTR
Eucliden distance from the given image : 1.1878103689652904
==========

ASIN : B07174CJXJ
BRAND : MG Collection
Eucliden distance from the given image : 1.1915521786532
==========



ASIN : B019R2XM6U
BRAND : ELAN
Eucliden distance from the given image : 1.1917139692531162
==========



ASIN : B07313BLD2
BRAND : Prime Leader's Shirt
Eucliden distance from the given image : 1.1917291940339043
==========

[8.5] IDF based product similarity

In [42]:

```
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 dimensions #data_points
* #words_in_corpus
# idf_title_features[doc_id, index_of_word_in_corpus] = number of times the word occured in that d
oc
```

In [43]:

```
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)))
```

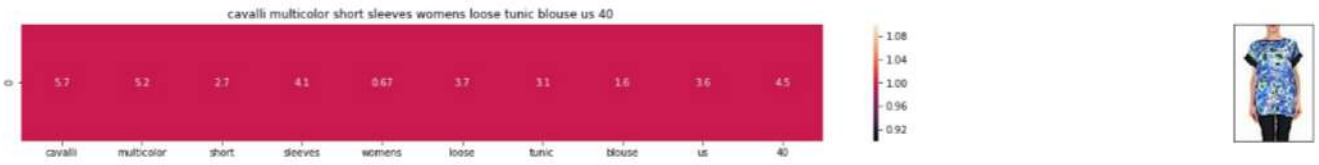
In [44]:

```
# 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)
```

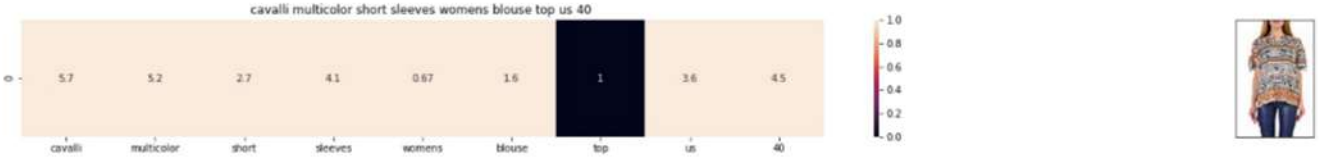
```
he word
    # idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()[0] will return all docu
ments in which the word i present
    for j in idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()[0]:

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

In [45]:

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

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

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

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

    for i in range(0,len(indices)):
        get_result(indices[i],data['title'].loc[df_indices[0]], data['title'].loc[df_indices[i]], d
ata['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(15000,20)
# in the output heat map each value represents the idf values of the label word, the color represe
nts the intersection with inputs title
```

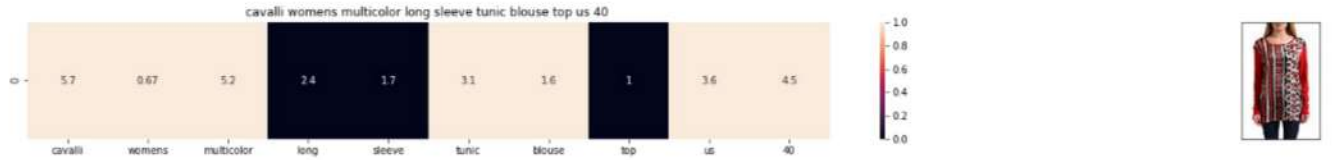



```
ASIN : B01151KH8M
Brand : Just Cavalli
euclidean distance from the given image : 0.0
=============================================================================================================
```

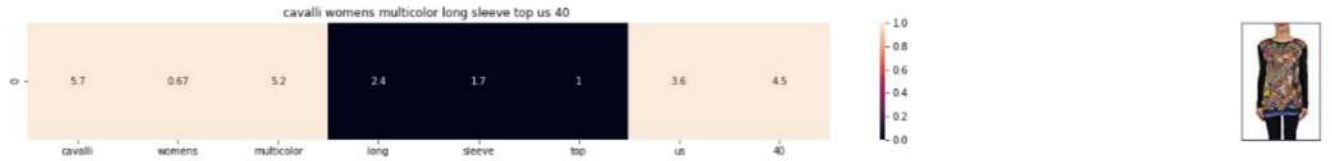



```
ASIN : B0115CTTI0
Brand : Just Cavalli
euclidean distance from the given image : 4.963986632779142
=============================================================================================================
```

ASIN : B01HWH2F42
Brand : Just Cavalli
euclidean distance from the given image : 5.280156135277855

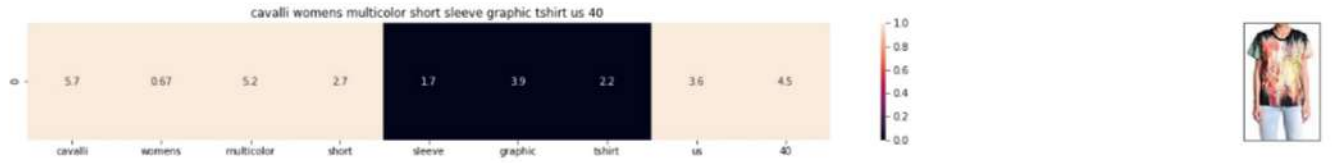


ASIN : B01CASX59M
Brand : Just Cavalli
euclidean distance from the given image : 6.883919903555224

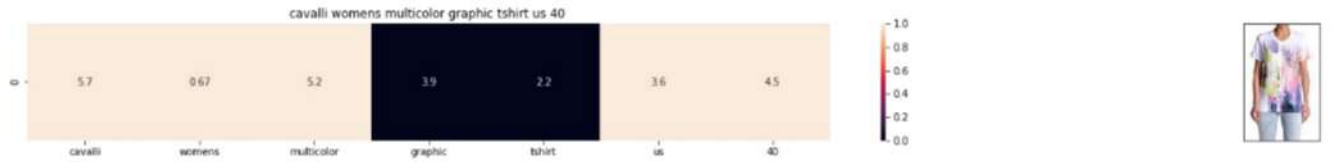


ASIN : B0175BBXY8
Brand : Just Cavalli
euclidean distance from the given image : 7.7350103284861

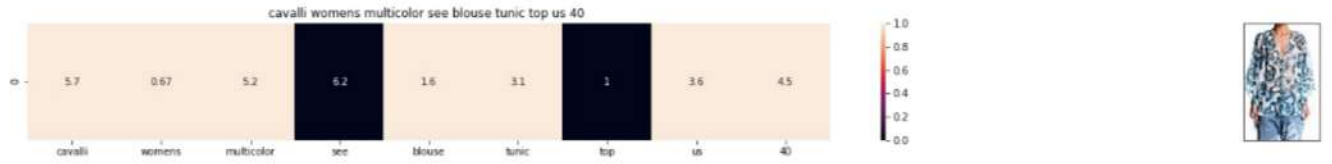
ASIN : B017ADYVZO
Brand : Just Cavalli
euclidean distance from the given image : 7.842854818326502



ASIN : B01FYHEEVY
Brand : Just Cavalli
euclidean distance from the given image : 8.113134916053644

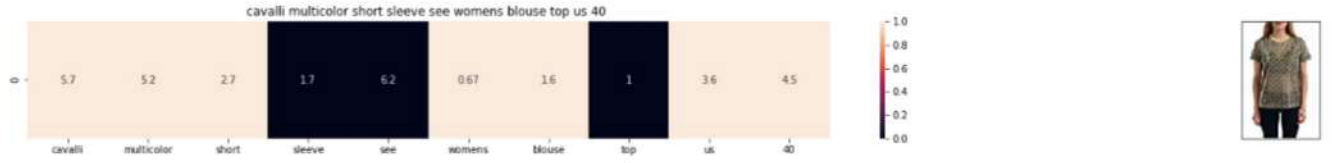


ASIN : B01FZUNBVO



ASIN : B01FZTUK8M
Brand : Just Cavalli
euclidean distance from the given image : 8.755383388349836

ASIN : B01FZ5QZ12
Brand : Just Cavalli
euclidean distance from the given image : 9.016413504062283

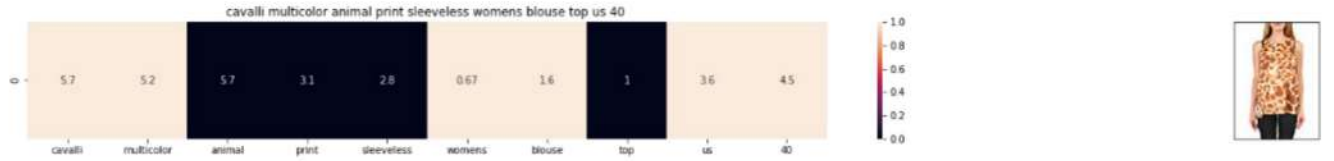


ASIN : B01HSKDJXY
Brand : Just Cavalli
euclidean distance from the given image : 9.058325082569132

ASIN : B01CAU74LK
Brand : Just Cavalli
euclidean distance from the given image : 9.21328314563803

ASIN : B0180UM25M
Brand : Just Cavalli
euclidean distance from the given image : 9.296284839945168

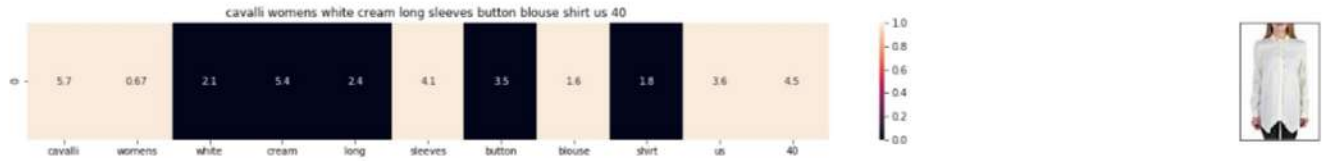
ASIN : B00TQ6OEMY
Brand : Just Cavalli
euclidean distance from the given image : 9.772884432394639



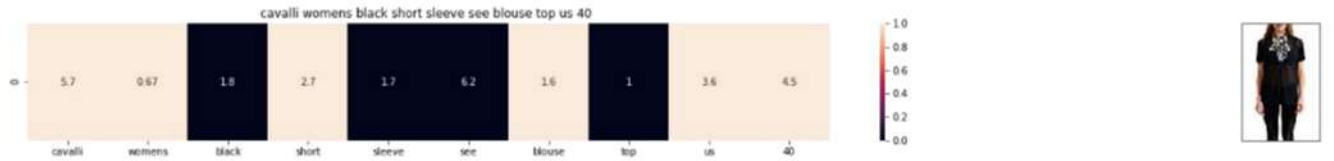
ASIN : B011AJXWA4
Brand : Just Cavalli
euclidean distance from the given image : 9.884336164635727

ASIN : B00TQ2LM1E
Brand : Just Cavalli
euclidean distance from the given image : 10.033144635314798

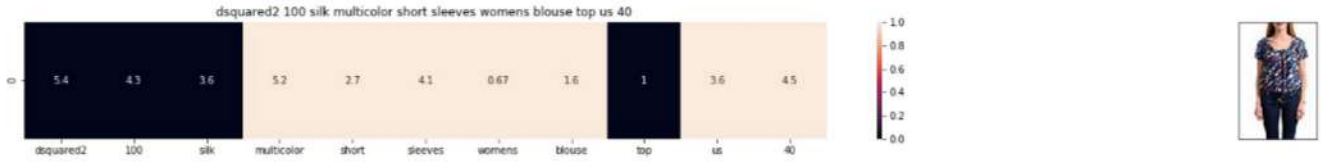
ASIN : B01GU7VHBM
Brand : Just Cavalli
euclidean distance from the given image : 10.272163591301123



ASIN : B00U7U4NAG
Brand : Just Cavalli
euclidean distance from the given image : 10.565876357293474



```
euclidean distance from the given image : 10.579983539012916
=====================================================================================================
======================
```




```
ASIN : B01D6F5CDK
Brand : DSQUARED2
euclidean distance from the given image : 10.875897624323407
=====================================================================================================
======================
```

[9] Text Semantics based product similarity

In [0]:

```
# 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)

'''
```

In [46]:

```
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.bin', 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 [47]:

```
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 idf(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.vocabulary_[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 corpus, 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/avg) 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 vectors in vec2
    for i in vec1:
        dist = []
        for j in vec2:
            # np.linalg.norm(i-j) will result the euclidean distance between vectors 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 title2)
    # 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(weighted/avg) of lengt
h 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(weighted/avg) of lengt
h 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 title2)
    # 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 displays image of appare
l
    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 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 [48]:

```
# 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 of 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 idf(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.vocabulary_:
                featureVec = np.add(featureVec, idf_title_features[doc_id, idf_title_vectorizer.voc
abulary_[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.

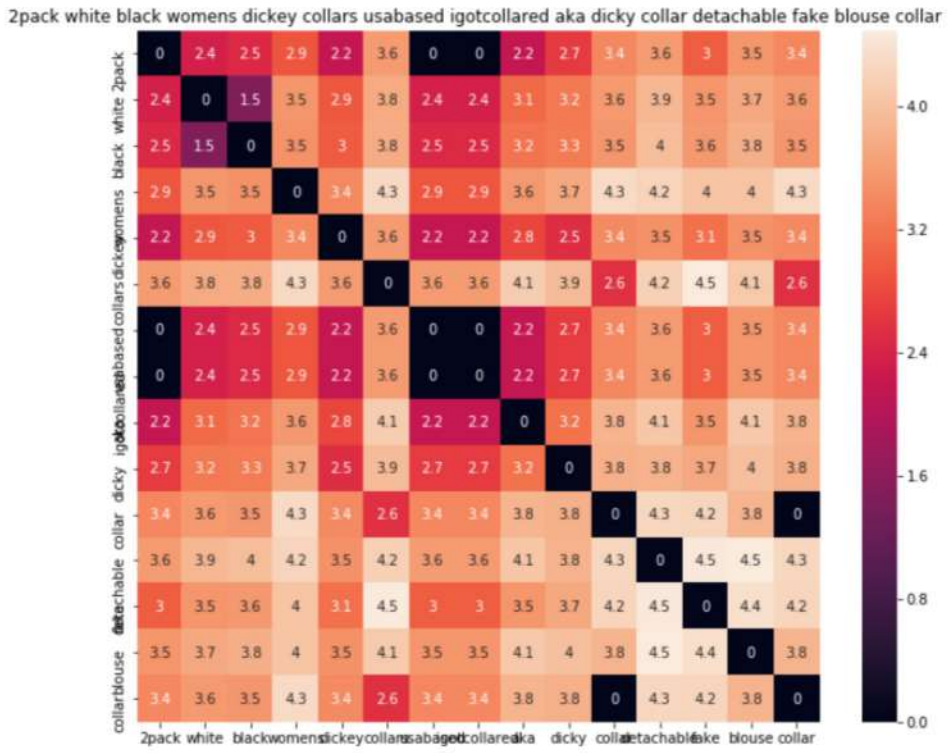
In [49]:

```
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)
```

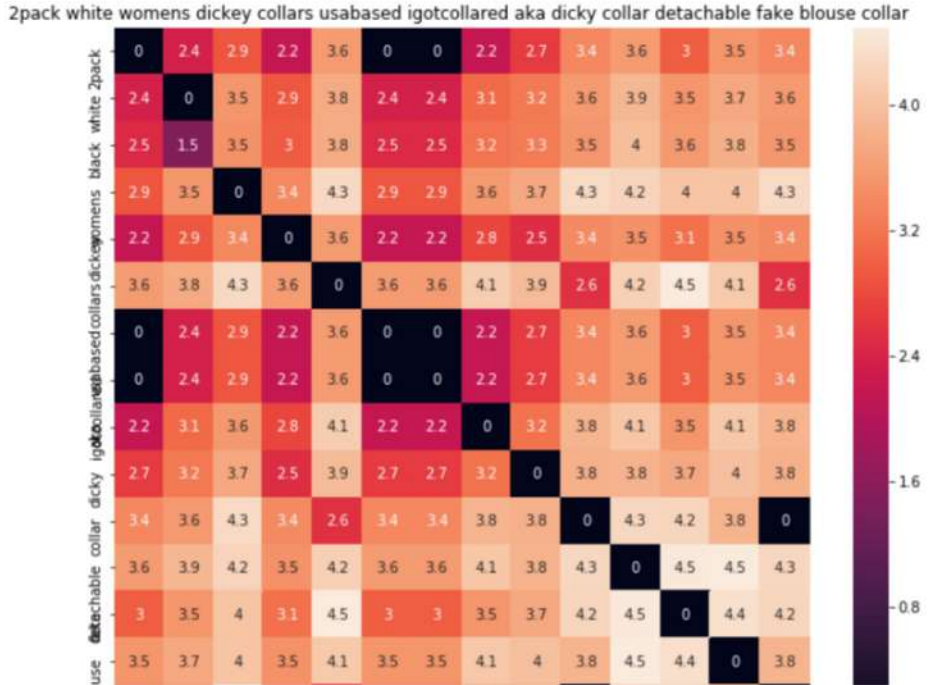
In [50]:

