Amazon Apparel Recommendations

Assignment 24

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[4.2] Data and Code:

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

[4.3] Overview of the data

In [59]:
```
#!pip install beautifulsoup4
```

In [2]:
```
#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 [0]:
```
# 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 [0]:
```
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 [0]:
```
# each product/item has 19 features in the raw dataset.
data.columns # prints column-names or feature-names.
```

Out[35]:
```
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 [0]:
```
data = data[['asin', 'brand', 'color', 'medium_image_url', 'product_type_name', '
```

In [0]:
```
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[37]:

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

[5.1] Missing data for various features.

Basic stats for the feature: product_type_name

In [0]:
```
# 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 [0]:
```
# 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 [0]:
```
# find the 10 most frequent product_type_names.
product_type_count = Counter(list(data['product_type_name']))
product_type_count.most_common(10)
```

Out[40]:
```
[('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 [0]:
```
# there are 10577 unique brands
print(data['brand'].describe())

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

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

In [0]:
```
brand_count = Counter(list(data['brand']))
brand_count.most_common(10)
```

Out[42]:
```
[('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 [0]:
```
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 [0]:
```
color_count = Counter(list(data['color']))
color_count.most_common(10)
```

Out[44]:
```
[(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 [0]:
```
print(data['formatted_price'].describe())

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

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

In [0]:
```
price_count = Counter(list(data['formatted_price']))
price_count.most_common(10)
```

Out[46]:
```
[(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 [0]:
```
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 [0]:
```
# 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 [0]:
```
# consider products which have color information
# data['color'].isnull() => gives the information about the dataframe row's which
data =data.loc[~data['color'].isnull()]
print('Number of data points After eliminating color=NULL :', data.shape[0])
```

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

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

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

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

In [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[52]:
```
"\nfrom PIL import Image\nimport requests\nfrom io import BytesIO\n\nfor index,
row in images.iterrows():\n        url = row['large_image_url']\n        respon
se = 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 [0]:
```
# 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 [0]:
```
# read data from pickle file from previous stage
data = pd.read_pickle('pickels/28k_apparel_data')
```

In [0]:
```
data.head()
```

Out[103]:

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

In [0]:
```
# 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 [0]:
```
# Sort the whole data based on title (alphabetical order of title)
data_sorted.sort_values('title',inplace=True, ascending=False)
data_sorted.head()
```

Out[105]:

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

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

```
Titles 1:
16. woman's place is in the house and the senate shirts for Womens XXL W
hite
17. woman's place is in the house and the senate shirts for Womens M Gre
y

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 An
imal Print Head Shirt for woman Neon Wolf t-shirt
62. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow An
imal Print Head Shirt for woman Neon Wolf t-shirt
63. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow An
imal Print Head Shirt for woman Neon Wolf t-shirt
64. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow An
imal Print Head Shirt for woman Neon Wolf t-shirt
```

In [0]:
```
indices = []
for i,row in data_sorted.iterrows():
    indices.append(i)
```

In [0]:
```
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', 'Qu
    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',
        b = data['title'].loc[indices[j]].split()

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

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

        # itertools.zip_longest(a,b): will map the corresponding words in both st
        # example: a =['a', 'b', 'c', 'd']
        # b = ['a', 'b', 'd']
        # itertools.zip_longest(a,b): will give [('a','a'), ('b','b'), ('c','d'),
        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 co
        # if the number of words in which both strings differ are < 2 , we are co
        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
            stage1_dedupe_asins.append(data_sorted['asin'].loc[indices[i]])


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

In [0]:
```
data = data.loc[data['asin'].isin(stage1_dedupe_asins)]
```

We removed the dupliactes which differ only at the end.

In [0]:
```
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 tit
les.Then, we removed titles which are adjacent and very similar title

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

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 B
lue XXL

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

In [4]:
```
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', 'Qu
    for j in indices:

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

        length = max(len(a),len(b))

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

        # itertools.zip_longest(a,b): will map the corresponding words in both st
        # example: a =['a', 'b', 'c', 'd']
        # b = ['a', 'b', 'd']
        # itertools.zip_longest(a,b): will give [('a','a'), ('b','b'), ('c','d'),
        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 co
        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 [5]:
```
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 [6]:
```
# 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: {'of', 'weren', 'into', 'o', 'wouldn', 'd', 'all', 'what',
'ma', 'that', 'now', "couldn't", 'your', 'his', 'will', 'having', 'is', "have
n't", 'should', 'we', 'with', 'am', 'until', "won't", 'himself', 'on', 'out',
'hadn', "doesn't", 'while', 'yours', 'themselves', 'here', 'both', 's', "might
n't", 'above', 'how', 'can', 'about', 'ours', 'again', 'when', 'had', 'where',
'and', 'against', "should've", 'over', 'under', 'other', "shan't", 'shouldn',
'itself', 'wasn', 'at', 'so', 'just', 'in', 'because', 'didn', 'most', 'these',
'don', 'very', 'which', "aren't", 'not', 'shan', 'then', 'being', "hadn't", 'yo
urselves', 'she', 'but', 'each', 'its', 'aren', 'such', 'the', 'a', 'only', "wo
uldn't", 'them', 'myself', "mustn't", 'll', 'hasn', 'below', 'mightn', 'for',
'ain', 've', 'than', 'they', "you'll", 'same', 'be', 'those', 'did', 't', 'wo
n', 'him', 'ourselves', "needn't", 'doing', 'nor', 'herself', 'before', 'from',
'it', 'isn', 'or', 'y', 'own', 'off', 'between', 'there', 'this', 'needn', 'fur
ther', "weren't", "it's", "you'd", 'yourself', 'me', 'through', 'were', 'some',
'if', 'up', 'couldn', 'my', 'has', 'any', "hasn't", 'theirs', 'by', "you're",
'down', 'too', 'who', 'our', 'their', 'whom', 'hers', "wasn't", 'an', 'been',
"she's", 'as', 'was', 'during', 'doesn', 'have', 'once', "shouldn't", "didn't",
'no', 'haven', 'more', "you've", 'after', 'he', 'are', 'why', 'few', "isn't",
'does', 'to', 'mustn', 'her', 'i', "don't", 're', 'you', 'do', 'm', "that'll"}
```

In [7]:
```
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")
```

```
10.459394 seconds
```

In [8]:
```
data.head()
```

Out[8]:

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

In [9]:
```
data.to_pickle('pickels/16k_apperal_data_preprocessed')
```

Stemming

In [10]:
```
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 [3]:
```
data = pd.read_pickle('pickels/16k_apperal_data_preprocessed')
data.head()
```

Out[3]:

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

In [12]:
```
# 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 o
        # labels: len(labels) == len(keys), the values of labels depends on the m
                # if model == 'bag of words': labels(i) = values(i)
                # if model == 'tfidf weighted bag of words':labels(i) = tfidf(key
                # 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 wor
        ax = plt.subplot(gs[0])
        # it displays a cell in white color if the word is intersection(lis of wo
        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-ax
        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 contribut
    intersection = set(vec1.keys()) & set(vec2.keys())

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

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

    # labels: len(labels) == len(keys), the values of labels depends on the model
        # 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
            # tfidf_title_features[doc_id, index_of_word_in_corpus] will give the
            if x in  tfidf_title_vectorizer.vocabulary_:
                labels.append(tfidf_title_features[doc_id, tfidf_title_vectorizer
            else:
                labels.append(0)
    elif model == 'idf':
        labels = []
        for x in vec2.keys():
            # idf_title_vectorizer.vocabulary_ it contains all the words in the c
            # idf_title_features[doc_id, index_of_word_in_corpus] will give the i
            if x in  idf_title_vectorizer.vocabulary_:
                labels.append(idf_title_features[doc_id, idf_title_vectorizer.voc
            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.s
    return Counter(words) # Counter counts the occurence of each word in list, it



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 [22]:
```
from sklearn.feature_extraction.text import CountVectorizer
title_vectorizer = CountVectorizer()
title_features   = title_vectorizer.fit_transform(data['title'])
title_features.get_shape() # get number of rows and columns in feature matrix.
# title_features.shape = #data_points * #words_in_corpus
# CountVectorizer().fit_transform(corpus) returns
# the a sparase matrix of dimensions #data_points * #words_in_corpus