```
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]
```

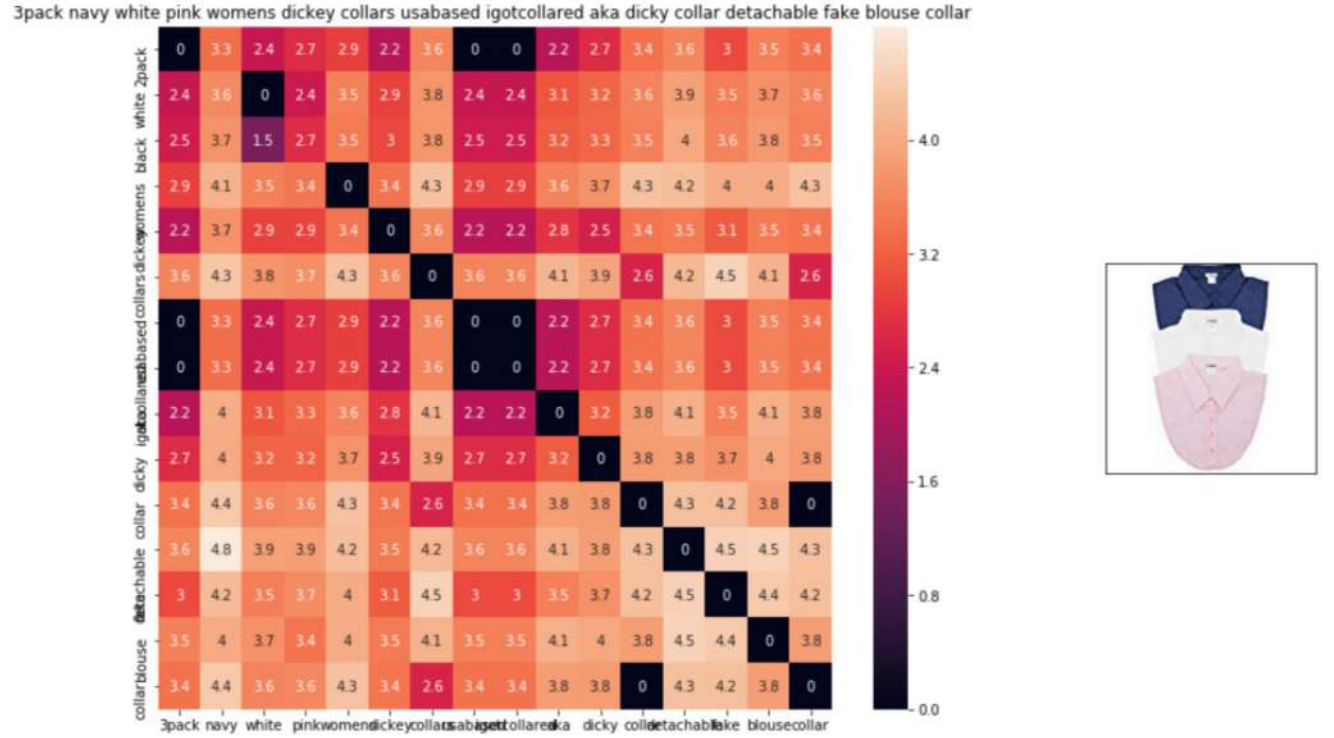
```
    for i in range(0, len(indices)):
        heat_map_w2v(data['title'].loc[df_indices[0]],data['title'].loc[df_indices[i]], data['mediu
m_image_url'].loc[df_indices[i]], indices[0], indices[i], 'avg')
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('BRAND :',data['brand'].loc[df_indices[i]])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