# What is a sparse vector?

# title_features[doc_id, index_of_word_in_corpus] = number of times the word occu
```

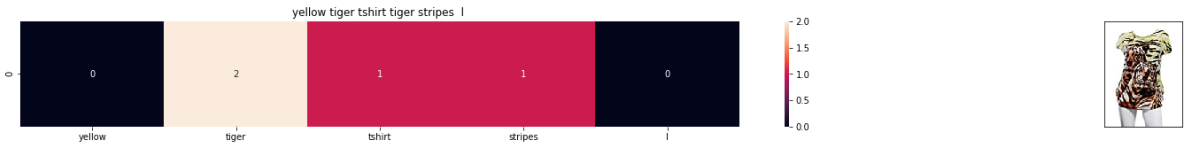
Out[22]:
```
(16042, 12609)
```

In [26]:
```
from PIL import Image
```

In [24]:
```
#import PIL.Image
```

In [27]:
```
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 remai
    # the metric we used here is cosine, the coside distance is mesured as K(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
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print ('Brand:', data['brand'].loc[df_indices[i]])
        print ('Title:', data['title'].loc[df_indices[i]])
        print ('Euclidean similarity with the query image :', pdists[i])
        print('='*60)

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

#try 12566
#try 931
```


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

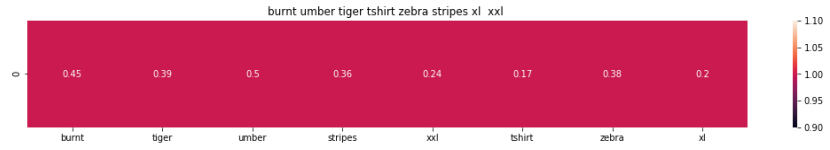



```
ASIN : B00JXQCUIC
Brand: Si Row
Title: yellow tiger tshirt tiger stripes  l
Euclidean similarity with the query image : 2.6457513110645907
============================================================
```

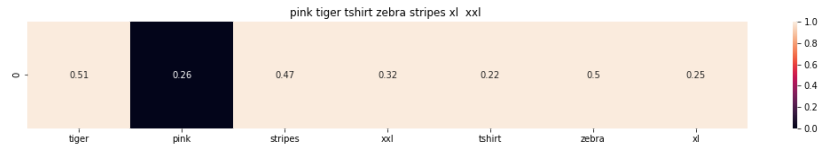
[8.5] TF-IDF based product similarity

In [28]:
```
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 dimens
# tfidf_title_features[doc_id, index_of_word_in_corpus] = tfidf values of the wor
```

In [29]:
```
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 remai
    # the metric we used here is cosine, the coside distance is mesured as K(X, Y
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(tfidf_title_features,tfidf_title_features[

    # 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'].lo
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('BRAND :',data['brand'].loc[df_indices[i]])
        print ('Eucliden distance from the given image :', pdists[i])
        print('='*125)
tfidf_model(12566, 20)
# in the output heat map each value represents the tfidf values of the label word
```



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



[8.5] IDF based product similarity

In [8]:
```
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 dimens
# idf_title_features[doc_id, index_of_word_in_corpus] = number of times the word
```

In [9]:
```
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 [10]:
```
# we need to convert the values into float
idf_title_features  = idf_title_features.astype(np.float)

for i in idf_title_vectorizer.vocabulary_.keys():
    # for every word in whole corpus we will find its idf value
    idf_val = idf(i)

    # to calculate idf_title_features we need to replace the count values with th
    # idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()[0] wil
    for j in idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()

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

In [13]:
```
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 remai
    # the metric we used here is cosine, the coside distance is mesured as K(X, Y
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(idf_title_features,idf_title_features[doc_

    # 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
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('Brand :',data['brand'].loc[df_indices[i]])
        print ('euclidean distance from the given image :', pdists[i])
        print('='*125)



idf_model(12566,20)
# in the output heat map each value represents the idf values of the label word,
```

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

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

[9] Text Semantics based product similarity

In [14]:
```
# credits: https://www.kaggle.com/c/word2vec-nlp-tutorial#part-2-word-vectors
# Custom Word2Vec using your own text data.
# Do NOT RUN this code.
# It is meant as a reference to build your own Word2Vec when you have
# lots of data.

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

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

'''
```

Out[14]:
```
'\n# Set values for various parameters\nnum_features = 300    # Word vector dim
ensionality                      \nmin_word_count = 1    # Minimum word count
\nnum_workers = 4       # Number of threads to run in parallel\ncontext = 10
# Context window size
\ndownsampling = 1e-3   # Downsample setting for frequent words\n\n# Initialize
and train the model (this will take some time)\nfrom gensim.models import word2
vec\nprint ("Training model...")\nmodel = word2vec.Word2Vec(sen_corpus, workers
=num_workers,            size=num_features, min_count = min_word_count,
window = context)\n    \n'
```

In [15]:
```
#!pip install gensim
```

In [16]:
```
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', b
'''

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

In [17]:
```
# Utility functions

def get_word_vec(sentence, doc_id, m_name):
    # sentence : title of the apparel
    # doc_id: document id in our corpus
    # m_name: model information it will take two values
        # if  m_name == 'avg', we will append the model[i], w2v representation of
        # if m_name == 'weighted', we will multiply each w2v[word] with the idf(w
    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.vocabu
            elif m_name == 'avg':
                vec.append(model[i])
        else:
            # if the word in our courpus is not there in the google word2vec corp
            vec.append(np.zeros(shape=(300,)))
    # we will return a numpy array of shape (#number of words in title * 300 ) 30
    # each row represents the word2vec representation of each word (weighted/avg)
    return  np.array(vec)

def get_distance(vec1, vec2):
    # vec1 = np.array(#number_of_words_title1 * 300), each row is a vector of ler
    # vec2 = np.array(#number_of_words_title2 * 300), each row is a vector of ler

    final_dist = []
    # for each vector in vec1 we caluclate the distance(euclidean) to all vectors
    for i in vec1:
        dist = []
        for j in vec2:
            # np.linalg.norm(i-j) will result the euclidean distance between vect
            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 titl
    # 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(weigh
    s1_vec = get_word_vec(sentence1, doc_id1, model)
    #s2_vec = np.array(#number_of_words_title1 * 300), each row is a vector(weigh
    s2_vec = get_word_vec(sentence2, doc_id2, model)

    # s1_s2_dist = np.array(#number of words in title1 * #number of words in titl
    # 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 display
    gs = gridspec.GridSpec(2, 2, width_ratios=[4,1],height_ratios=[2,1])
    fig = plt.figure(figsize=(15,15))

    ax = plt.subplot(gs[0])
    # ploting the heap map based on the pairwise distances
    ax = sns.heatmap(np.round(s1_s2_dist,4), annot=True)
    # set the x axis labels as recommended apparels title
    ax.set_xticklabels(sentence2.split())
    # set the y axis labels as input apparels title
    ax.set_yticklabels(sentence1.split())
    # set title as recommended apparels title
    ax.set_title(sentence2)

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

    plt.show()
```

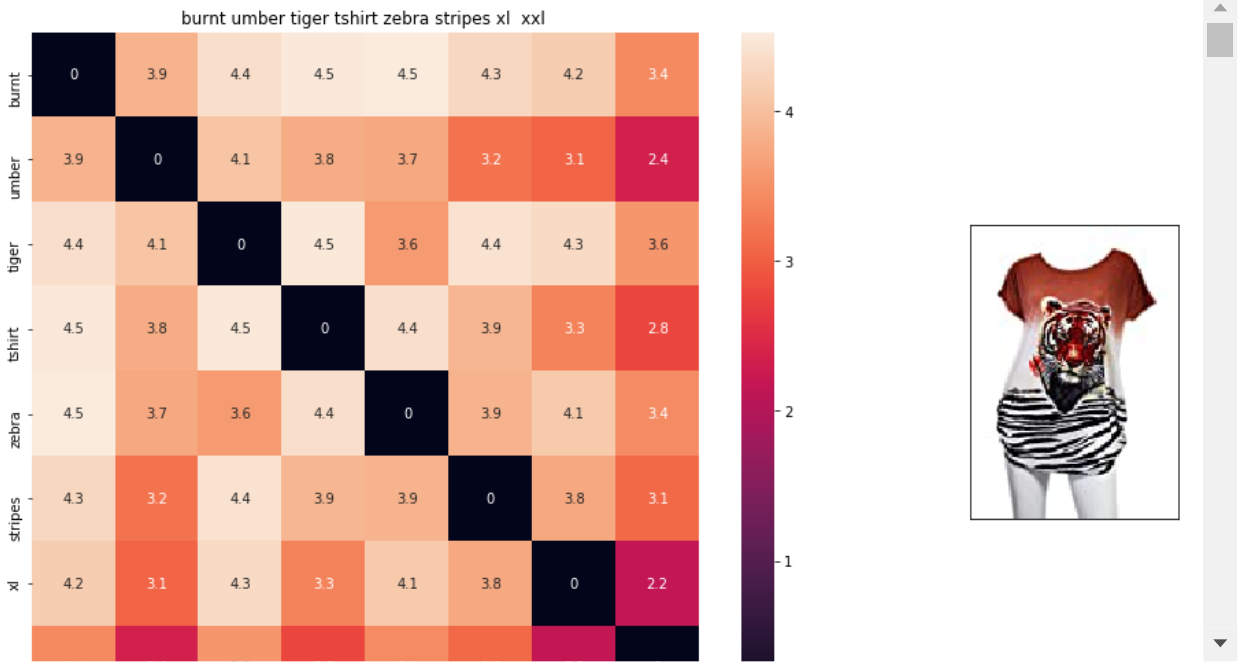
In [18]:

```
# 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 g
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
        # if m_name == 'weighted', we will multiply each w2v[word] with the idf(w

    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_ti
            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 [19]:
```
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
w2v_title = np.array(w2v_title)
```

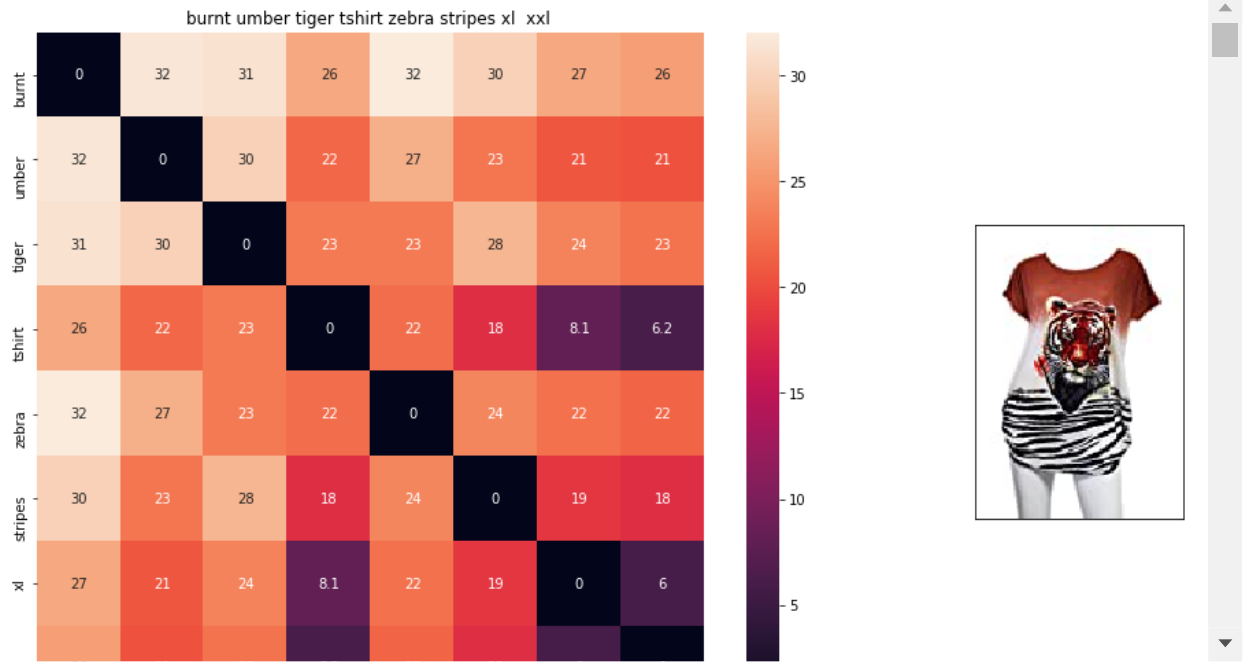
In [20]:
```
def avg_w2v_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

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

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

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

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


avg_w2v_model(12566, 20)
# in the give heat map, each cell contains the euclidean distance between words i
```



[9.4] IDF weighted Word2Vec for product similarity

In [21]:
```
doc_id = 0
w2v_title_weight = []
# for every title we build a weighted vector representation
for i in data['title']:
    w2v_title_weight.append(build_avg_vec(i, 300, doc_id,'weighted'))
    doc_id += 1
# w2v_title = np.array(# number of doc in courpus * 300), each row corresponds to
w2v_title_weight = np.array(w2v_title_weight)
```

In [22]:
```
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 remai
    # the metric we used here is cosine, the coside distance is mesured as K(X, Y
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(w2v_title_weight, w2v_title_weight[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)):
        heat_map_w2v(data['title'].loc[df_indices[0]],data['title'].loc[df_indice
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('Brand :',data['brand'].loc[df_indices[i]])
        print('euclidean distance from input :', pdists[i])
        print('='*125)

weighted_w2v_model(12566, 20)
#931
#12566
# in the give heat map, each cell contains the euclidean distance between words i
```



[9.6] Weighted similarity using brand and color.

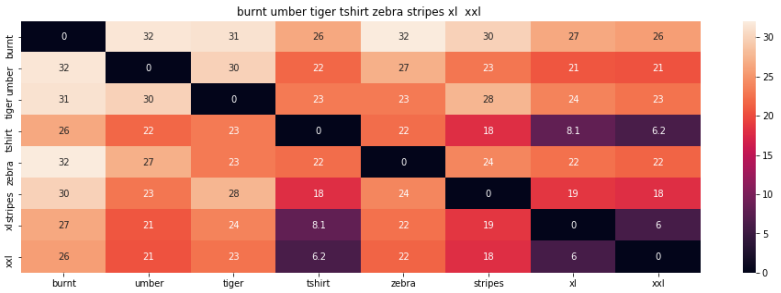
In [23]:
```
# some of the brand values are empty.
# Need to replace Null with string "NULL"
data['brand'].fillna(value="Not given", inplace=True )