avg_w2v_model(5166, 20)
# in the give heat map, each cell contains the euclidean distance between words i, j
```



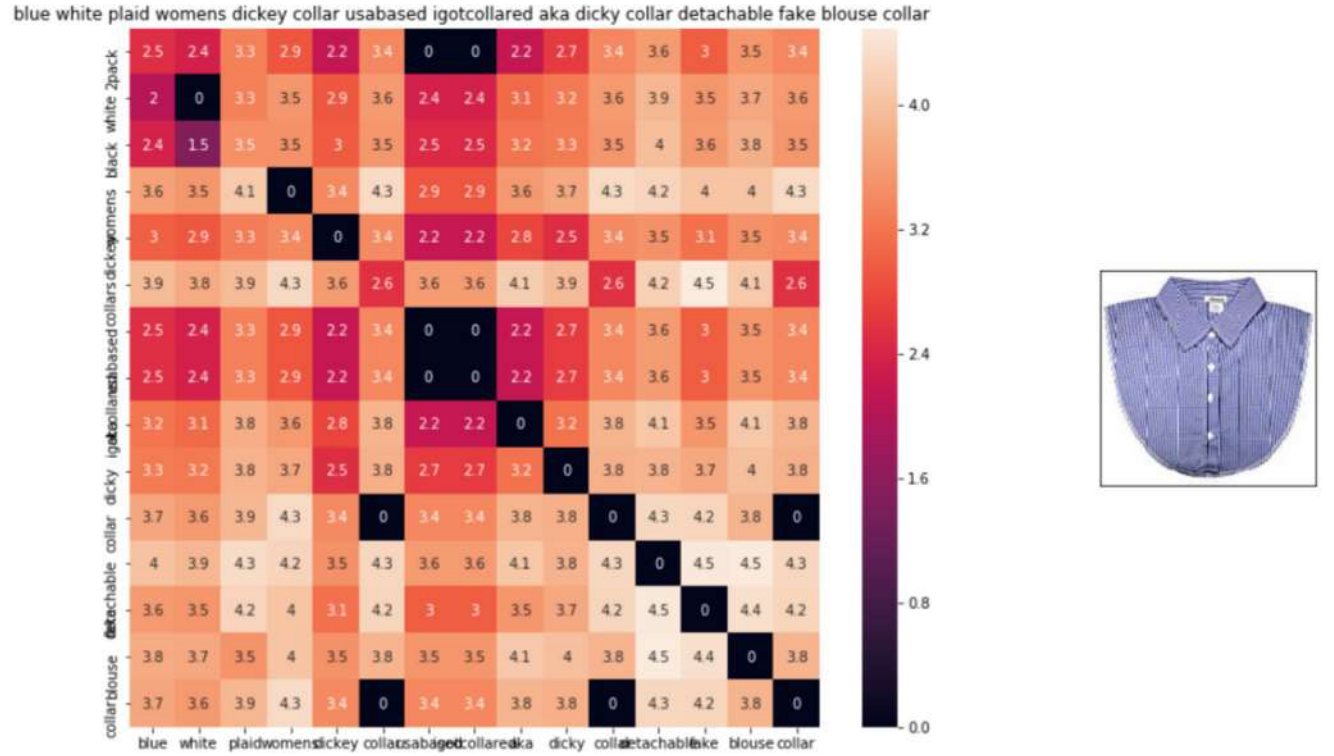
```
ASIN : B01N4GCBUM
BRAND : IGotCollared Pronounced I Got Collared
euclidean distance from given input image : 0.0
=============================================================================================================
```



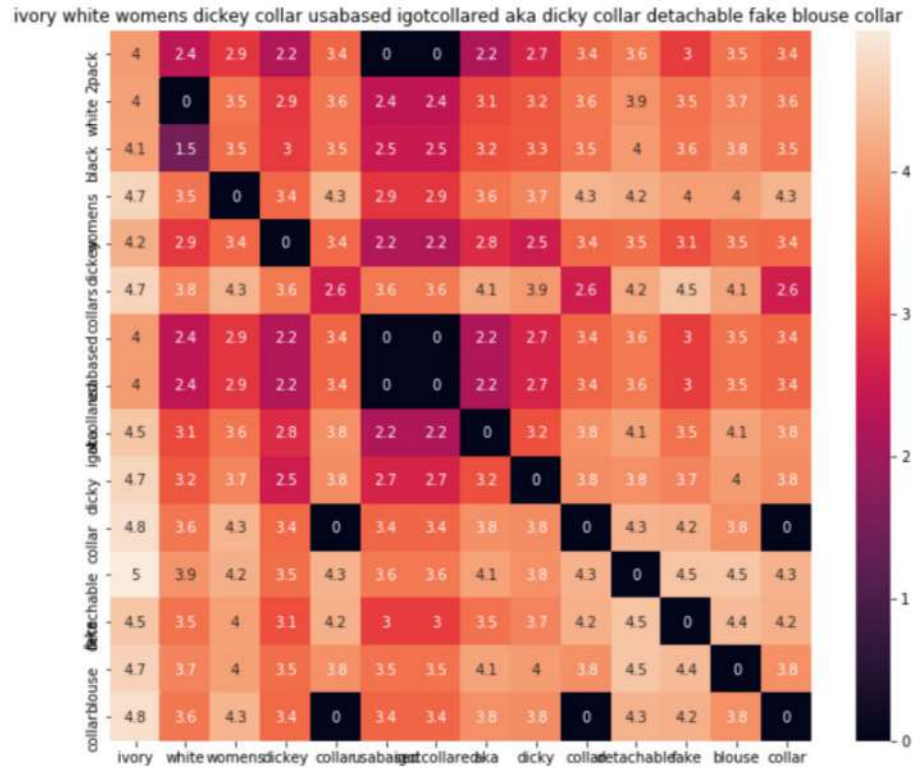
ASIN : B01N9JYI2N
BRAND : IGotCollared Pronounced I Got Collared
euclidean distance from given input image : 0.14638343



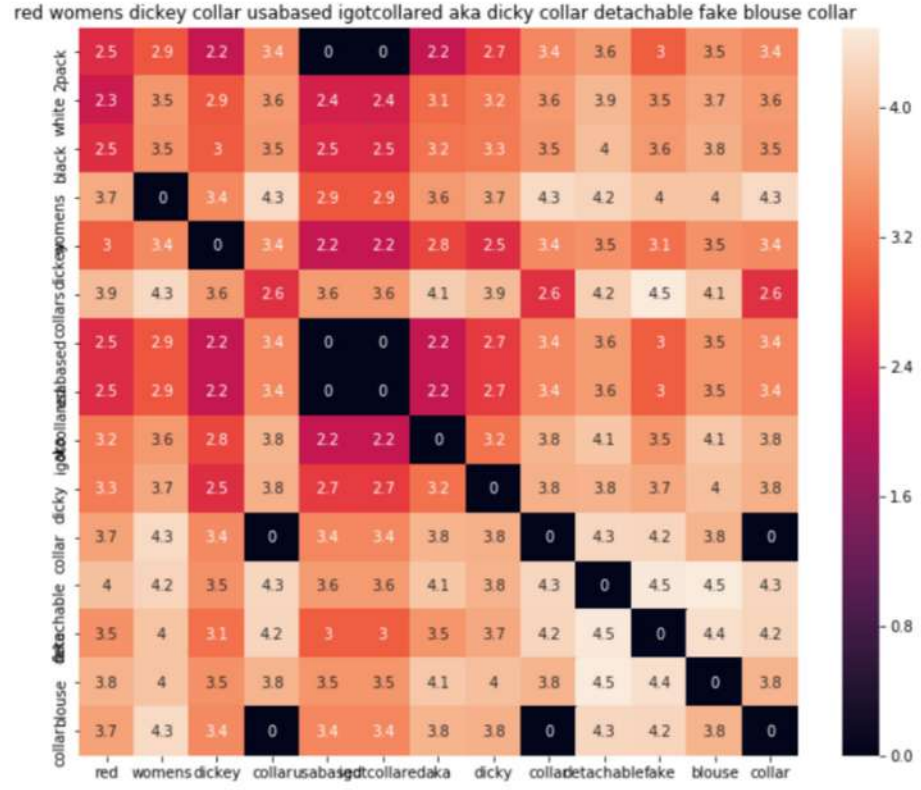
ASIN : B01MZ24OV9
BRAND : IGotCollared Pronounced I Got Collared
euclidean distance from given input image : 0.26626623



ASIN : B01MRXXYMA

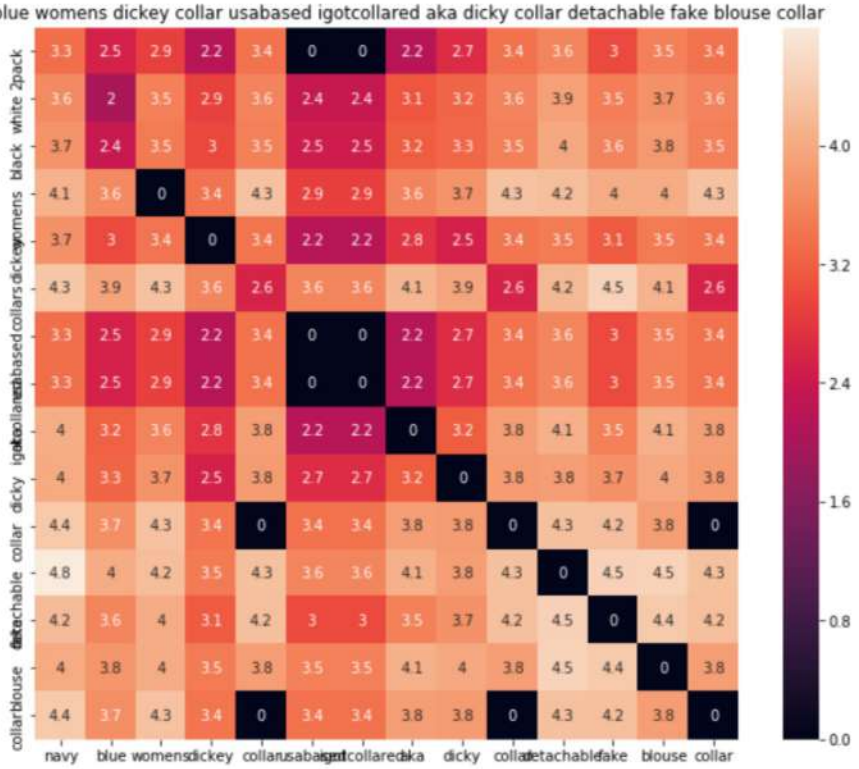


ASIN : B01MRUN3UC
BRAND : IGotCollared
euclidean distance from given input image : 0.32946828



ASIN : B01MQWLG2I
BRAND : IGotCollared
euclidean distance from given input image : 0.34613767

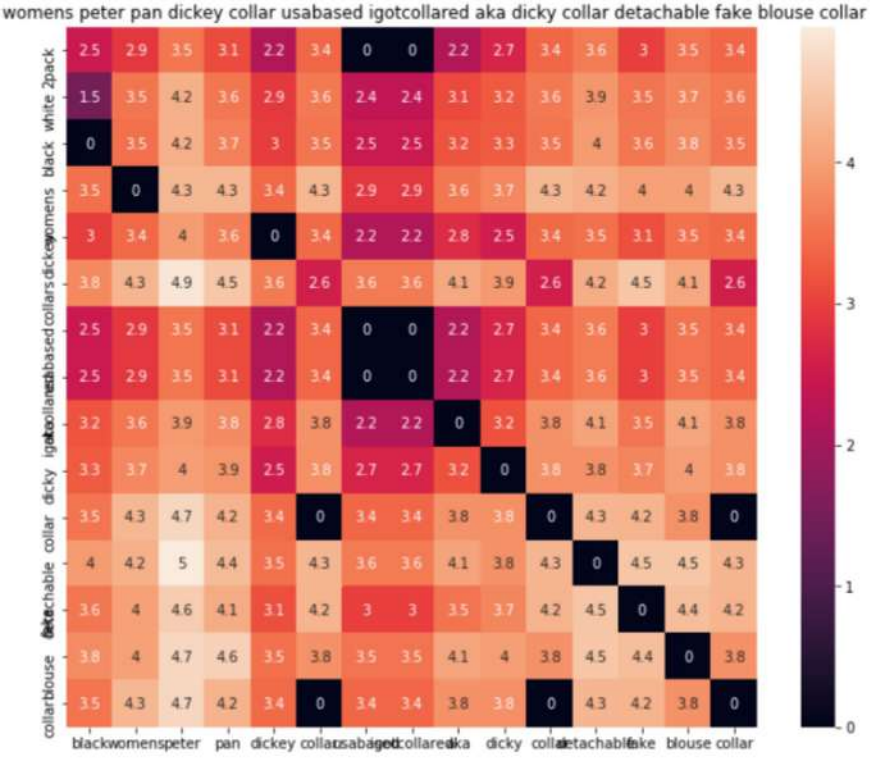
navy blue womens dickey collar usabased igotcollared aka dicky collar detachable fake blouse collar



ASIN : B01NGYF4IJ
BRAND : IGotCollared
euclidean distance from given input image : 0.37557733

---

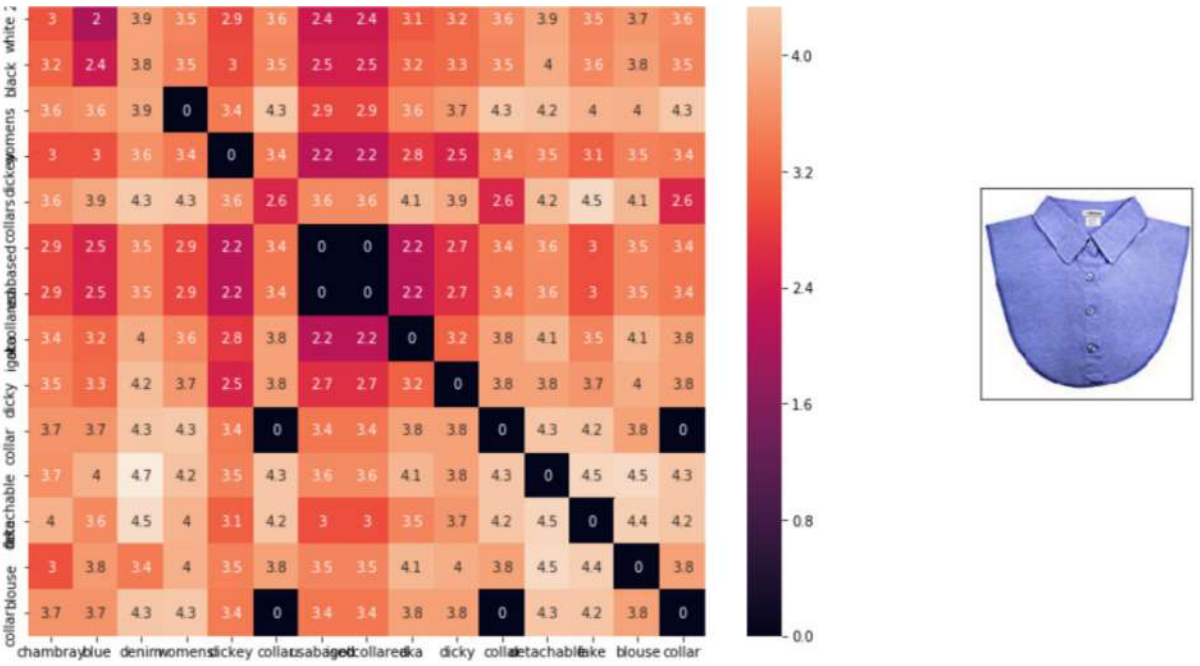
black womens peter pan dickey collar usabased igotcollared aka dicky collar detachable fake blouse collar



ASIN : B01MQWMK92
BRAND : IGotCollared
euclidean distance from given input image : 0.40530652

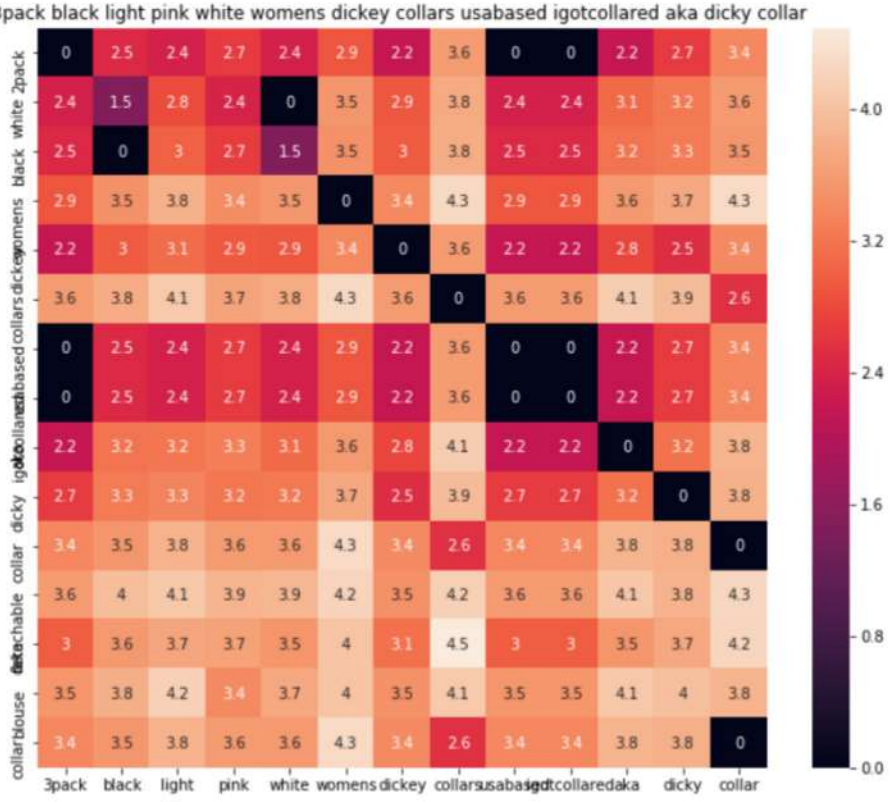
---

chambray blue denim womens dickey collar usabased igotcollared aka dicky collar detachable fake blouse collar



ASIN : B01MQWKWME
BRAND : IGotCollared
euclidean distance from given input image : 0.44265327

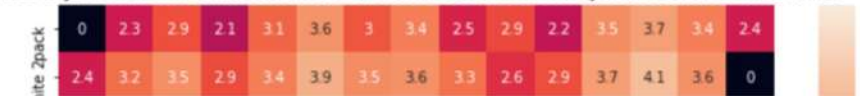
3pack black light pink white womens dickey collars usabased igotcollared aka dicky collar

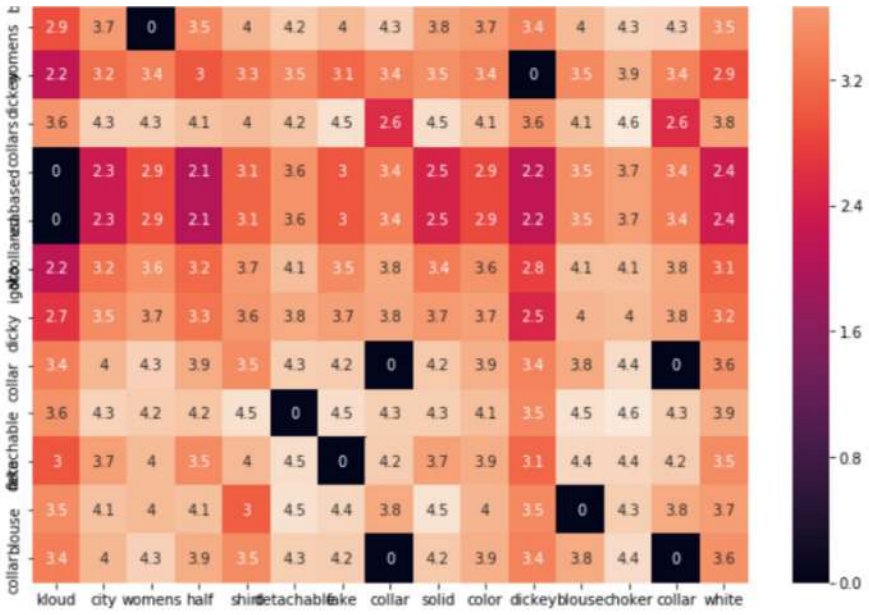


ASIN : B01N2W9P7A
BRAND : IGotCollared Pronounced I Got Collared
euclidean distance from given input image : 0.47885767

---

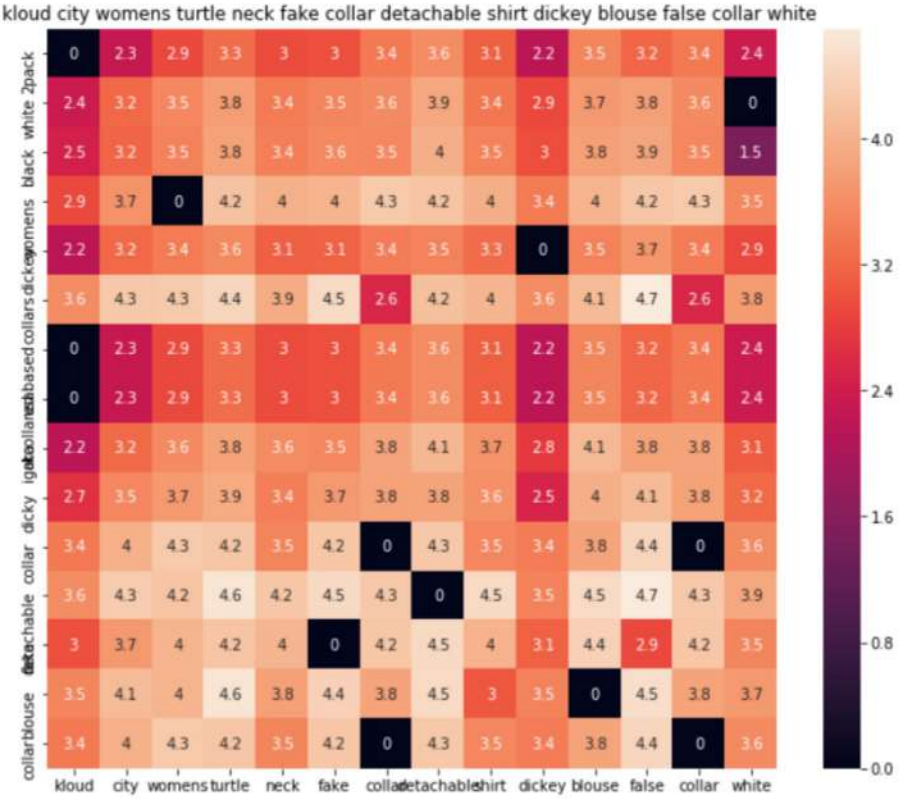
kloud city womens half shirt detachable fake collar solid color dickey blouse choker collar white





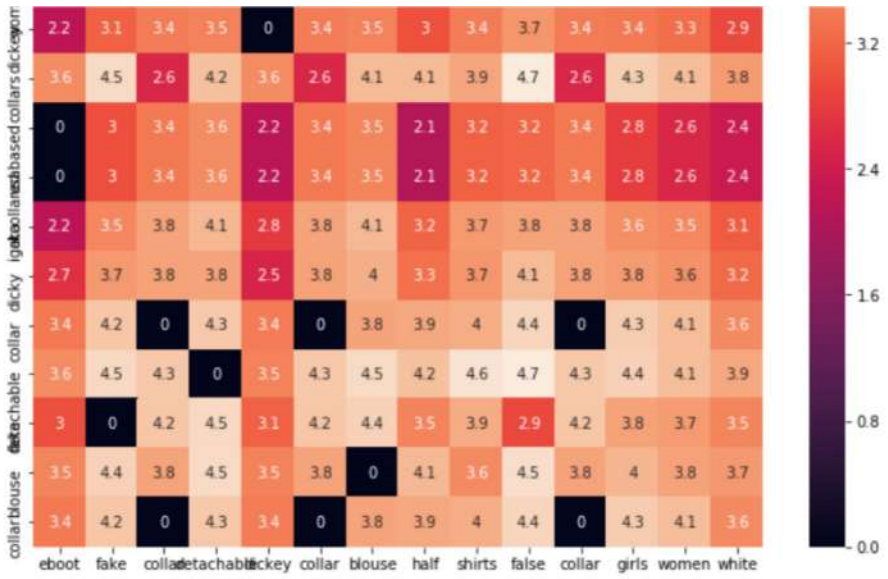
ASIN : B01MU2K4EU
BRAND : KLOUD City
euclidean distance from given input image : 0.5530486

kloud city womens turtle neck fake collar detachable shirt dickey blouse false collar white



ASIN : B01N7IVVAJ
BRAND : KLOUD City
euclidean distance from given input image : 0.5642932

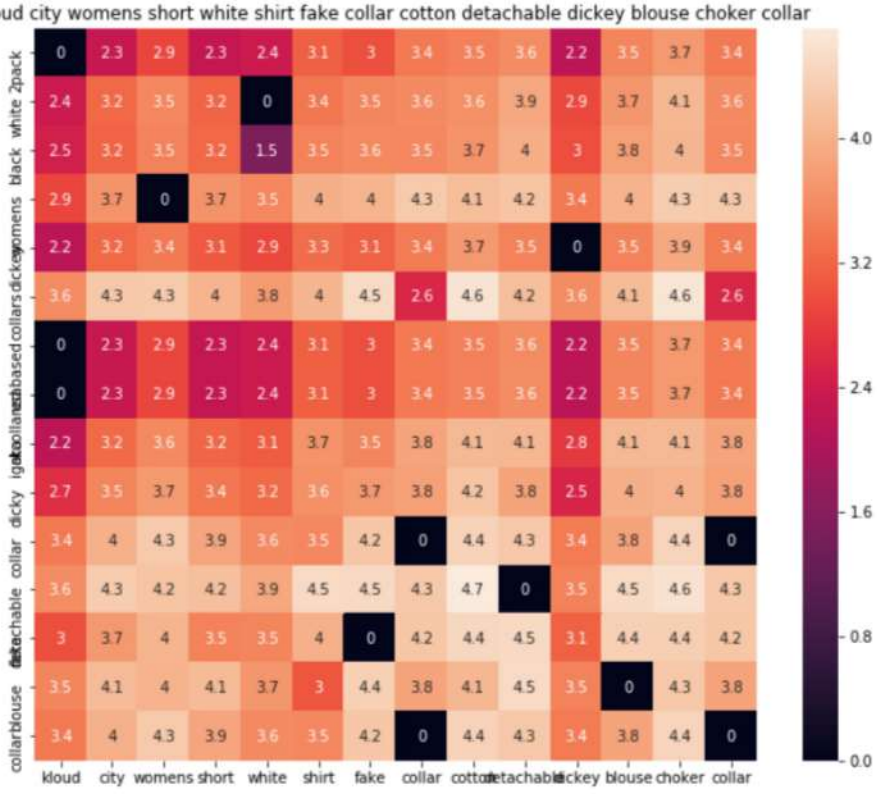
eboot fake collar detachable dickey collar blouse half shirts false collar girls women white



ASIN : B01N230VOY
BRAND : eBoot
euclidean distance from given input image : 0.5687726

---

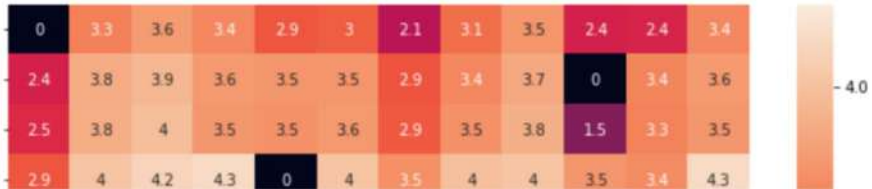
kloud city womens short white shirt fake collar cotton detachable dickey blouse choker collar

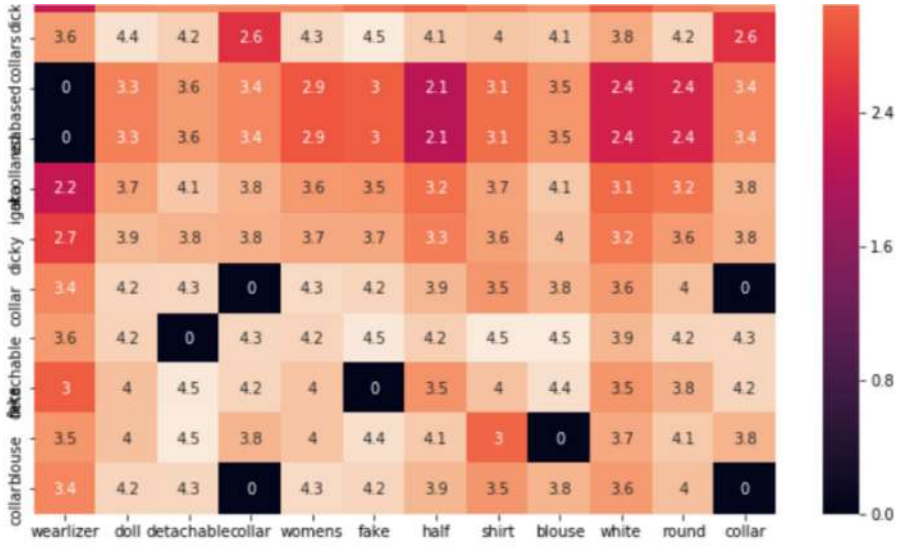


ASIN : B01MZ1OMK9
BRAND : KLOUD City
euclidean distance from given input image : 0.57407403

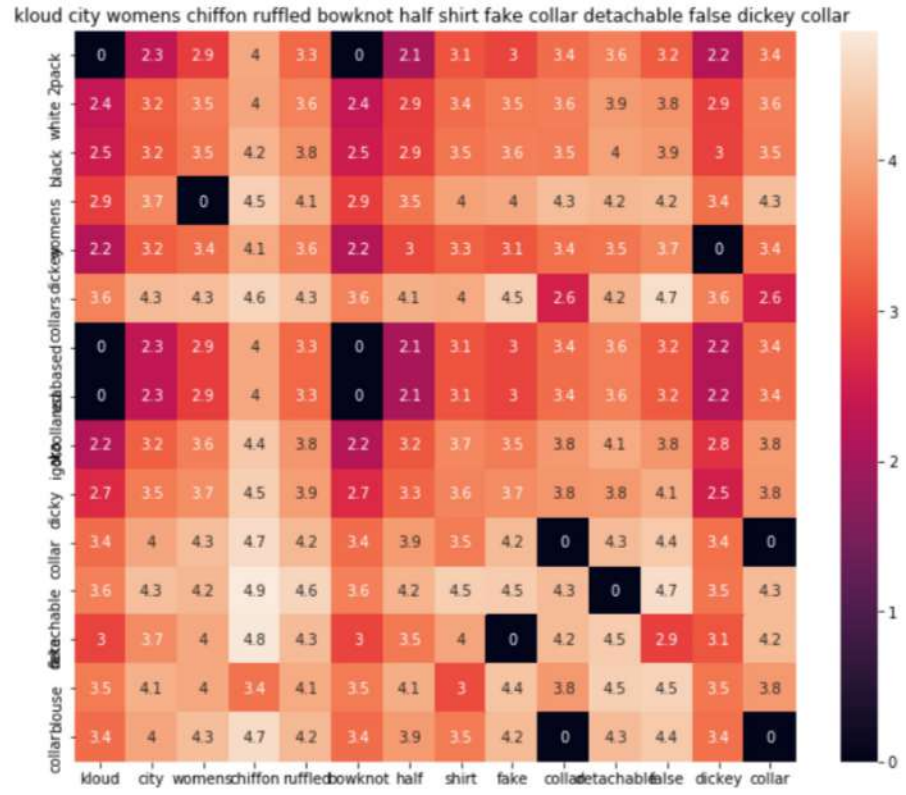
---

wearlizer doll detachable collar womens fake half shirt blouse white round collar

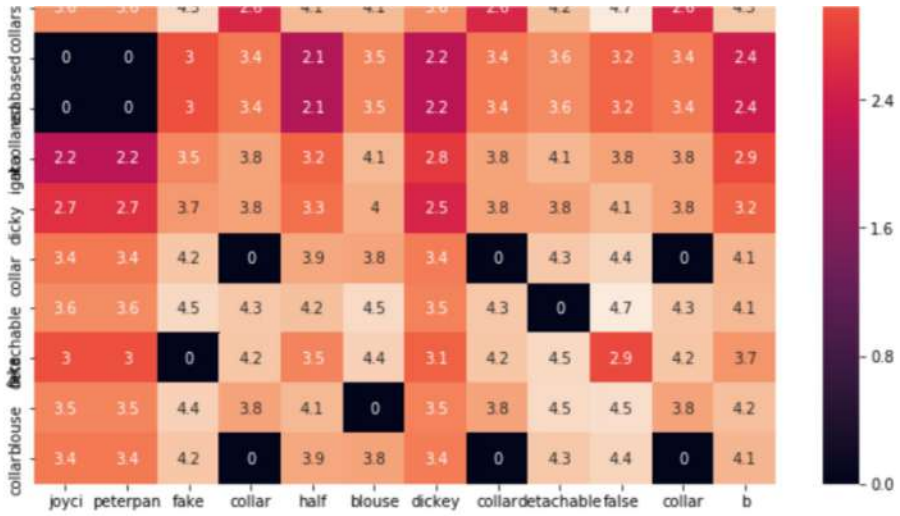




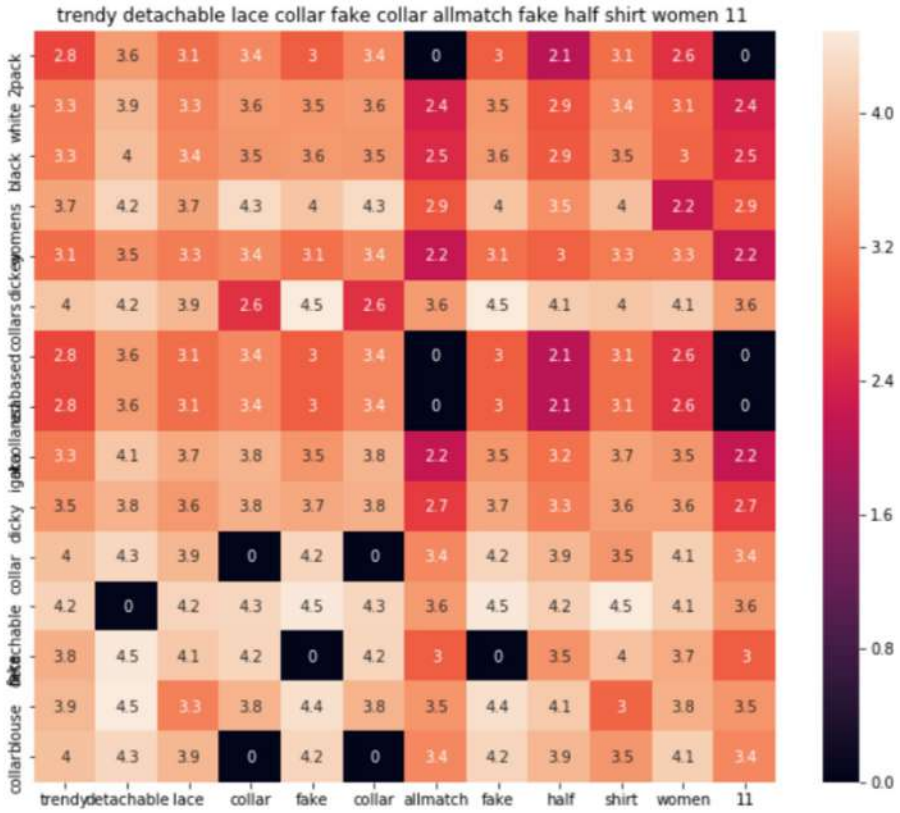
ASIN : B018HQVFFM
BRAND : Wearlizer
euclidean distance from given input image : 0.5997495



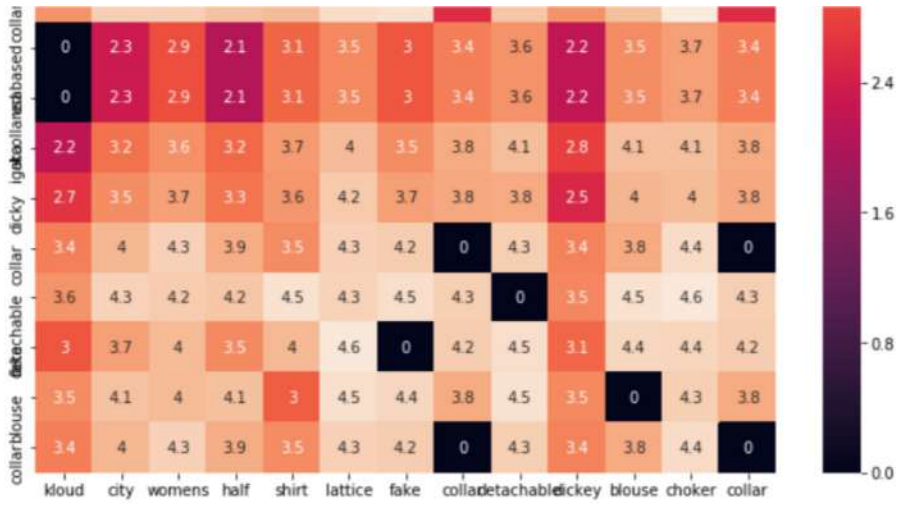
ASIN : B01N6IGKIE
BRAND : KLOUD City
euclidean distance from given input image : 0.6061027



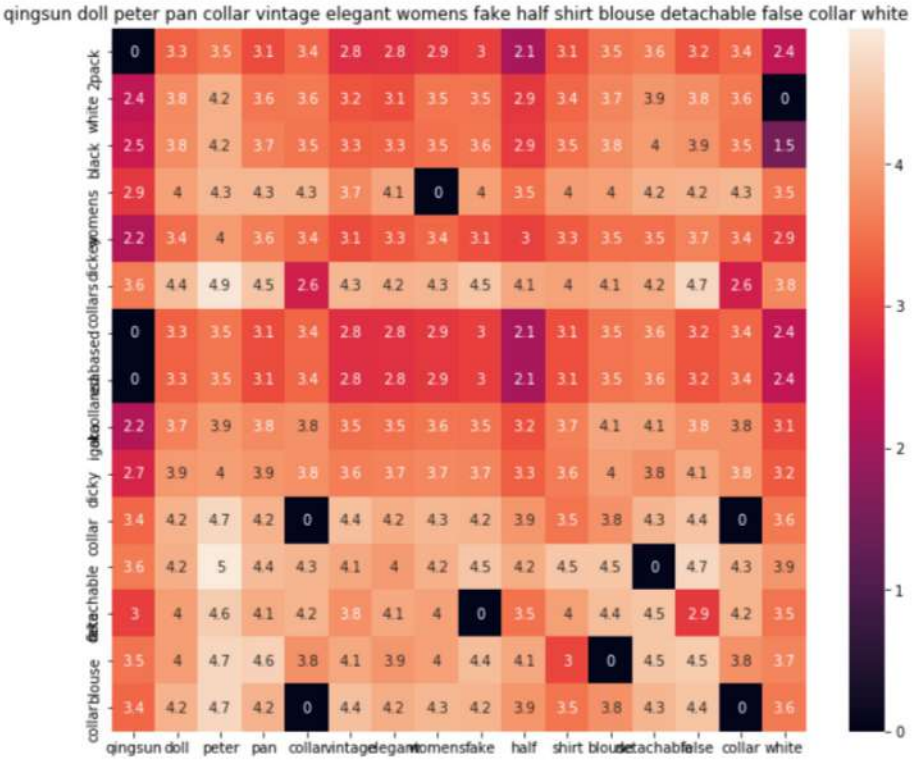
ASIN : B01M29GPK7
BRAND : Joyci
euclidean distance from given input image : 0.6093709



ASIN : B06X1G835Q
BRAND : George Jimmy
euclidean distance from given input image : 0.62557757