# 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 [24]:
```
def heat_map_w2v_brand(sentance1, sentance2, url, doc_id1, doc_id2, df_id1, df_id

    # 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(weigh
    s1_vec = get_word_vec(sentance1, doc_id1, model)
    #s2_vec = np.array(#number_of_words_title2 * 300), each row is a vector(weigh
    s2_vec = get_word_vec(sentance2, doc_id2, model)

    # s1_s2_dist = np.array(#number of words in title1 * #number of words in titl
    # 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[
                   [data['asin'].loc[df_id2],brands[doc_id2], colors[doc_id2], types[

    colorscale = [[0, '#1d004d'],[.5, '#f2e5ff'],[1, '#f2e5d1']] # to color the h

    # 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()
```

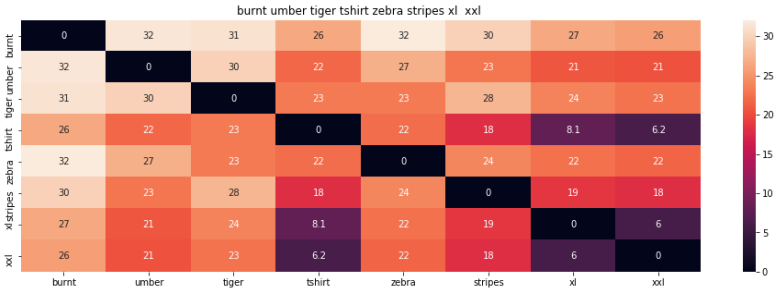
In [25]:
```
def idf_w2v_brand(doc_id, w1, w2, num_results):
    # doc_id: apparel's id in given corpus
    # w1: weight for  w2v features
    # w2: weight for brand and color features

    # pairwise_dist will store the distance from given input apparel to all remai
    # the metric we used here is cosine, the coside distance is mesured as K(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]
    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_
        print('ASIN :',data['asin'].loc[df_indices[i]])
        print('Brand :',data['brand'].loc[df_indices[i]])
        print('euclidean distance from input :', pdists[i])
        print('='*125)

idf_w2v_brand(12566, 5, 5, 20)
# in the give heat map, each cell contains the euclidean distance between words i
```

Asin	Brand	Color	P
B00JXQB5FQ	Si-Row	Brown	T



In [26]:
```
# brand and color weight =50
# title vector weight = 5

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

Asin	Brand	Color	P
B00JXQB5FQ	Si-Row	Brown	T



ASIN : B00JXQB5FQ

[10.2] Keras and Tensorflow to extract features

In [29]:
```
#!pip install Keras
```

In [30]:
```
#!pip install tensorflow
```

In [31]:
```
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 [32]:
```
# https://gist.github.com/fchollet/f35fbc80e066a49d65f1688a7e99f069
# Code reference: https://blog.keras.io/building-powerful-image-classification-mo



# 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 outp

# 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_sampl
    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))


save_bottlebeck_features()
```

```
'''
```

Out[32]:
```
"\n# dimensions of our images.\nimg_width, img_height = 224, 224\n\ntop_model_w
eights_path = 'bottleneck_fc_model.h5'\ntrain_data_dir = 'images2/'\nnb_train_s
amples = 16042\nepochs = 50\nbatch_size = 1\n\n\ndef save_bottlebeck_features
():\n    \n    #Function to compute VGG-16 CNN for image feature extraction.\n
\n    asins = []\n    datagen = ImageDataGenerator(rescale=1. / 255)\n    \n
# build the VGG16 network\n    model = applications.VGG16(include_top=False, we
ights='imagenet')\n    generator = datagen.flow_from_directory(\n        train_
data_dir,\n        target_size=(img_width, img_height),\n        batch_size=bat
ch_size,\n        class_mode=None,\n        shuffle=False)\n\n    for i in gene
rator.filenames:\n        asins.append(i[2:-5])\n\n    bottleneck_features_trai
n = model.predict_generator(generator, nb_train_samples // batch_size)\n    bot
tleneck_features_train = bottleneck_features_train.reshape((16042,25088))\n
\n    np.save(open('16k_data_cnn_features.npy', 'wb'), bottleneck_features_trai
n)\n    np.save(open('16k_data_cnn_feature_asins.npy', 'wb'), np.array(asins))
\n    \n\nsave_bottlebeck_features()\n\n"
```

[10.3] Visual features based product similarity.

In [33]:
```
#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(

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

get_similar_products_cnn(12566, 20)
```

```
Product Title:  burnt umber tiger tshirt zebra stripes xl  xxl
Euclidean Distance from input image: 0.044194173
Amazon Url: www.amzon.com/dp/B00JXQB5FQ
```

In [ ]:

In [ ]:

In [ ]:

In [ ]:

ASSIGNMENT APPAREL RECOMMENDATION

1: Text(IDF W2V),Brand(one hot),Color(one hot),Image(VGG16_CNN) & Different Weights are Given

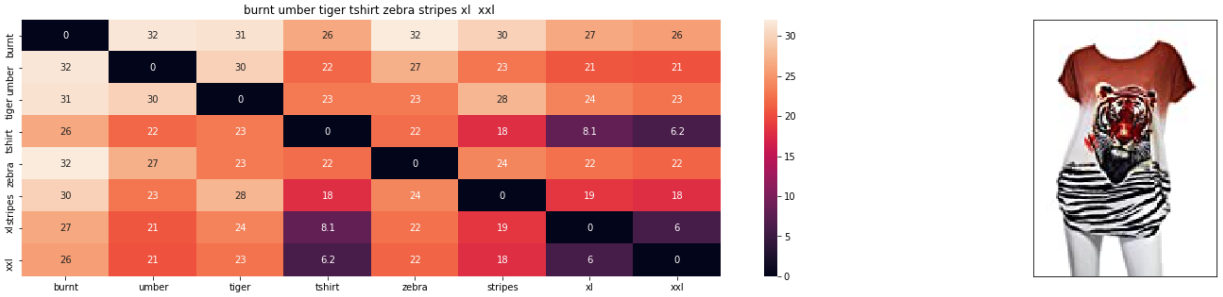
In [38]:
```
from PIL import Image
```

In [50]:
```
def idf_w2v_brand_color_image(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
    # W3: Weight color features
    # W4: weight VGG16 (cnn) IMAGE FEATURE

    # pairwise_dist will store the distance from given input apparel to all remai
    # the metric we used here is cosine, the coside distance is mesured as K(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]

    brand_features_dist=pairwise_distances(brand_features, brand_features[doc_id]

    color_features_dist=pairwise_distances(color_features, color_features[doc_id]
    #ex_feat_dist = pairwise_distances(extra_features, extra_features[doc_id])
    cnn_image_feature_dist= pairwise_distances(bottleneck_features_train, bottler

    pairwise_dist   = (w1 * idf_w2v_dist +  w2 * brand_features_dist + w3 * color
                       w4 * cnn_image_feature_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(len(indices)):
        rows = data[['medium_image_url','title']].loc[data['asin']==asins[indices
        heat_map_w2v_brand(data['title'].loc[df_indices[0]],data['title'].loc[df_
                           data['medium_image_url'].loc[df_indices[i]],
                           indices[0], indices[i],df_indices[0], df_indices[i],
                           'weighted')
        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]])


    #for i in range(0, len(indices)):

     #   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)
```