```
ASIN : B01MU29AKG
BRAND : KLOUD City
euclidean distance from given input image : 0.6342003
```



```
ASIN : B06XMYD2Z1
BRAND : Qingsun
euclidean distance from given input image : 0.63936865
```

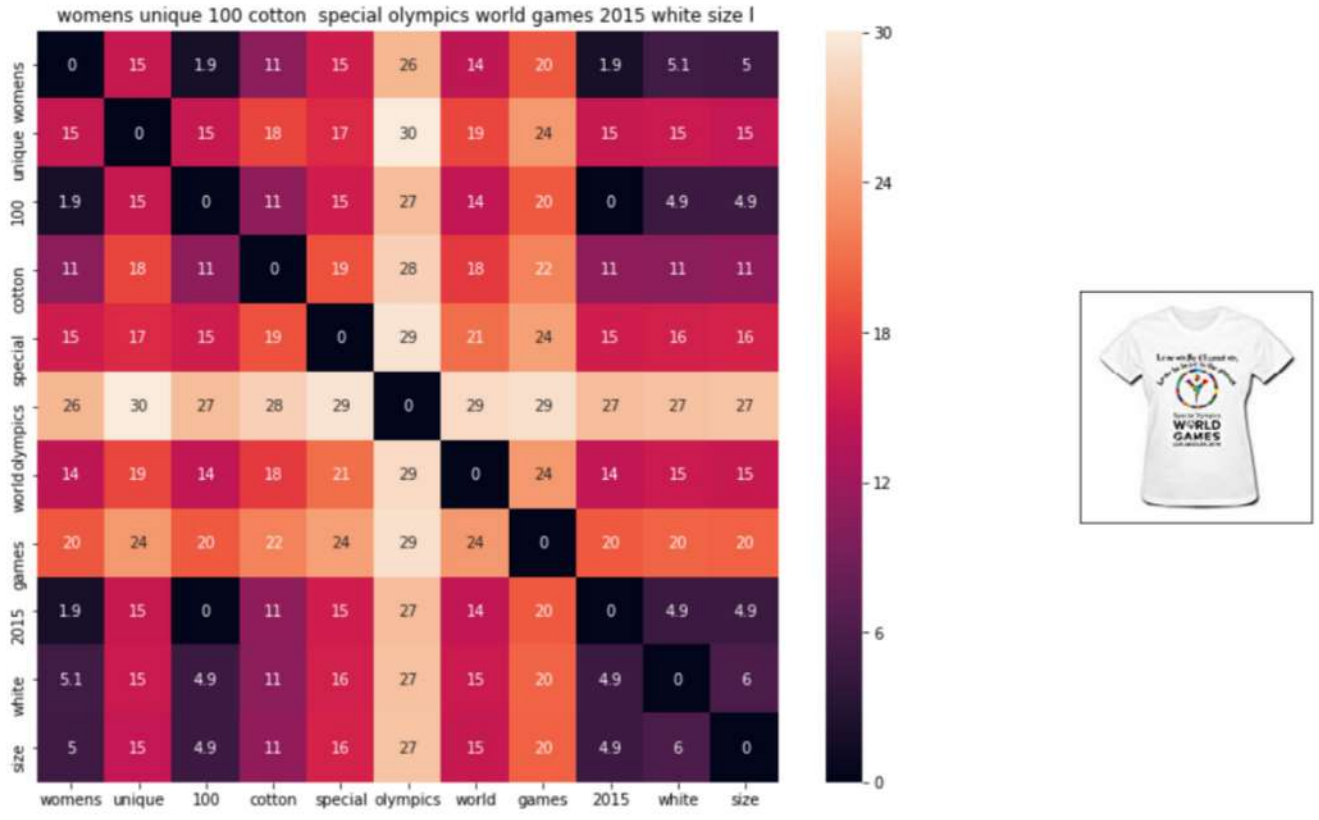
[9.4] IDF weighted Word2Vec for product similarity

In [51]:

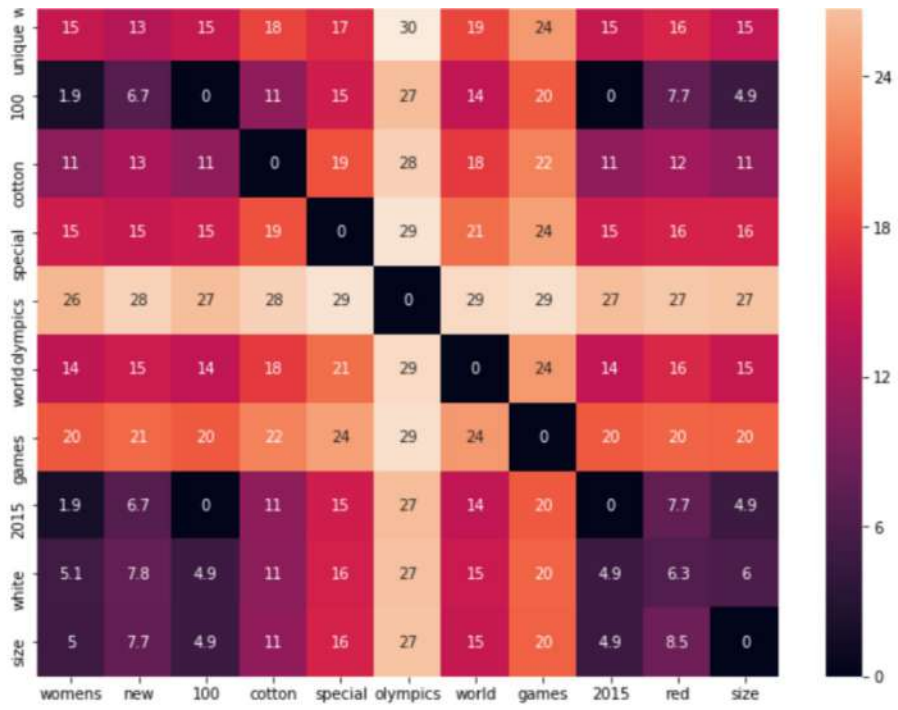
```
doc_id = 0
w2v_title_weight = []
# for every title we build a weighted vector representation
for i in data['title']:
    w2v_title_weight.append(build_avg_vec(i, 300, doc_id,'weighted'))
    doc_id += 1
```

In [52]:

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

    # pairwise_dist will store the distance from given input apparel to all remaining apparels
    # the metric we used here is cosine, the 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_indices[i]], data['mediu
m_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(1, 20)
#931
#12566
# in the give heat map, each cell contains the euclidean distance between words i, j
```

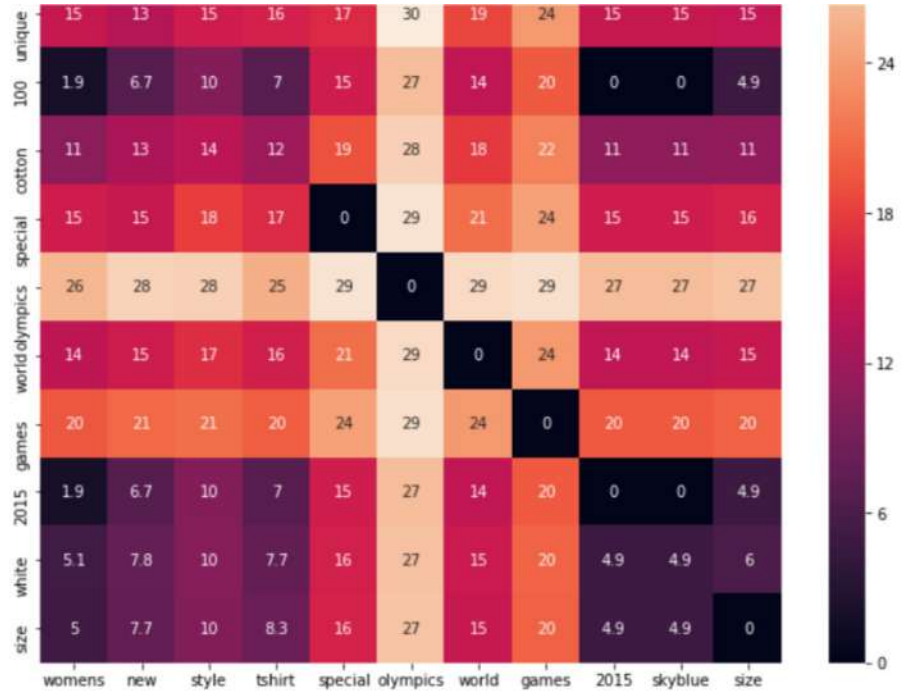


ASIN : B012YX2ZPI
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 0.0027621358

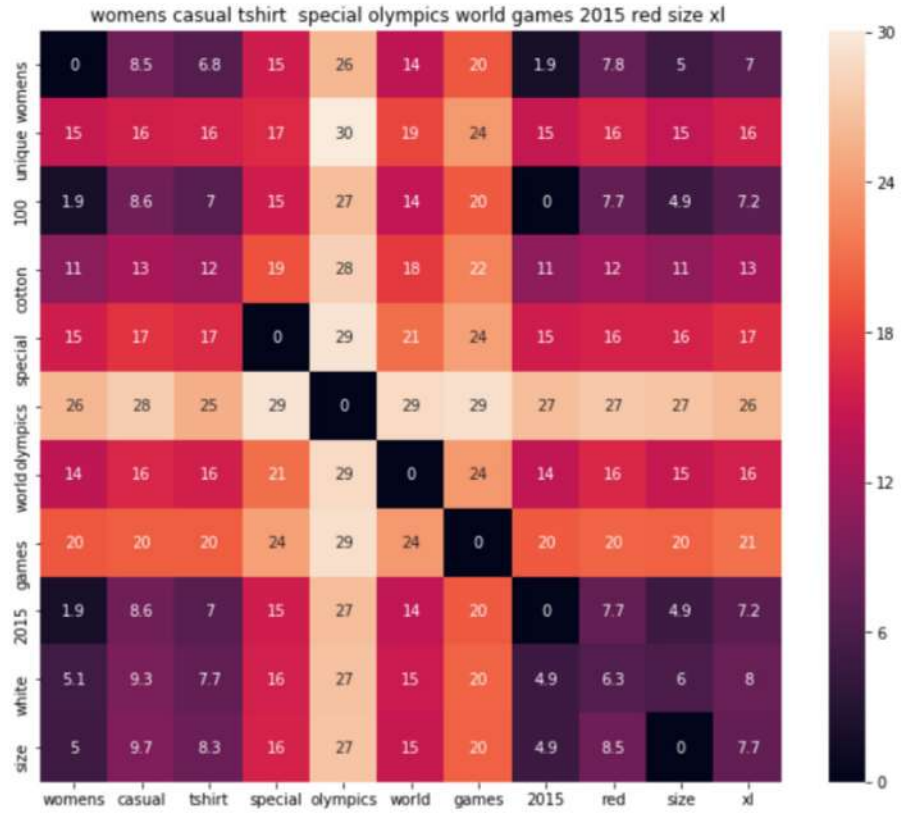


ASIN : B012YX3I5E
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 1.2900431

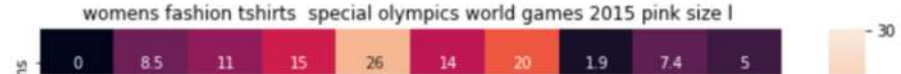
ASIN : B012YX4TVG
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 1.5112537

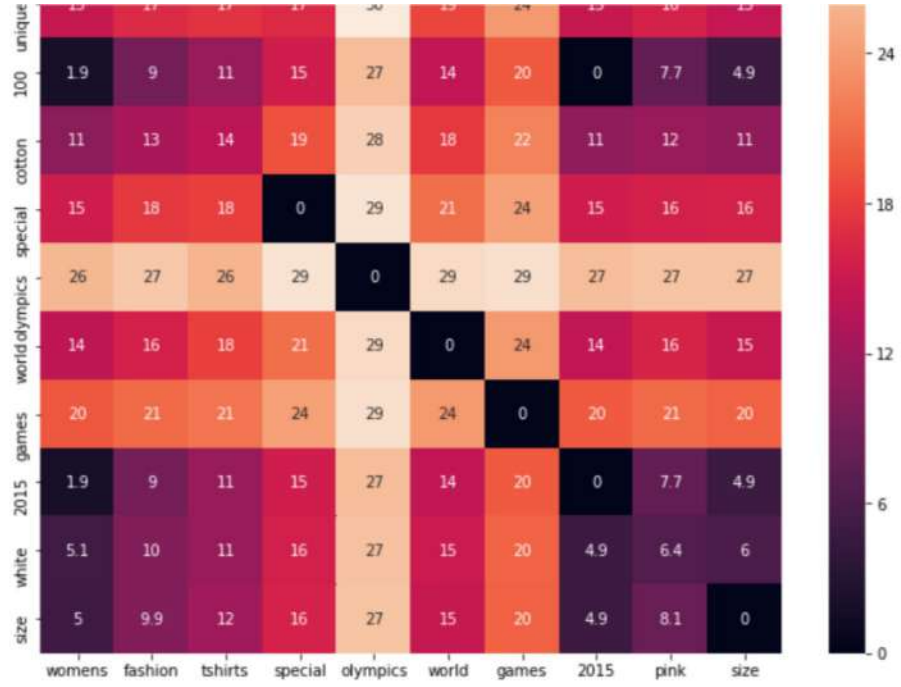


ASIN : B012YX2OJU
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 1.704583

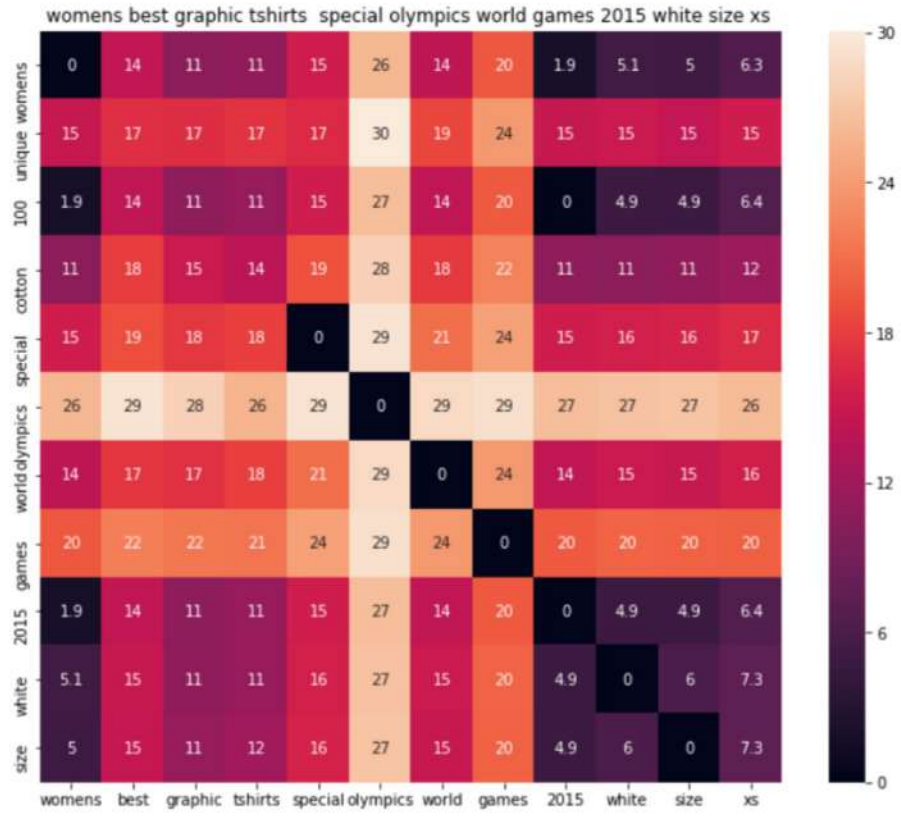


ASIN : B012YX3XTU
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 1.9207155