1.1 QUERY DOCID=12566 W1(TITLE)=1, W2(BRAND)=2, W3(COLOR)=300,W4(CNN_IMAGE)=1

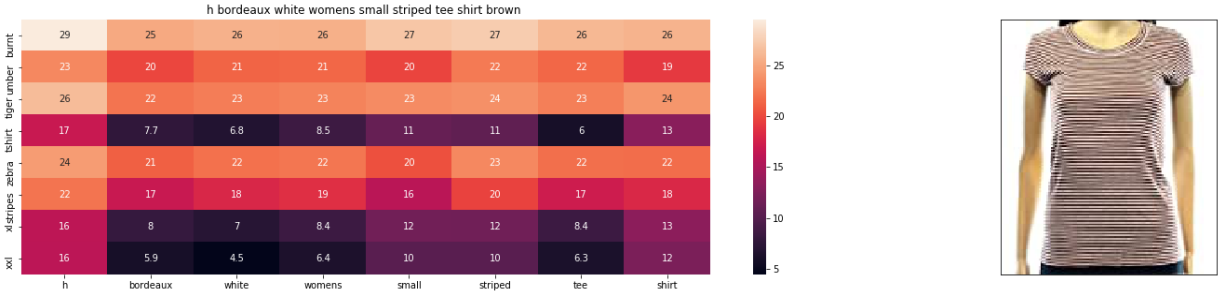
In [55]:
```
idf_w2v_brand_color_image(12566, 1, 2, 300, 1, 20)
# in the give heat map, each cell contains the euclidean distance between words i
```

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



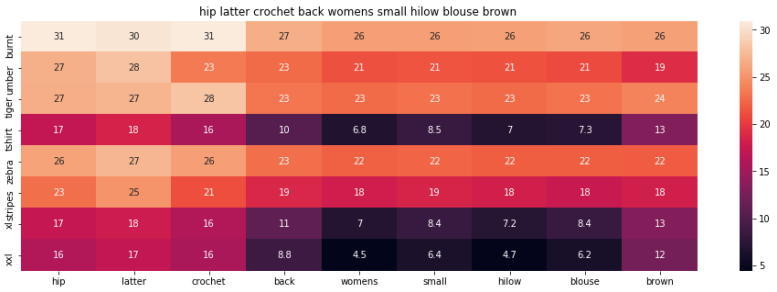
Product Title: foxcroft nyc womens pinpoint oxford shirt noniron stretch popli
n blouse xlarge white
Euclidean Distance from input image: 1.2849506578947368e-05
Amazon Url: www.amzon.com/dp/B072277HVB

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



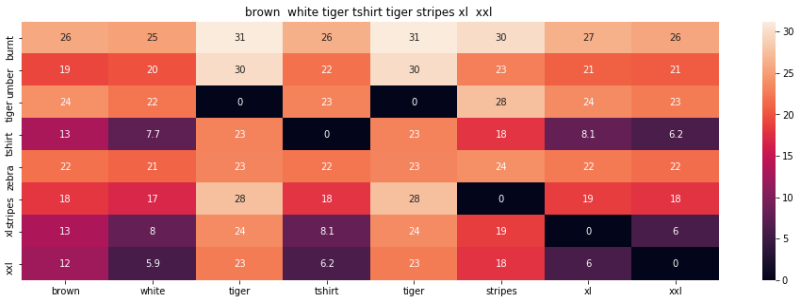
Product Title: shop flash slimming body shaping pro performance muscle womens
tank top white xxlarge
Euclidean Distance from input image: 0.1869291929822219
Amazon Url: www.amzon.com/dp/B00TO30Z2W

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



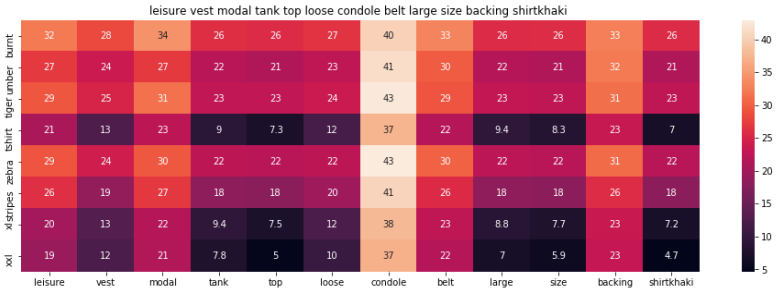
Product Title: felina lingerie cotton stretch camisole w hint modal assorted c
olors medium mint green
Euclidean Distance from input image: 0.18851820988151488
Amazon Url: www.amzon.com/dp/B0716PDM8C

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



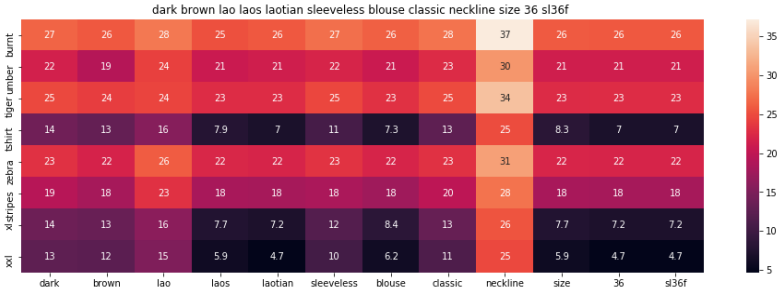
Product Title: exotic india yellow gray jamawar wrap fauxfur collar
Euclidean Distance from input image: 0.19841724791024862
Amazon Url: www.amzon.com/dp/B073ZHRBV8

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



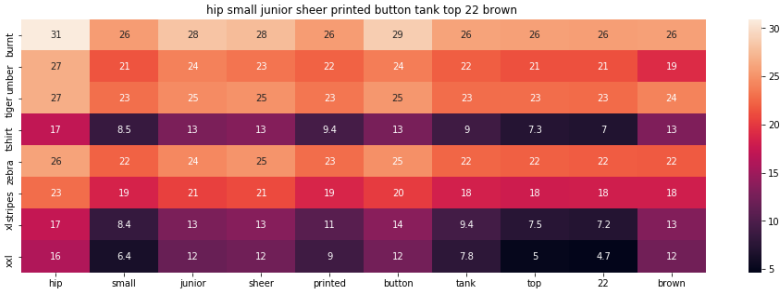
Product Title: boden womens stitched craft top us sz 4 pearl
Euclidean Distance from input image: 0.19851583869833694
Amazon Url: www.amzon.com/dp/B01JN90OMW

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



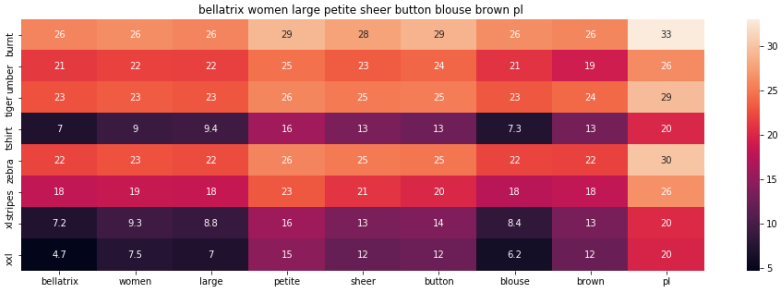
Product Title: drew womens tweed knit audie top sz ivorygrey 230135f
Euclidean Distance from input image: 0.202492567473947
Amazon Url: www.amzon.com/dp/B01ETLYQ6E

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



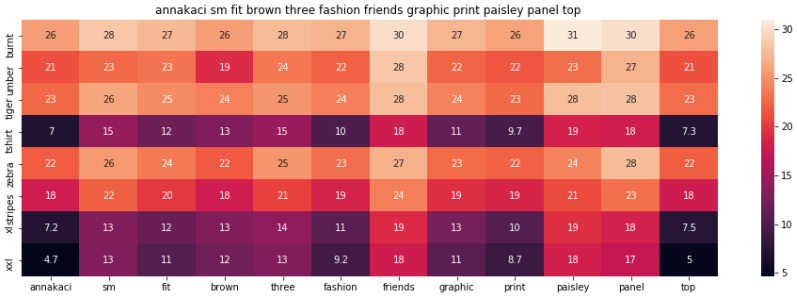
Product Title: janette plus women knit top short sleeves collared neck yellow plaid size 1xl
Euclidean Distance from input image: 0.2035232180519941
Amazon Url: www.amzon.com/dp/B0756RB1JC

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



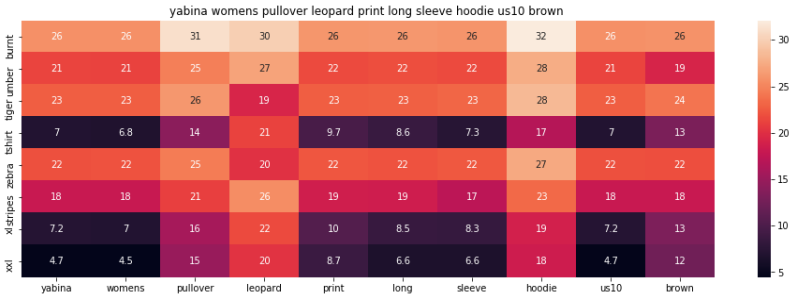
Product Title: black casual hollow sleeveless lace blouse bky8054
Euclidean Distance from input image: 0.20415630721793263
Amazon Url: www.amzon.com/dp/B00UP2467G

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



Product Title: ladies sleeve hooded slub tee white 2xl
Euclidean Distance from input image: 0.2041717406950499
Amazon Url: www.amzon.com/dp/B00CO8F6XW

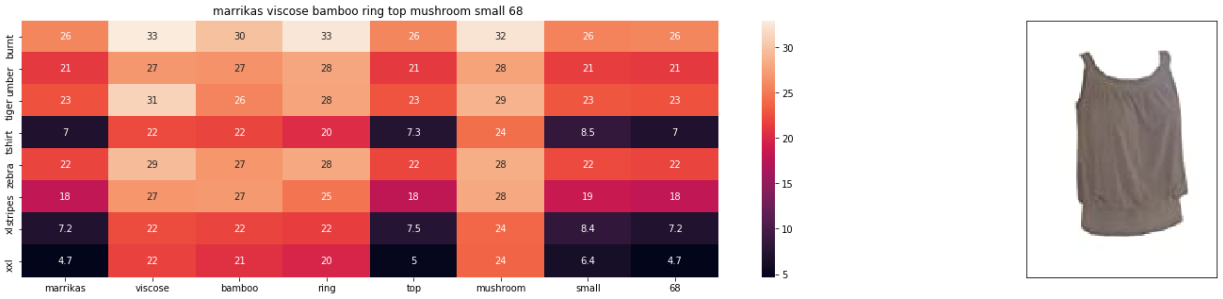
Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



Product Title: ana shortsleeve boyfriend tee plus size 2 extra large color white

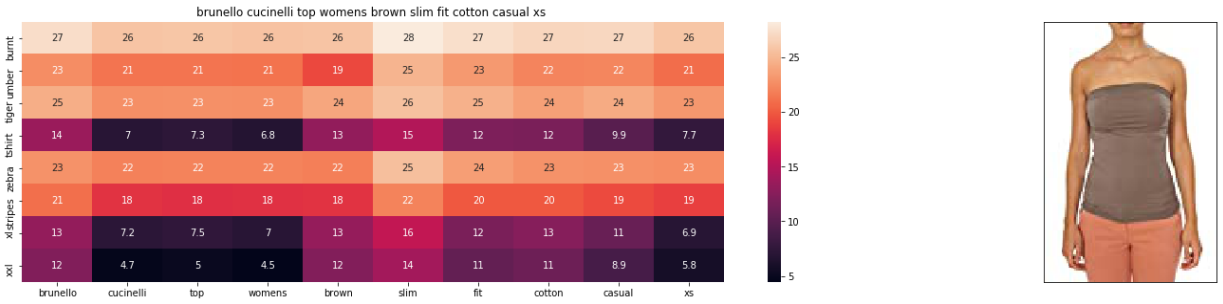
Euclidean Distance from input image: 0.20477606690304745
Amazon Url: www.amzon.com/dp/B01MSN4CTE

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



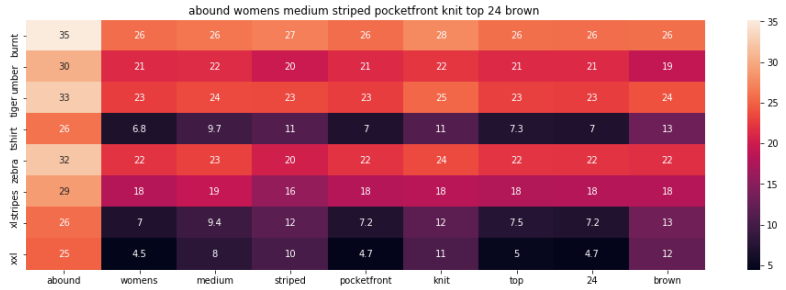
Product Title: baishitop hollow crochet loose cover blouse tops shirt bikini swimwear women
Euclidean Distance from input image: 0.20523814093186568
Amazon Url: www.amzon.com/dp/B01G89AKD8

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



Product Title: st john liquid satin tank top small
Euclidean Distance from input image: 0.20532586072620593
Amazon Url: www.amzon.com/dp/B07237HGYL

Asin	Brand	Color	Pr
B00JXQB5FQ	Si-Row	Brown	TC



Product Title: chfashion womens button back stand collar spots chiffon blouse white xlarge
Euclidean Distance from input image: 0.2063096128488675
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Asin	Brand	Color	Pr
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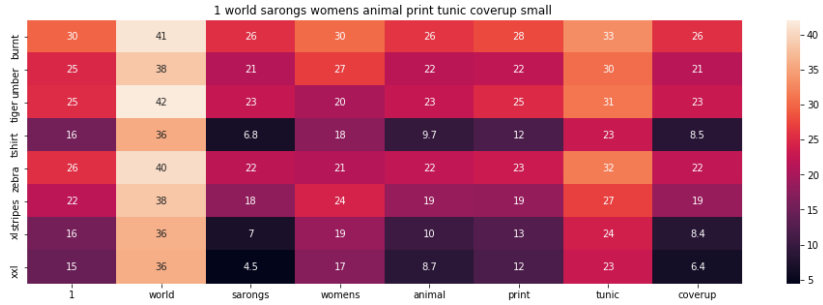

Product Title: devon jones ladies crown collection whtgrphlt grph xxxlarge
Euclidean Distance from input image: 0.20663816050479286
Amazon Url: www.amzon.com/dp/B01GGAEPRG

Asin	Brand	Color	Pr
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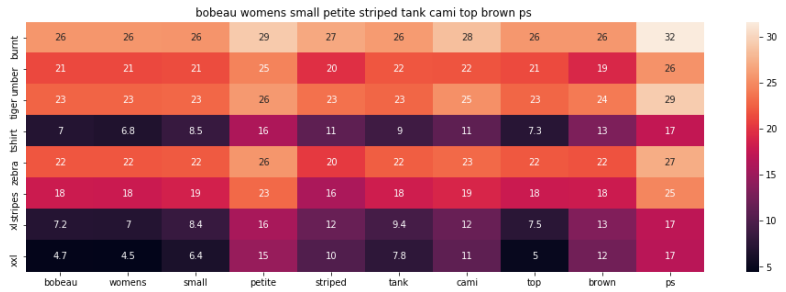

Product Title: dkny womens small highsplithem button shirt white
Euclidean Distance from input image: 0.20697465637857876
Amazon Url: www.amzon.com/dp/B073V3QWD5