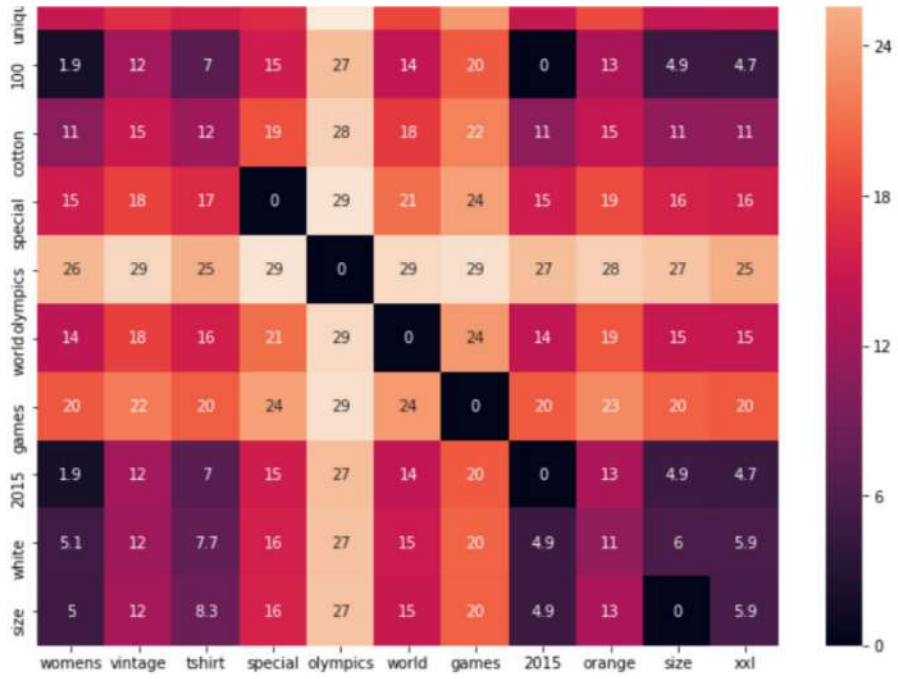




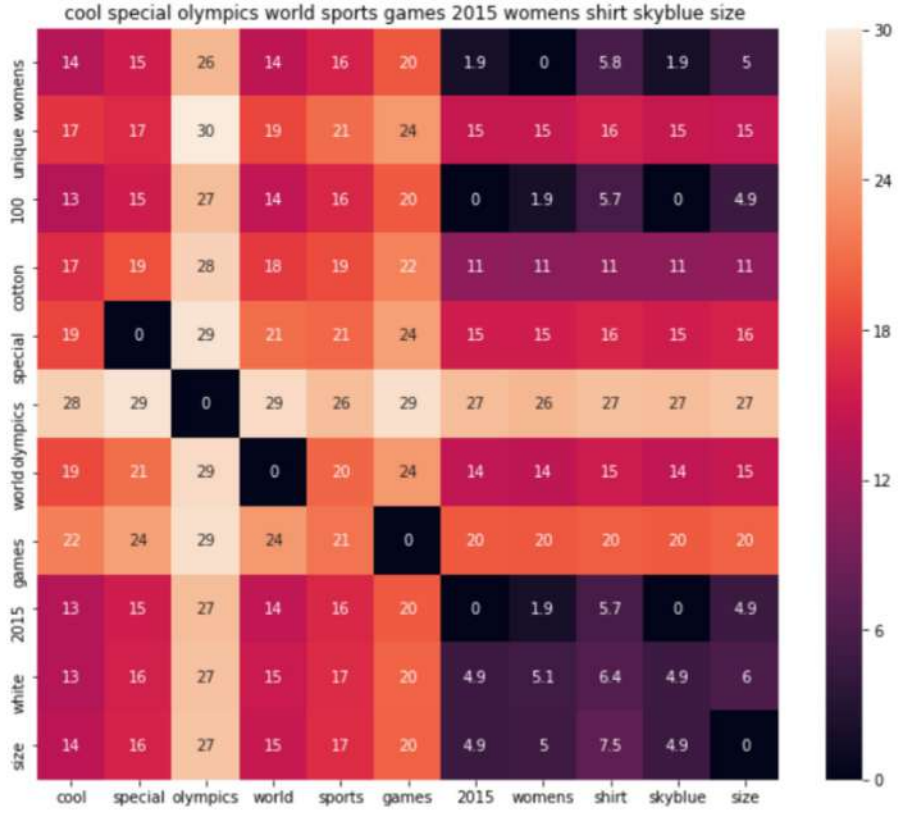
ASIN : B012YX26Q6
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 2.0728219



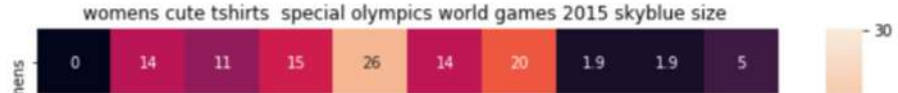
ASIN : B012YX2M3I
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 2.1508017



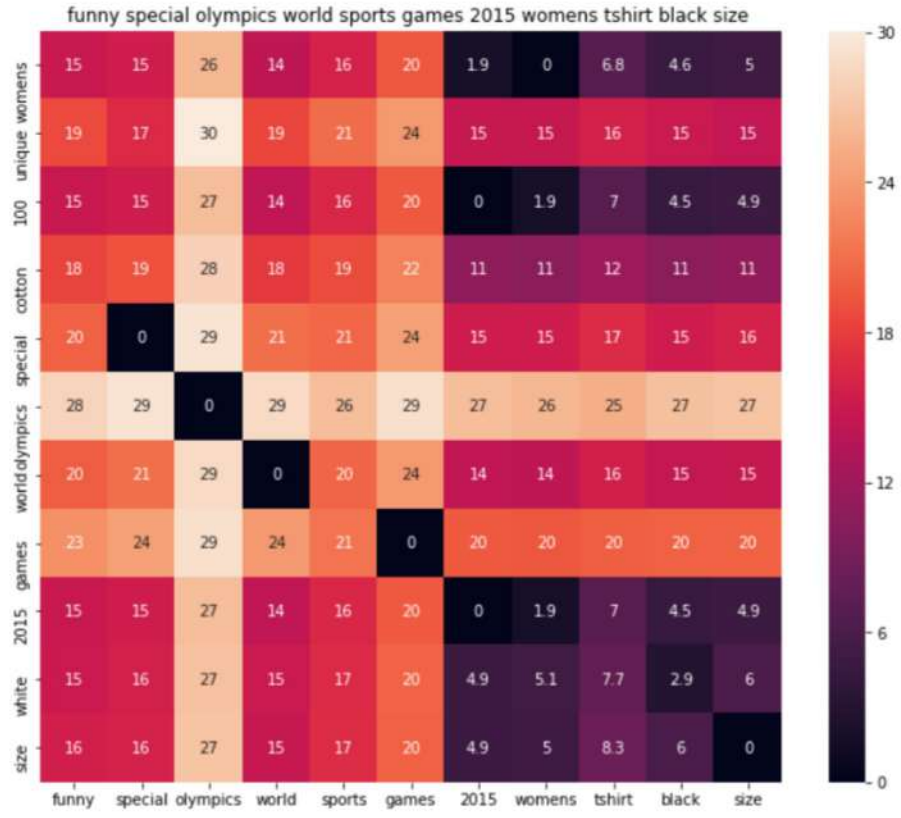
ASIN : B012YX4LVE
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 2.2502222



ASIN : B01338LWAM
Brand : MAM2 Arts
euclidean distance from input : 2.4271648

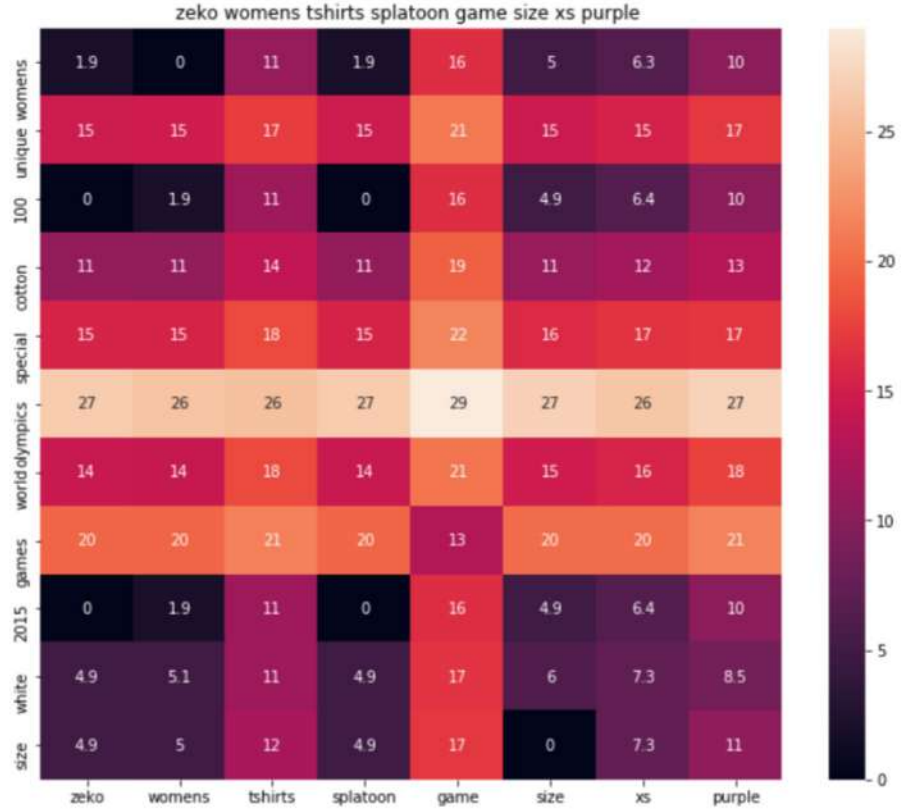


ASIN : B012YX30T8
Brand : HX-Kingdom Fashion T-shirts
euclidean distance from input : 2.436382

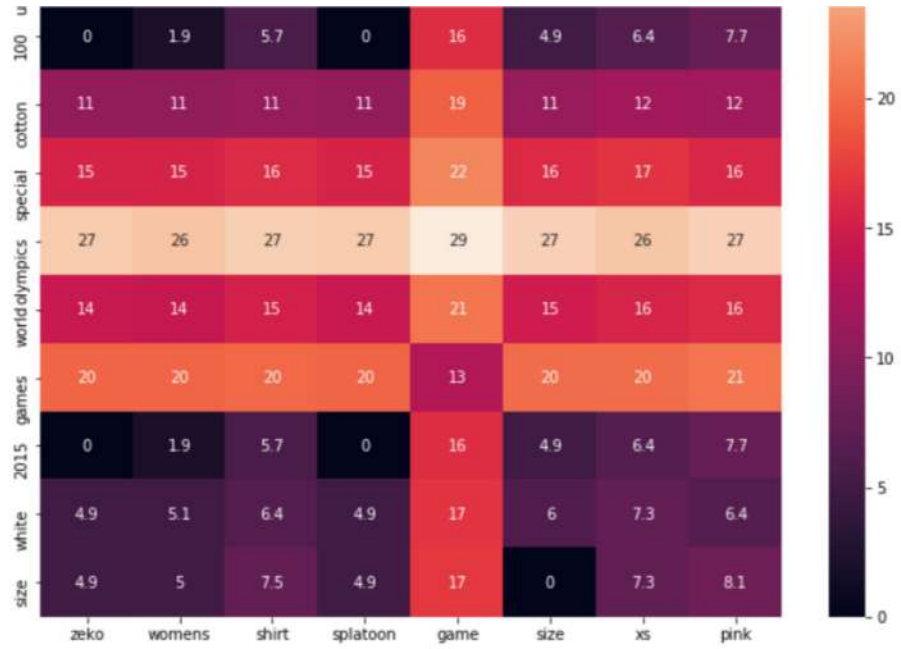


ASIN : B01338MTHM
Brand : MAM2 Arts
euclidean distance from input : 2.6622996

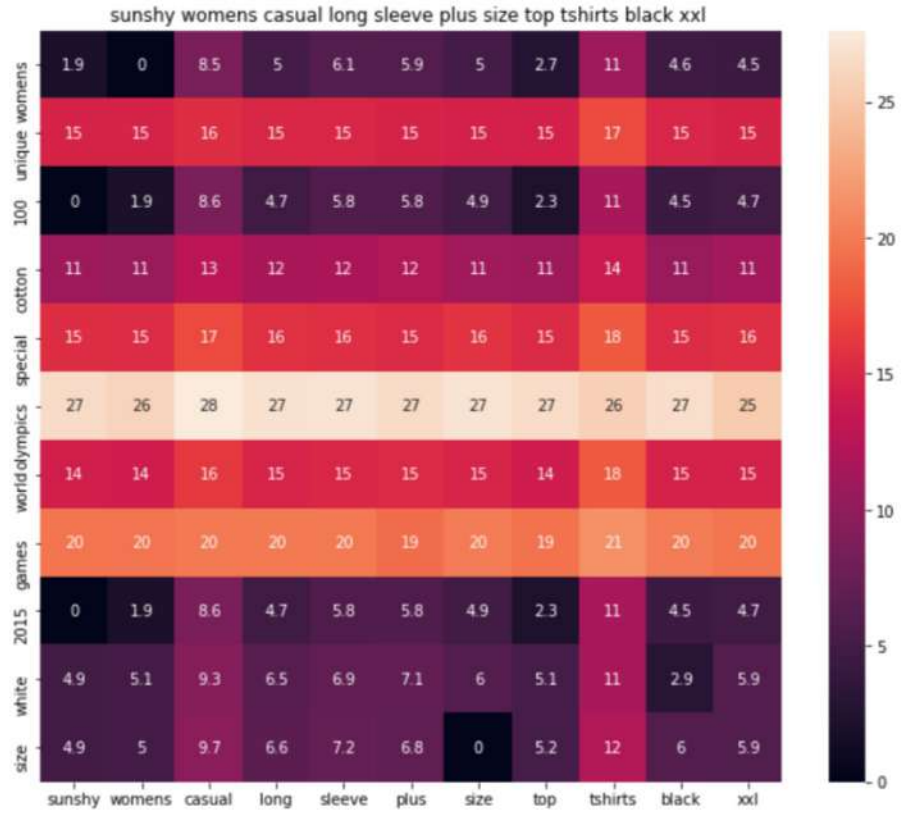
ASIN : B0167UU5ZQ
Brand : ZEKO
euclidean distance from input : 3.7380502



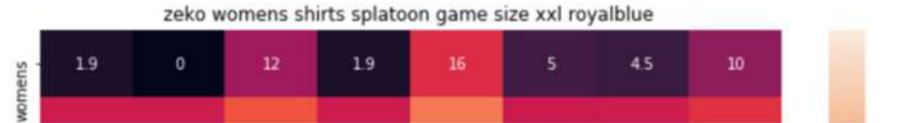
ASIN : B0167UURXQ
Brand : ZEKO
euclidean distance from input : 3.815717



ASIN : B0167UTZ4I
Brand : ZEKO
euclidean distance from input : 3.8381796



ASIN : B018EB3Q34
Brand : Juntong
euclidean distance from input : 3.8647017



ASIN : B0167UVCGW
Brand : ZEKO
euclidean distance from input : 3.9313798

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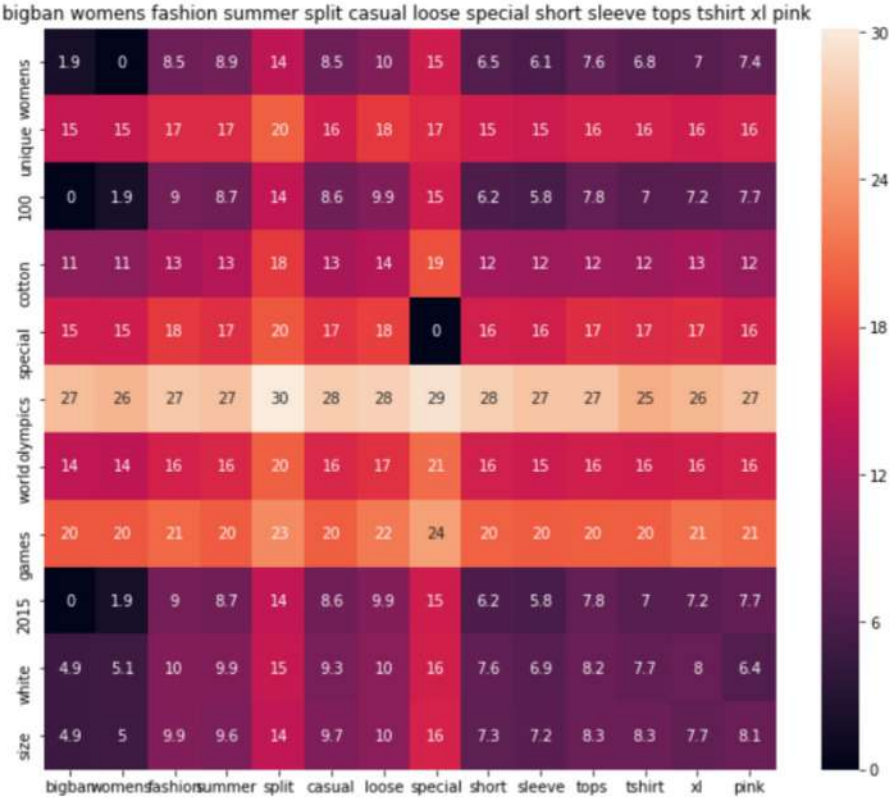
bigban womens fashion summer split casual loose special short sleeve tops tshirt xl pink