Asin	Brand	Color	Pr
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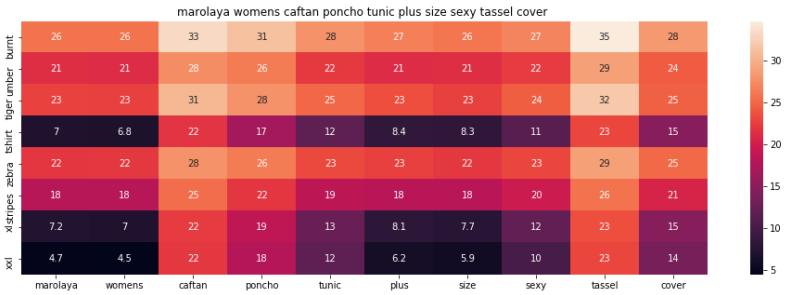

Product Title: azkara womens fashion tshirt casual vneck cross front tops uniq
ue tees shirts white large
Euclidean Distance from input image: 0.2077658296108079
Amazon Url: www.amzon.com/dp/B06WW8FVN9

Asin	Brand	Color	Pr
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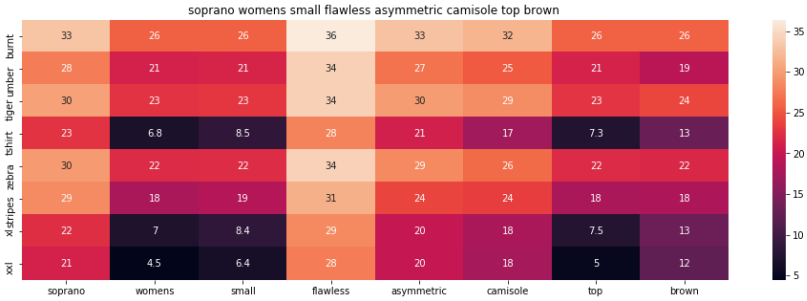

Product Title: official tangerinetane infinities art small white tshirt women
Euclidean Distance from input image: 0.20859892373083352
Amazon Url: www.amzon.com/dp/B06XPH6KS6

Asin	Brand	Color	Pr
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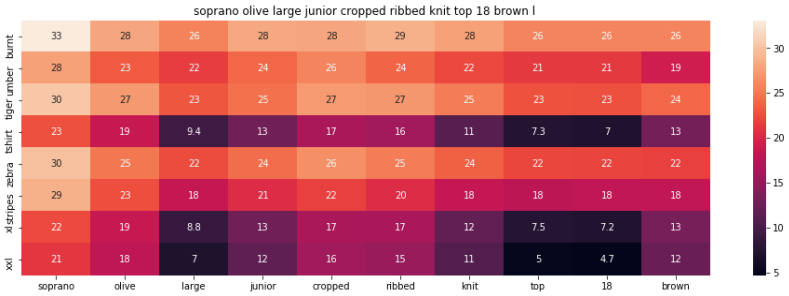

Product Title: roberta roller rabbit womens floral print wide sleeve tunic xsm all white multi
Euclidean Distance from input image: 0.2088030257199773
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Asin	Brand	Color	Pr
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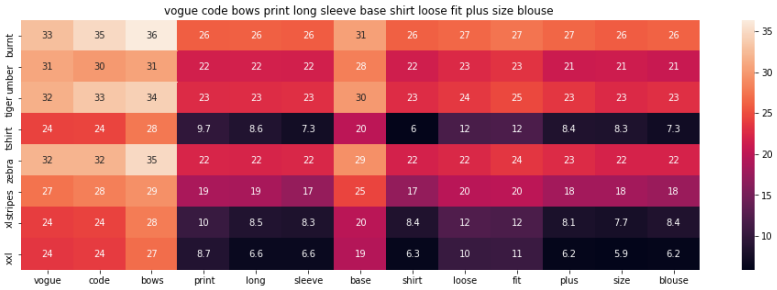

Product Title: generation love womens mona leopard print lace back top black small
Euclidean Distance from input image: 0.20933042388213308
Amazon Url: www.amzon.com/dp/B075BDRD7R

Asin	Brand	Color	Pr
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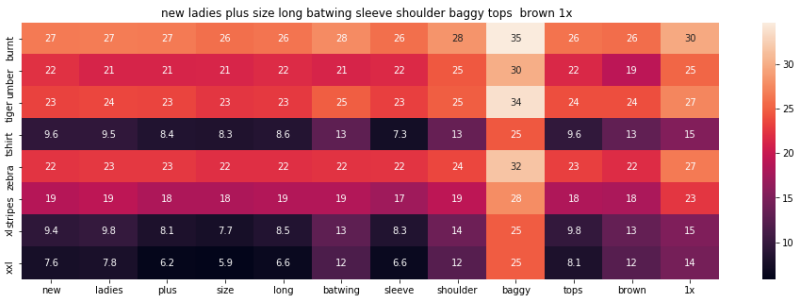

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Product Title:  san soleil jade cooling long sleeve mock neck upf 50 polo golf
shirtme
Euclidean Distance from input image: 0.20969239191005104
Amazon Url: www.amzon.com/dp/B06XKM62R1
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1.2 QUERY DOCID=1000, W1(TITLE)=10, W2(BRAND)=5, W3(COLOR)=5, W4(CNN_IMAGE)=5

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# in the give heat map, each cell contains the euclidean distance between words i
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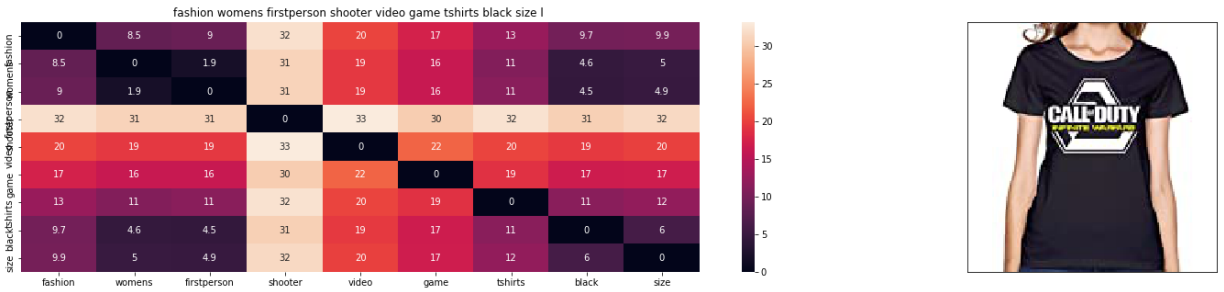
Asin	Brand	Color	Pr
B01INF7UVA	Aip-Yep-Novelty-Fashion	Black	BC



Product Title: lush tie dye denim sleeveless collared top shoulder collar tip spikes
Euclidean Distance from input image: 0.00078125
Amazon Url: www.amzon.com/dp/B00FH9CBE2

Asin	Brand	Color	Pr
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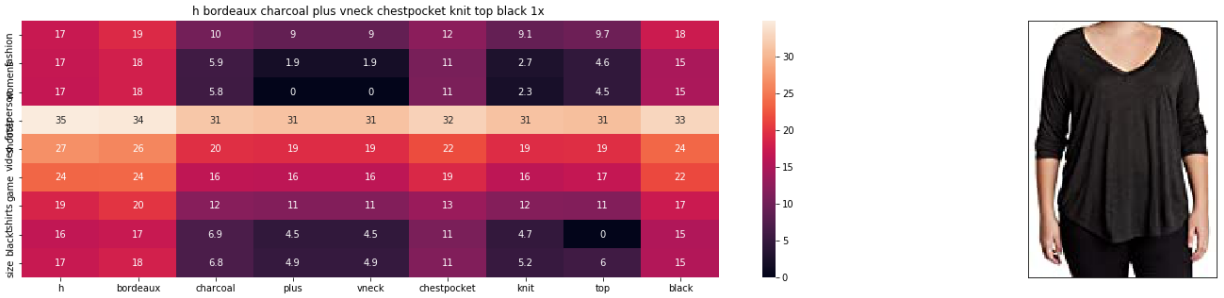