ASIN : B01HXCS9BO
Brand : Bigban
euclidean distance from input : 3.9710717

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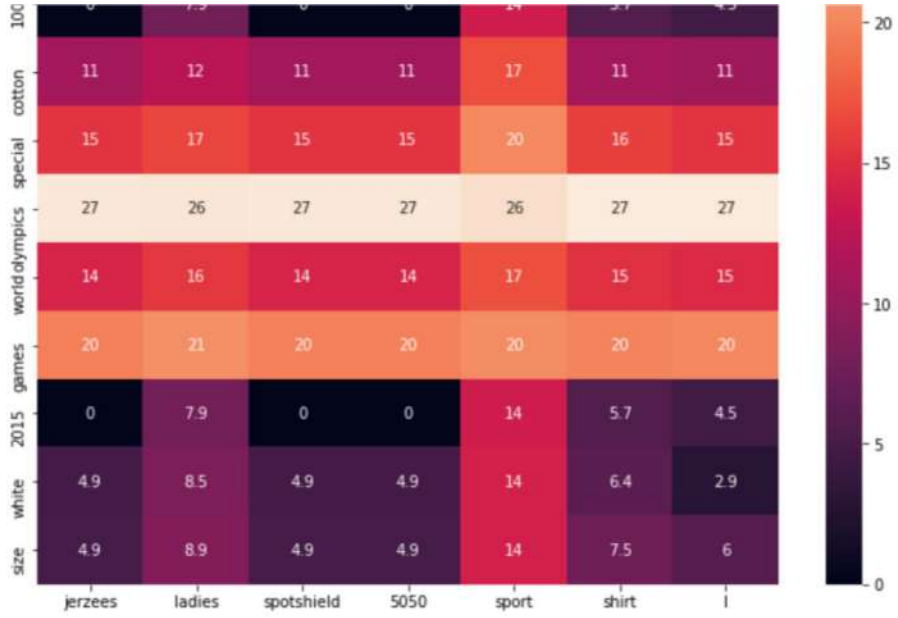
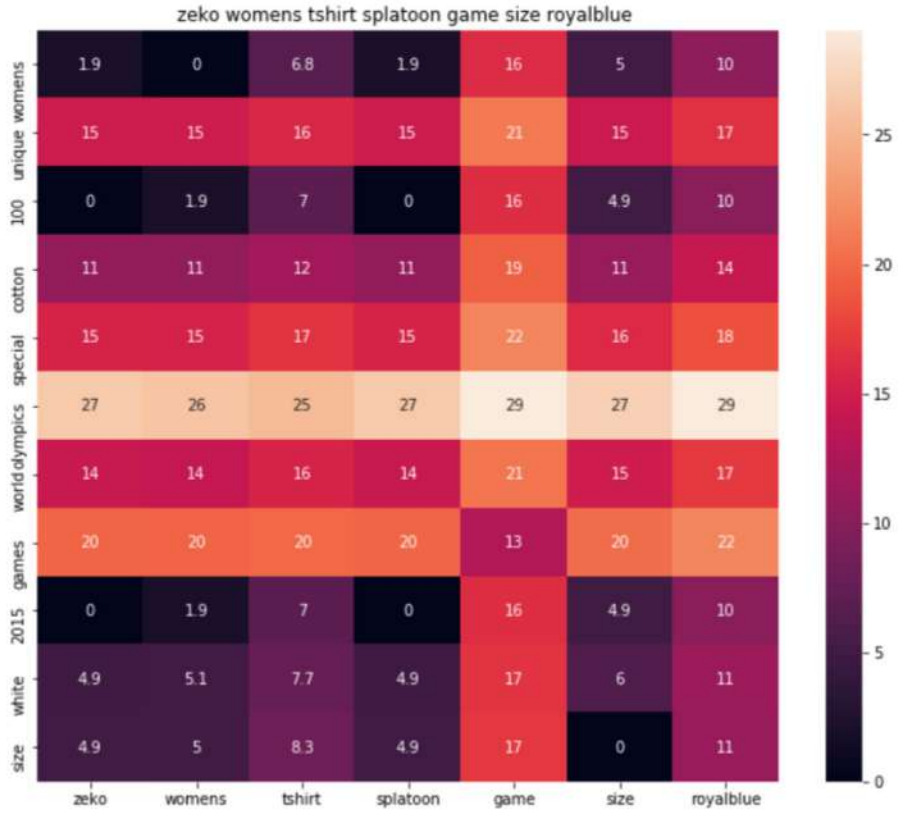
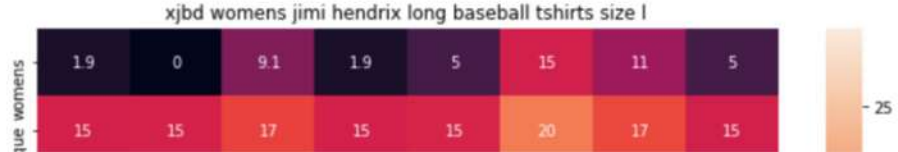
jerzees ladies spotshield 5050 sport shirt l black

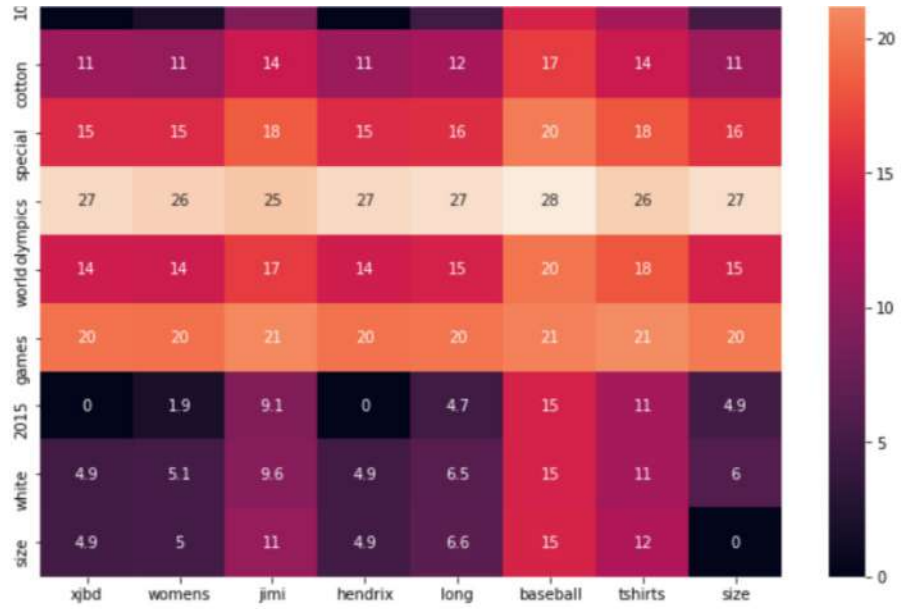


ASIN : B00FK49HDW
Brand : Jerzees
euclidean distance from input : 3.9770153



ASIN : B0167UV4KQ
Brand : ZEKO
euclidean distance from input : 3.9830794





```
ASIN : B01MF5BN69
Brand : XJBD
euclidean distance from input : 3.9987867
```

```
==========================================================================================================
=====================
```

[9.6] Weighted similarity using brand and color.

In [74]:

```
# 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 [75]:

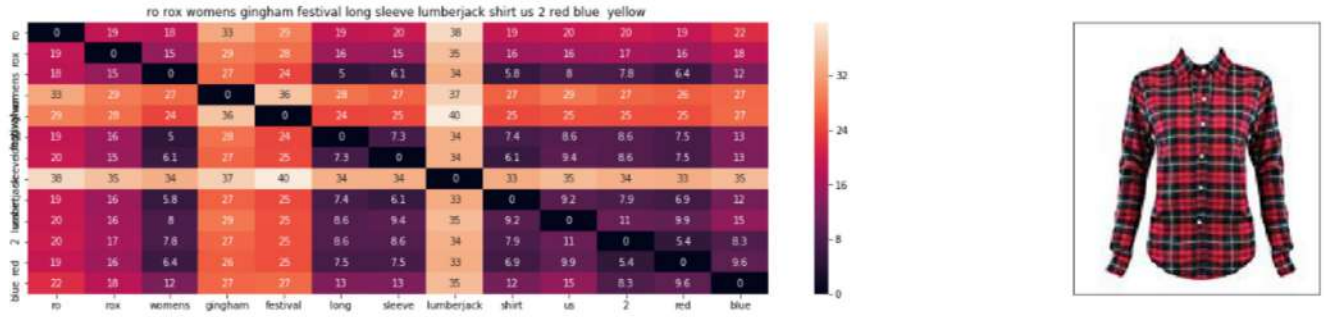
```
def heat_map_w2v_brand(sentance1, sentance2, url, doc_id1, doc_id2, df_id1, df_id2, model):

    # 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(weighted/avg) of lengt
h 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(weighted/avg) of lengt
h 300 corresponds to each word in give title
```

```
    # s1_s2_dist = np.array(#number of words in title1 * #number of words in title2)
    # 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], types[doc_id1]], # input
apparel's features
                   [data['asin'].loc[df_id2],brands[doc_id2], colors[doc_id2], types[doc_id2]]] #
recommonded apparel's features

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

    # 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()
```

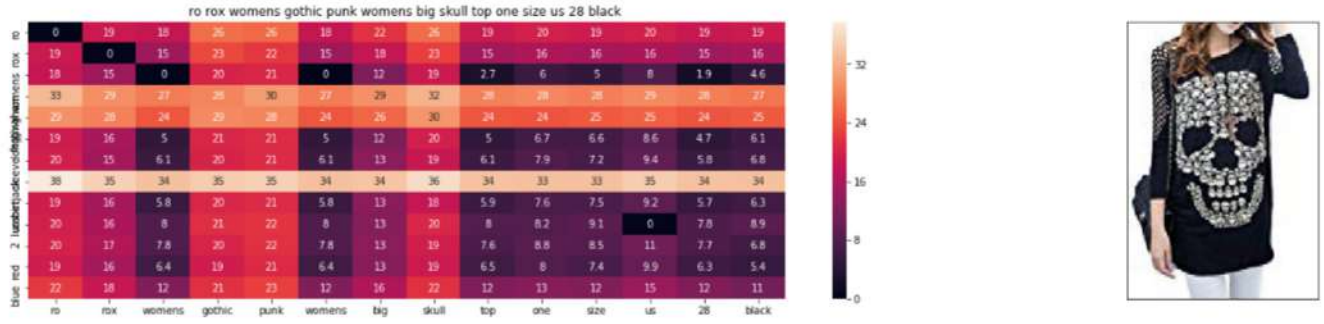
In [56]:

```
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 remaining apparels
    # the metric we used here is cosine, the coside distance is mesured as K(X, Y) = <X, Y> / (||X
||*||Y||)
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    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], indices[i],df_indices[0], df_indices[i], 'weigh
ted')
        print('ASIN :',data['asin'].loc[df_indices[i]])
```

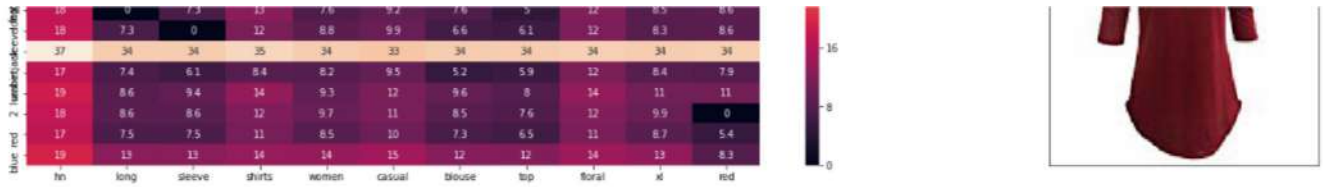
```
        print('='*125)

idf_w2v_brand(4000, 5, 5, 20)
# in the give heat map, each cell contains the euclidean distance between words i, j
```



ASIN : B00THPW4VM
Brand : Ro Rox
euclidean distance from input : 0.001381067931652069

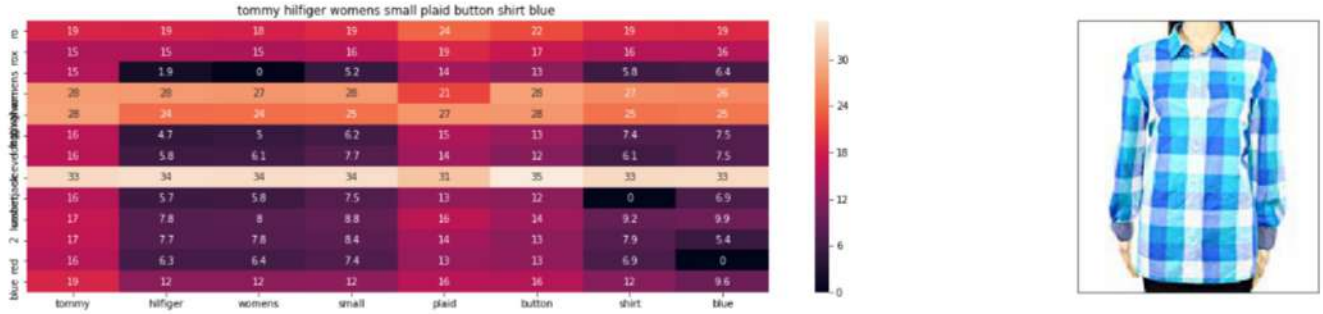


ASIN : B00VOE195Q
Brand : Ro Rox
euclidean distance from input : 3.2149560928344725

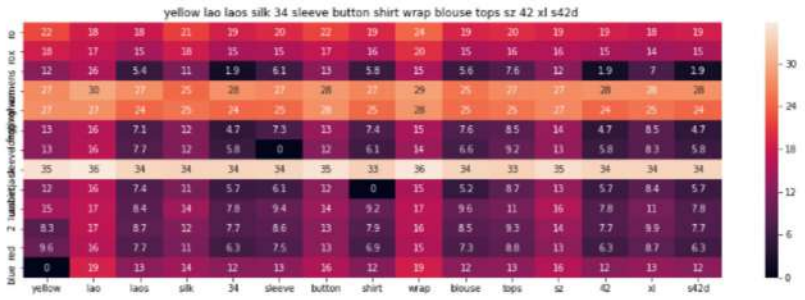


ASIN : B0711KH9DX
Brand : H&N
euclidean distance from input : 3.2256261825561525

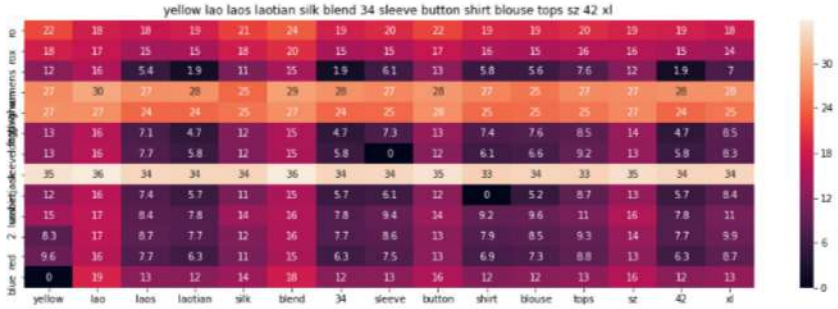
ASIN : B074J781N9
Brand : Nanon
euclidean distance from input : 3.2533508375047773



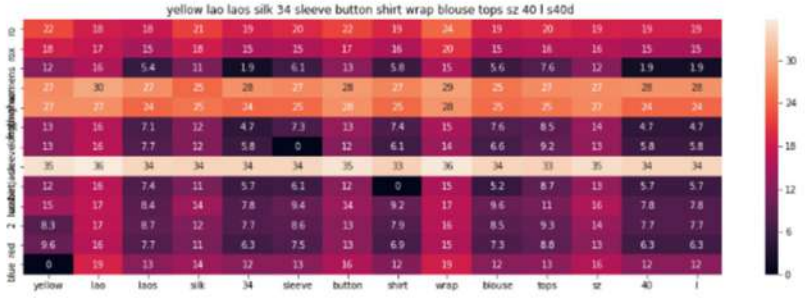
ASIN : B0759NSBCL
Brand : Tommy Hilfiger
euclidean distance from input : 3.256801489128405



ASIN : B0718YTQT5
Brand : Nanon
euclidean distance from input : 3.277779395854387

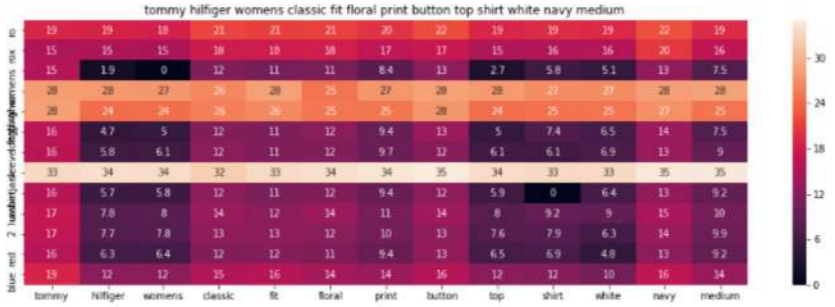


ASIN : B01JFLTO9W
Brand : Nanon
euclidean distance from input : 3.287353523051652



ASIN : B06XHCK59R
Brand : Nanon

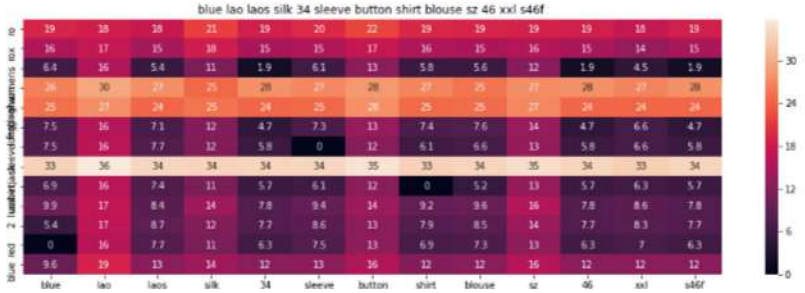
==========



ASIN : B00198OFEY
Brand : Ashworth
euclidean distance from input : 3.3072891309618084

==========

==========

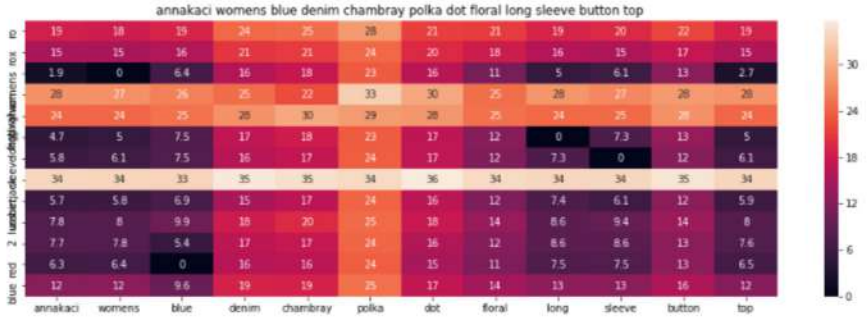


ASIN : B071HBD7LY
Brand : Nanon
euclidean distance from input : 3.307752998149309

==========

==========

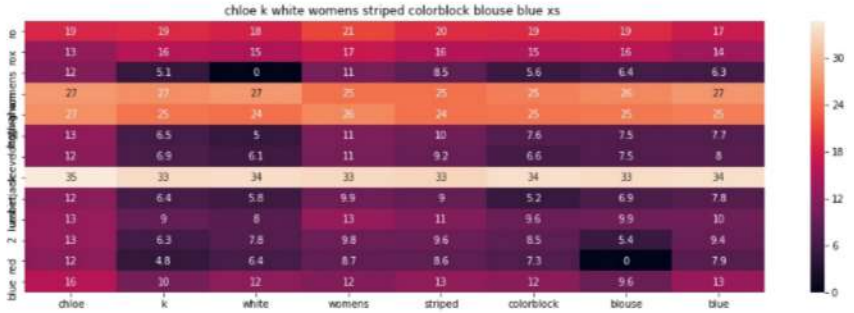
ASIN : B01K5BRKGK
Brand : RRL
euclidean distance from input : 3.3118551328538985



ASIN : B008SMIFN6
Brand : Anna-Kaci
euclidean distance from input : 3.3135590345995967

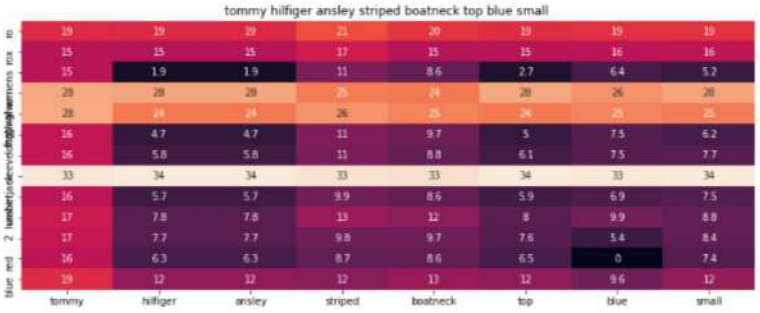
ASIN : B01MS7H2R5
Brand : Shouhengda
euclidean distance from input : 3.3166797712205978

ASIN : B071YMD8QN
Brand : Nanon
euclidean distance from input : 3.3183124616502853

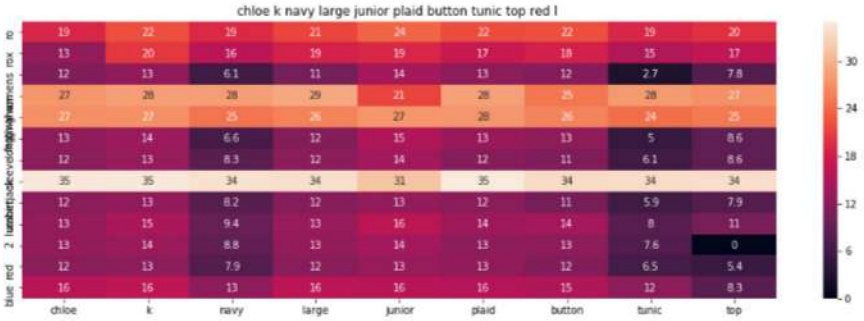


ASIN : B074QTKXPP
Brand : Chloe K.
euclidean distance from input : 3.3226463392137617

ASIN : B06XG6HCZJ
Brand : Nanon
euclidean distance from input : 3.326060493266496



ASIN : B01LYYU8BB
Brand : Tommy Hilfiger
euclidean distance from input : 3.328615453972155



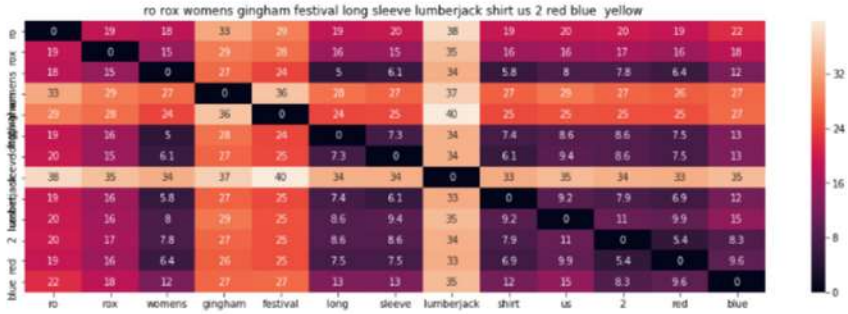
ASIN : B074MJSJX8
Brand : Chloe K.
euclidean distance from input : 3.3397876813768477

ASIN : B074HXKRSG
Brand : Nanon
euclidean distance from input : 3.3486057355760663

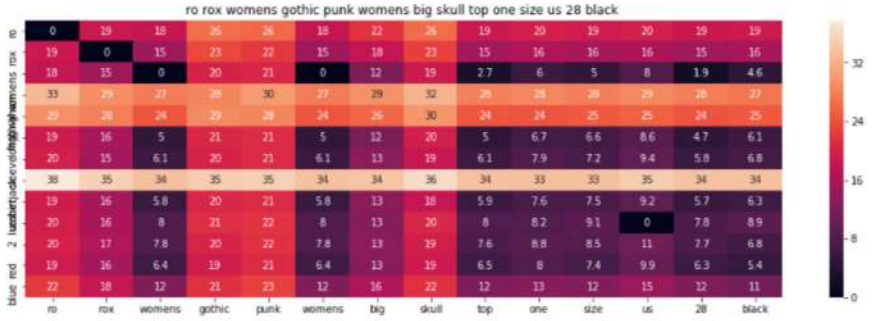
ASIN : B0759NSBV6
Brand : Tommy Hilfiger
euclidean distance from input : 3.359269407524401

In [57]:

```
# brand and color weight =50
# title vector weight = 5

idf_w2v_brand(4000, 5, 50, 20)
```

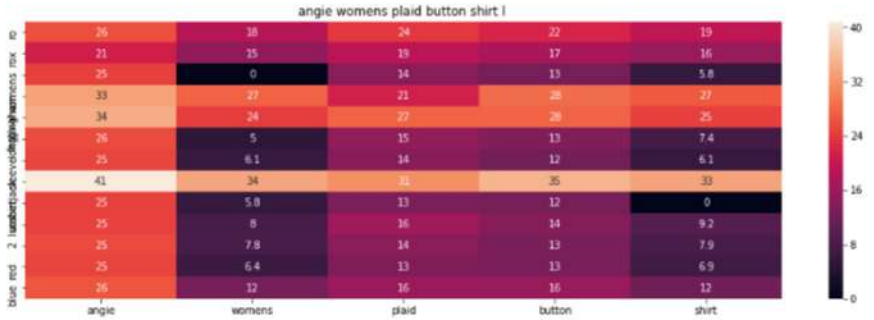


ASIN : B00THPW4VM
Brand : Ro Rox
euclidean distance from input : 0.0002511032603003762

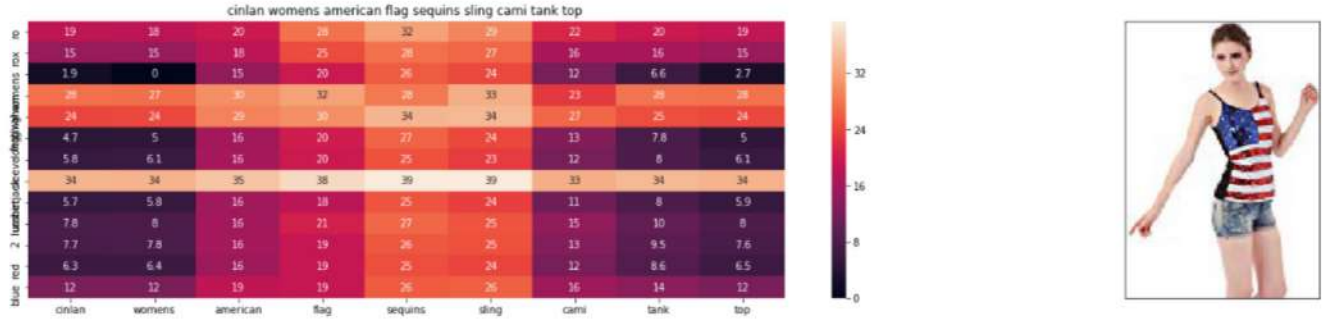


ASIN : B00VOE195Q
Brand : Ro Rox
euclidean distance from input : 2.220901107788086

ASIN : B0711KH9DX
Brand : H&N
euclidean distance from input : 2.2228411241011186

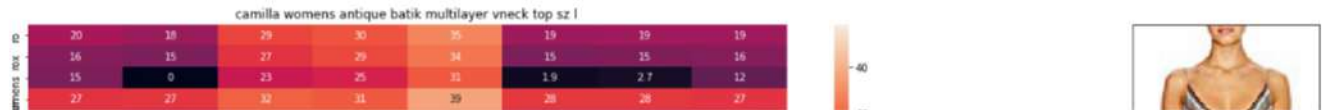


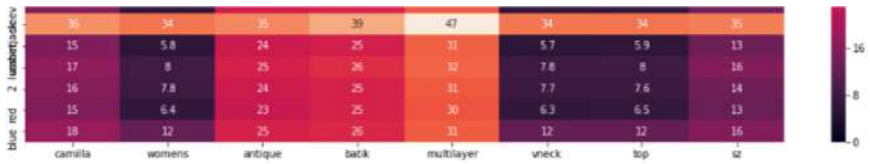
euclidean distance from input : 2.3228708440607244



ASIN : B01AUJPCP8
Brand : Cinlan
euclidean distance from input : 2.3829784740101205

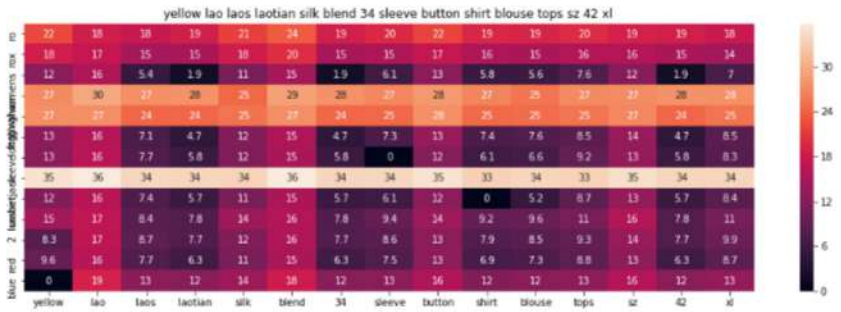
ASIN : B074J781N9
Brand : Nanon
euclidean distance from input : 2.4210284975006964





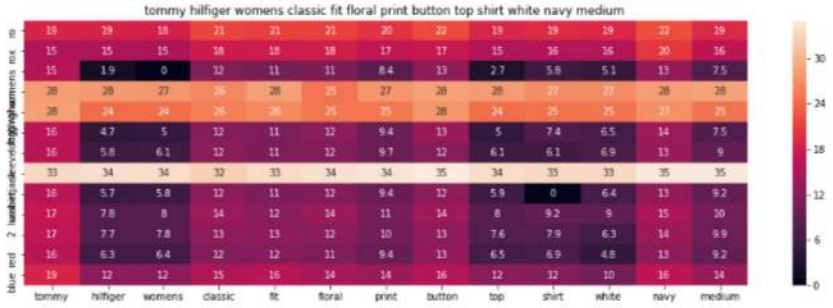
ASIN : B073YK11HQ
Brand : Camilla
euclidean distance from input : 2.424445134943182

ASIN : B0718YTQT5
Brand : Nanon
euclidean distance from input : 2.4254700535642617



ASIN : B01JFLTO9W
Brand : Nanon
euclidean distance from input : 2.4272108039637645

ASIN : B06XHCK59R
Brand : Nanon
euclidean distance from input : 2.4292667870736726

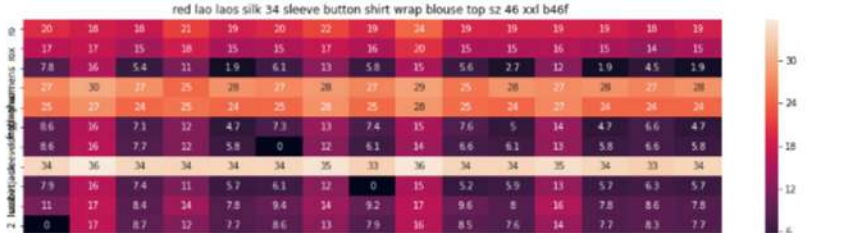


ASIN : B00198OFEY
Brand : Ashworth
euclidean distance from input : 2.4308354599474296

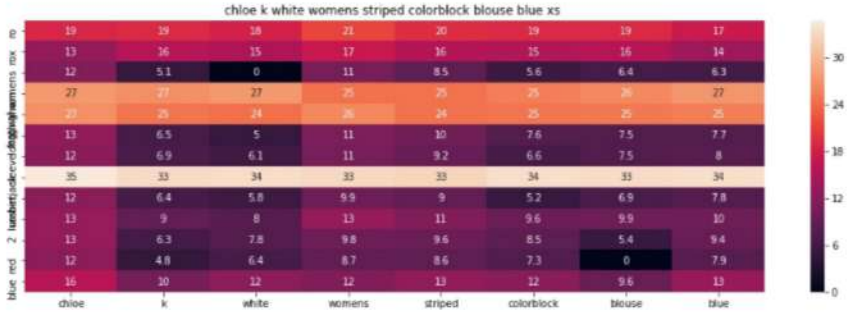
ASIN : B071HBD7LY
Brand : Nanon
euclidean distance from input : 2.430919799436066

ASIN : B01K5BRKGK
Brand : RRL
euclidean distance from input : 2.431665642109628

ASIN : B01MS7H2R5
Brand : Shouhengda
euclidean distance from input : 2.432542849085391

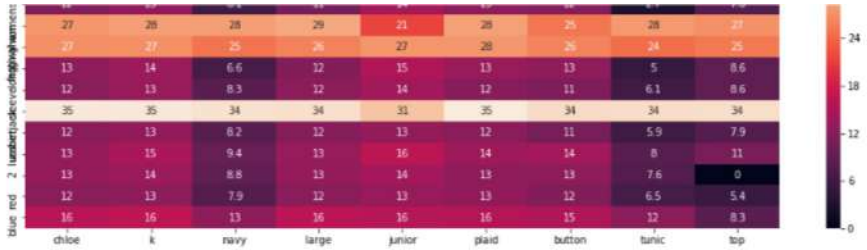


ASIN : B071YMD8QN
Brand : Nanon
euclidean distance from input : 2.432839701890789



ASIN : B074QTKXPP
Brand : Chloe K.
euclidean distance from input : 2.433627679629603

ASIN : B06XG6HCZJ
Brand : Nanon
euclidean distance from input : 2.4342484349119182



ASIN : B074MJSJX8
Brand : Chloe K.
euclidean distance from input : 2.4367442872956184

ASIN : B074HXKRSG
Brand : Nanon
euclidean distance from input : 2.4383475698772945

ASIN : B003BSQPW0
Brand : FeatherLite
euclidean distance from input : 2.4403316979623444

[5.2] Keras and Tensorflow to extract features

In [58]:

```
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 [0]:

```
# 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 output

# 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_samples // batch_size)
    bottleneck_features_train = bottleneck_features_train.reshape((16042,25088))

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

```
'''
```

[10.3] Visual features based product similarity.

In [59]:

```
#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_features_train[doc_id]
.reshape(1,-1))

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

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

get_similar_products_cnn(12345, 20)
```

```
Product Title:  mahogany girl tshirt swarovski purlple clear crystals
Euclidean Distance from input image: 0.07654656
Amazon Url: www.amzon.com/dp/B01K5Q5PGW
```

```
Product Title:  district juniors vintage wash vneck teem black dt4501
Euclidean Distance from input image: 44.158707
Amazon Url: www.amzon.com/dp/B00TSNTQI2
```

Product Title: district juniors vintage wash vneck teexl warm grey dt4501
Euclidean Distance from input image: 44.929653
Amazon Url: www.amzon.com/dp/B00TSNY902

Product Title: levis womens womens perfect graphic tee pins print jet black tshirt
Euclidean Distance from input image: 46.451305
Amazon Url: www.amzon.com/dp/B071V93RRN

Product Title: district juniors vintage wash vneck tee4xl deep turquoise dt4501
Euclidean Distance from input image: 47.209816
Amazon Url: www.amzon.com/dp/B00TSNVHZC

Product Title: district womens comfortable triblend crewneck tshirt mari hecha he3xl
Euclidean Distance from input image: 47.58396
Amazon Url: www.amzon.com/dp/B01BKCZTPW

Product Title: port company womens soft perfect pique polo shirtyellowmedium
Euclidean Distance from input image: 48.71448
Amazon Url: www.amzon.com/dp/B00GYZM6Z2

Product Title: authentic pigment ladies best summer pocket tank nautical red xlarge
Euclidean Distance from input image: 49.52847
Amazon Url: www.amzon.com/dp/B01GESXJ3G

Product Title: womens basic short sleeve vneck tee shirt cotton blend junior plus sizes charcoal small
Euclidean Distance from input image: 49.762405
Amazon Url: www.amzon.com/dp/B00JPT2PRS

Product Title: two vince camuto womens striped tribal beat shirt ultra white small
Euclidean Distance from input image: 49.779545
Amazon Url: www.amzon.com/dp/B01H24W0IG

Product Title: harriton womens breathable double needle polo shirt black xxlarge
Euclidean Distance from input image: 50.382065
Amazon Url: www.amzon.com/dp/B0038JFOU6

Product Title: devon jones womens ycollar polo shirt espresso xxxlarge
Euclidean Distance from input image: 50.438766
Amazon Url: www.amzon.com/dp/B01GGACDZ2

Product Title: levis womens womens slim crew neck tee slasher jet black tshirt
Euclidean Distance from input image: 50.58456
Amazon Url: www.amzon.com/dp/B071YMRVSP

Product Title: levis womens womens perfect graphic tee wink jet black tshirt
Euclidean Distance from input image: 50.737858
Amazon Url: www.amzon.com/dp/B072L2HS3V

Product Title: nili lotan womens normandy blouse black xsmall
Euclidean Distance from input image: 50.823578
Amazon Url: www.amzon.com/dp/B0736D8BVV

Product Title: miraclebody womens jersey slimming tunic top black
Euclidean Distance from input image: 51.06024
Amazon Url: www.amzon.com/dp/B0059GPDDE

Product Title: fox womens flipped tank top size small color black
Euclidean Distance from input image: 51.328533
Amazon Url: www.amzon.com/dp/B00MONRNOM

```
Product Title:  elizabeth  james womens kim gathered front tank top purple xsmall
Euclidean Distance from input image: 51.410038
Amazon Url: www.amzon.com/dp/B0717B9WYS
```

```
Product Title:  dna rhea long sleeve knit top sm 1012 currant purple
Euclidean Distance from input image: 51.618755
Amazon Url: www.amzon.com/dp/B0755KBYW3
```

```
Product Title:  authentic pigment ladies true spirit raglan tshirt nautical red xsmall
Euclidean Distance from input image: 51.621075
Amazon Url: www.amzon.com/dp/B01GESXQ8E
```

Assignment

[9.6] Weighted similarity using Brand , Color , Image and Text

In [68]:

```
# 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)
```

In [69]:

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

```
    # 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(weighted/avg) of lengt
h 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(weighted/avg) of lengt
h 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 title2)
    # 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], types[doc_id1]], # input
apparel's features
                [data['asin'].loc[df_id2],brands[doc_id2], colors[doc_id2], types[doc_id2]]] #
recommonded apparel's features

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

    # 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()
```

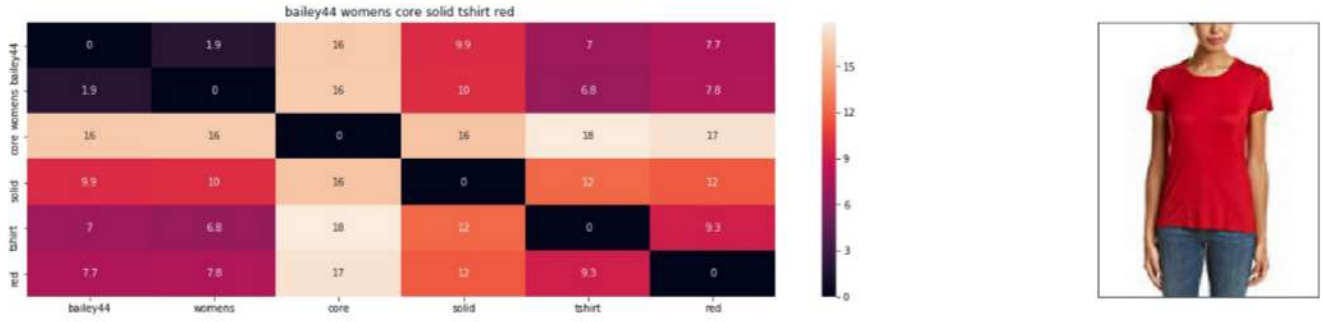
Weights assigned to features

1. Text feature - 5
2. Color feature - 10
3. Brand feature - 15
4. Image feature - 20

In [81]:

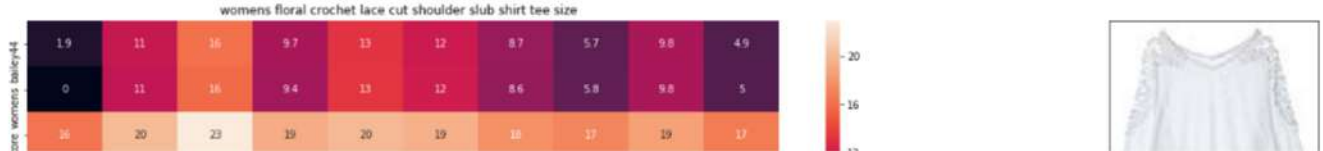
```
def idf_w2v(doc_id, w1, w2, w3, w4, num_results):
    # doc_id: apparel's id in given corpus
    # w1: weight for  w2v features
    # w2: weight for brand and color features
```

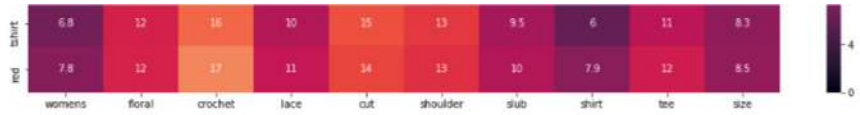
```
    # the metric we used here is cosine, the coside distance is mesured as K(X, Y) = <X, Y> / (||X
||*||Y||)
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    text_dist  = pairwise_distances(w2v_title_weight, w2v_title_weight[doc_id].reshape(1,-1))
    color_dist = pairwise_distances(color_features, color_features[doc_id])
    brand_dist = pairwise_distances(brand_features, brand_features[doc_id])
    image_dist = pairwise_distances(bottleneck_features_train, bottleneck_features_train[doc_id].re
shape(1,-1))
    pairwise_dist   = (w1 * text_dist +  w2 * color_dist + w3 * brand_dist + w4 * image_dist)/float
(w1 + w2 + w3 + w4)

    # 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(data['title'].loc[df_indices[0]],data['title'].loc[df_indices[i]], data['medium_im
age_url'].loc[df_indices[i]], indices[0], indices[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(444, 5, 10, 15, 20, 20)
# in the give heat map, each cell contains the euclidean distance between words i, j
```



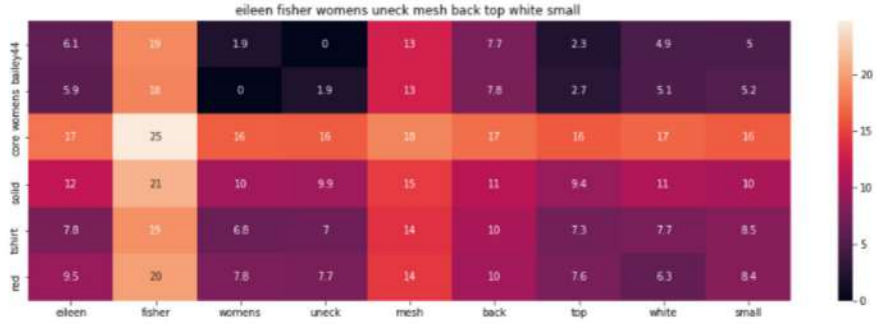

```
ASIN : B06Y5PL72B
Brand : Bailey 44
euclidean distance from input : 0.009034147262573242
```

```
==========================================================================================
======================
```

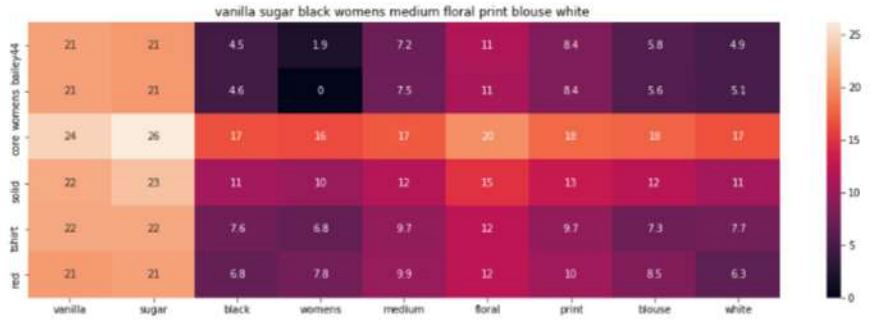




ASIN : B00YC8PK7Y
Brand : Kiki
euclidean distance from input : 15.065632393221845

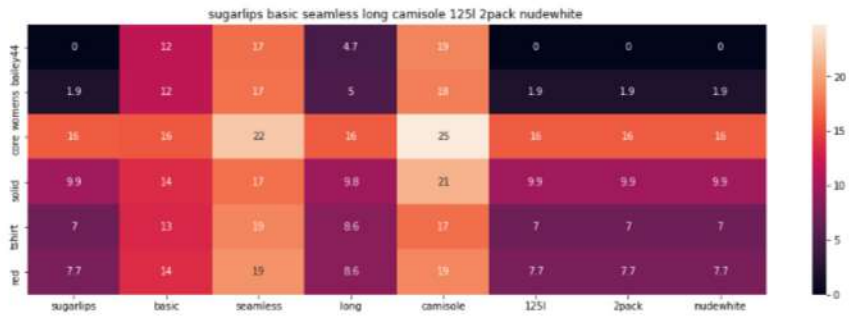


ASIN : B0728J4S62
Brand : Eileen Fisher
euclidean distance from input : 15.8746301270254

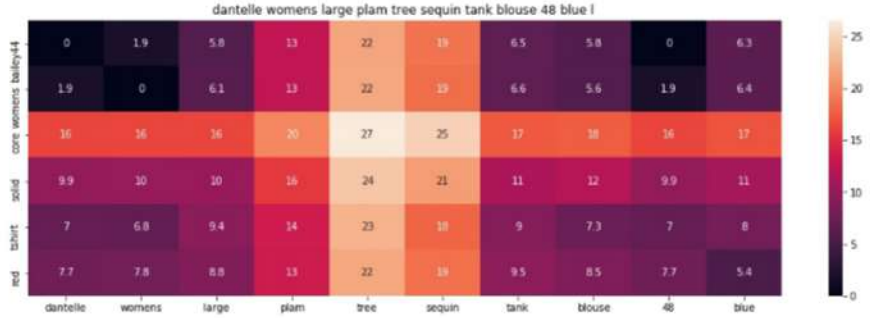


ASIN : B072K3CZW6
Brand : Vanilla Sugar
euclidean distance from input : 15.929152832103526

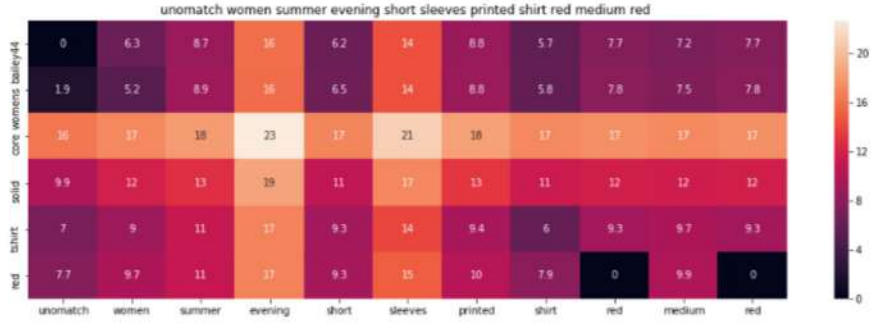
ASIN : B01EV1NKNW
Brand : Creazy
euclidean distance from input : 16.071655647616375



ASIN : B01D9B49LW
Brand : Sugar Lips
euclidean distance from input : 16.111947326660157

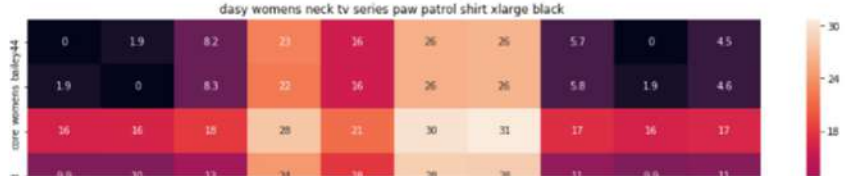


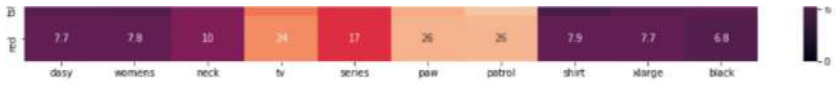
ASIN : B074P85Y4R
Brand : Dantelle
euclidean distance from input : 16.13022116885661



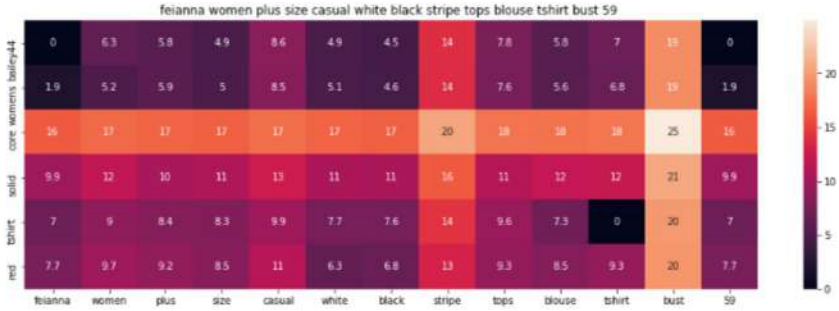
ASIN : B06WP5F7VW
Brand : Unomatch
euclidean distance from input : 16.20692145564957

ASIN : B01NCV1TKU
Brand : WIIPU
euclidean distance from input : 16.305874931673994

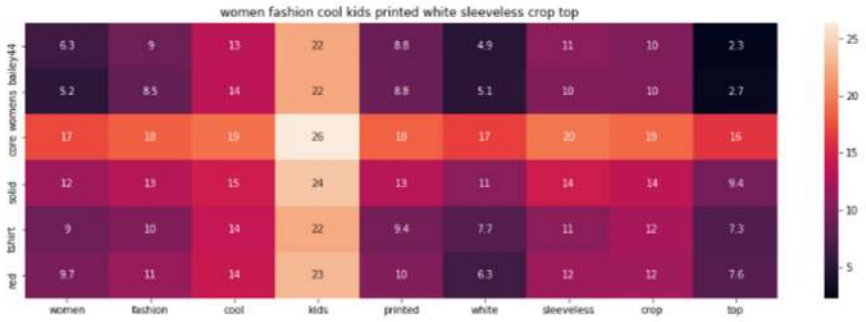




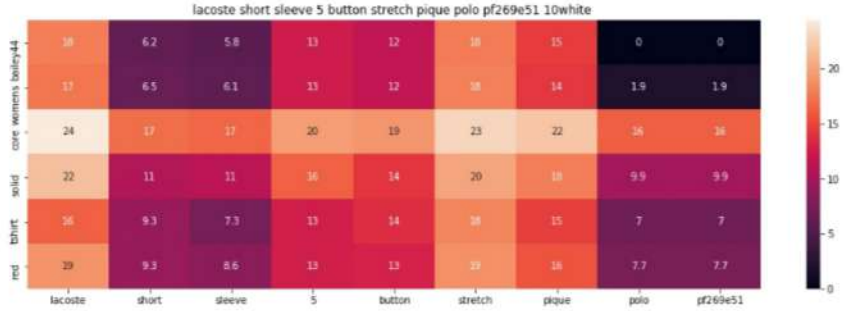
ASIN : B015J2XE56
Brand : Dasy
euclidean distance from input : 16.35471305118083



ASIN : B072WQ86QJ
Brand : FEIANNA
euclidean distance from input : 16.631052009848787

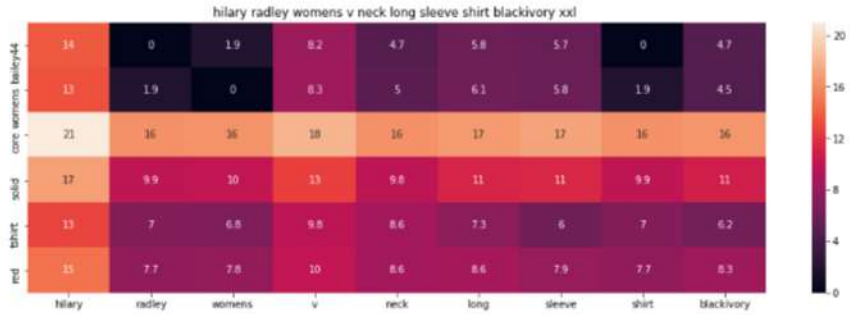


ASIN : B017UCA5GE
Brand : MKP Crop Top
euclidean distance from input : 16.636476371562395

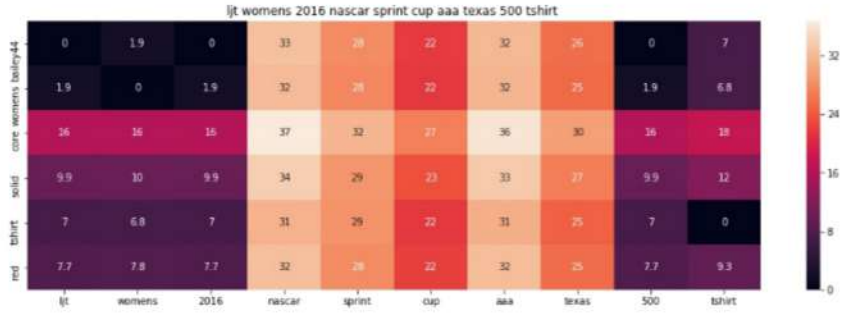


ASIN : B006WNYWT4
Brand : Lacoste
euclidean distance from input : 16.65859690890788

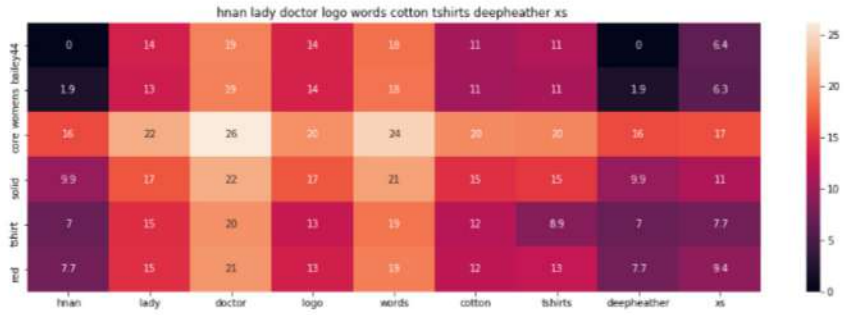
ASIN : B01HCZLYW8
Brand : Free People
euclidean distance from input : 16.703107338023937



ASIN : B01MR25ZVJ
Brand : Hilary Radley
euclidean distance from input : 16.707399655837506

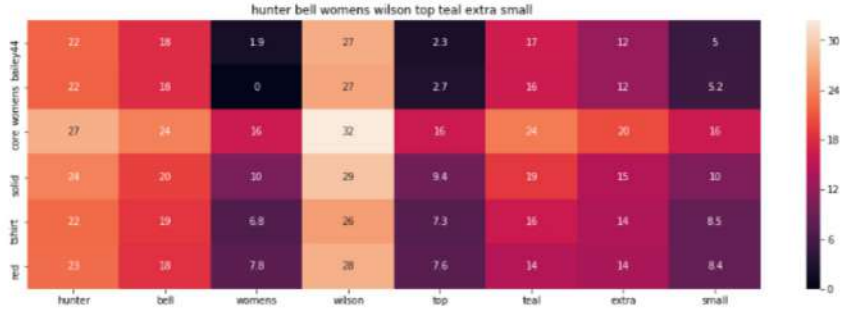


ASIN : B01IBEXL48
Brand : LaJiTong
euclidean distance from input : 16.728553077964023

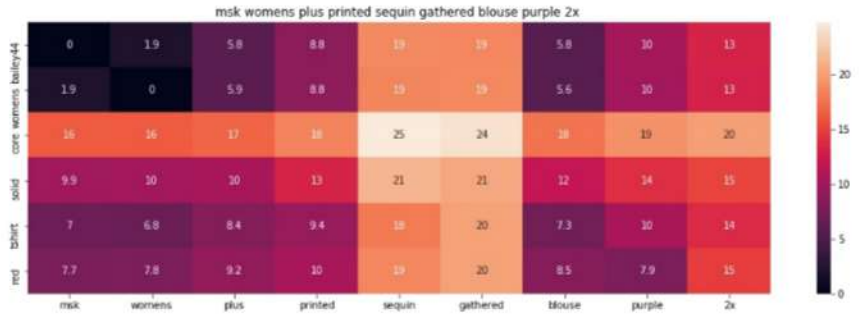


ASIN : B0142LT93Q
Brand : H'nan
euclidean distance from input : 16.753663208346357

ASIN : B074XG4RZJ
Brand : Jess & Jane
euclidean distance from input : 16.820871429515634
==========



ASIN : B01N2OSO76
Brand : Hunter Bell
euclidean distance from input : 16.879165496898448
==========



ASIN : B07229JP6M
Brand : MSK
euclidean distance from input : 16.92327536807536
==========

Step by Step procedure

1. Our objective was to Recommend Apparels to user based on their current selection of Apparel on a E-commerce website
2. I got the data from the Amazon website for womens shirt
3. Number of data points : 183138 and Number of features/variables: 19
4. There were 72 unique Product type and the most frequent type was shirt

6. I eliminated the data points which were containing NULL value for Price and color and the no of data points got reduced to 28K
7. I removed data points where the item was same and the differnce was just because of size or color
8. I removed the data points where the titles differ only in the last few words.
9. In the previous step, I sorted whole data in alphabetical order of titles.Then, I removed titles which are adjacent and very similar title But there are some products whose titles are not adjacent but very similar, so in this step I removed those data points
10. I did some text preprocessing of text title and removed the stop words from them
11. I did text based product similarity using Bag of Words on the title data
12. Then I did text based product similarity using TF-IDF on the title data
13. Then I did text based product similarity using IDF on the title data
14. Then I did text based product similarity using Average Word2VEc on the title data
15. Then I did text based product similarity using IDF weighted Word2Vec on the title data
16. Then I did weighted Brand and Color based product similarity
17. Then I did visual features based product similarity
18. Then I combine all the above and did weighted Brand , Color, Text and Image based product similarity
19. To find the product similarity in all the above I was using Euclidean distance from the Input Data or Query Data
20. I used the function Pairwise_distances to compute the Euclidean distance