Product Title: blansdi womens ladies chiffon loose casual sleeveless vest shir t tops blouse blacks
Euclidean Distance from input image: 10.304610778146479
Amazon Url: www.amzon.com/dp/B01B3Y99XA

Asin	Brand	Color	Pr
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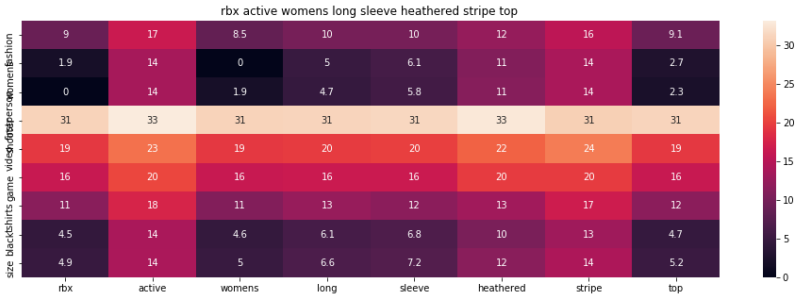

Product Title: max mara womens zigrino curved hem tshirt sz xlarge beige metal lic
Euclidean Distance from input image: 10.406092227091754
Amazon Url: www.amzon.com/dp/B0749S4BCF

Asin	Brand	Color	Pr
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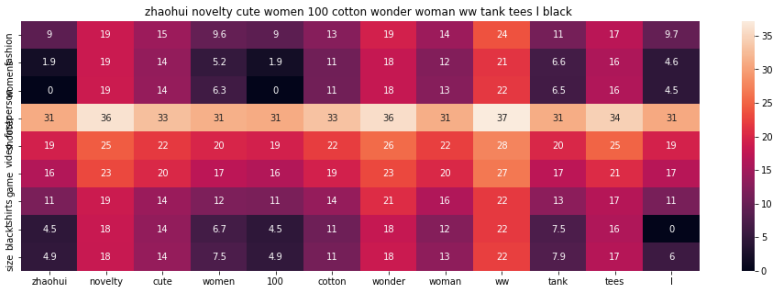

Product Title: harper liv womens plus size sleeveless printed top 2x cadet blue
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Asin	Brand	Color	Pr
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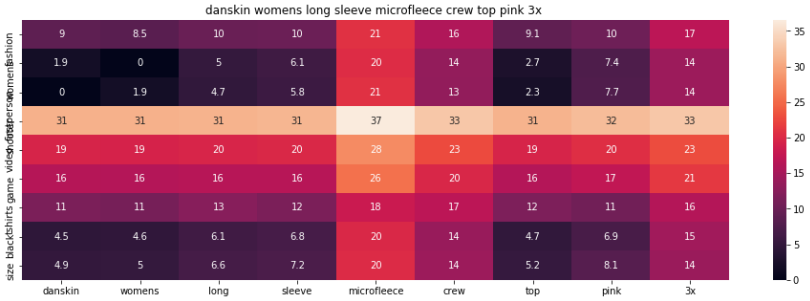

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Product Title:  inc womens plus dip dyed sleeveless faux wrap blouse 22w dip dy
e
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Asin	Brand	Color	Pr
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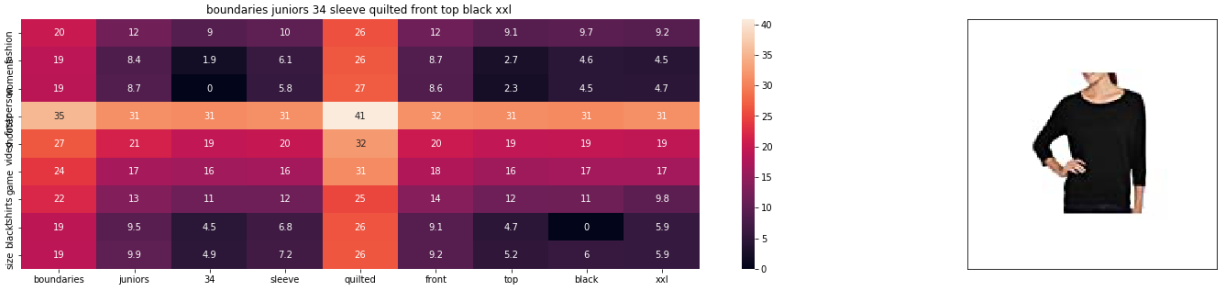


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Product Title:  j crew vneck bandsleeve shell
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Asin	Brand	Color	Pr
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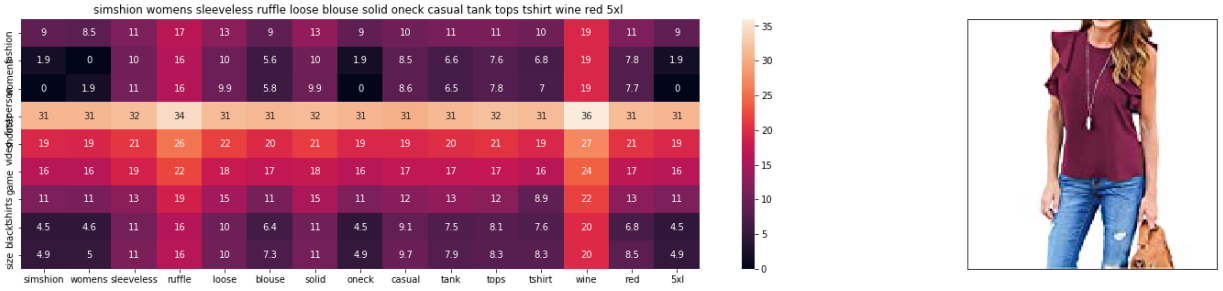


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Product Title:  mlv womens beaded v back luna tank top sz dove grey 270745dh
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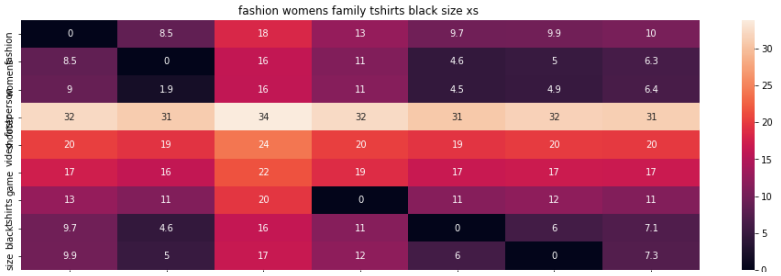

Product Title: sf tshirt drop detail heather grey xs
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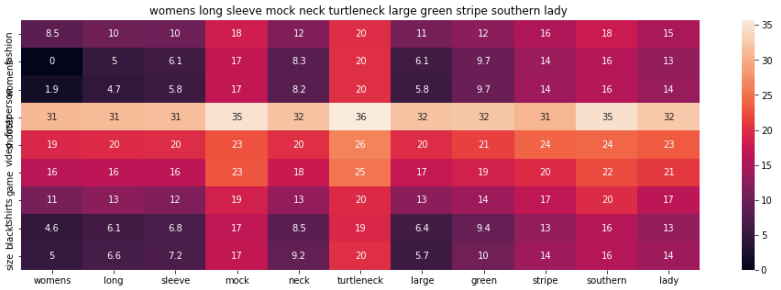

Product Title: autumnfall woman sleeveless vneck candy vest loose tank tops ts hirt
Euclidean Distance from input image: 10.69924725801963
Amazon Url: www.amzon.com/dp/B00YONC7AU

Asin	Brand	Color	Pr
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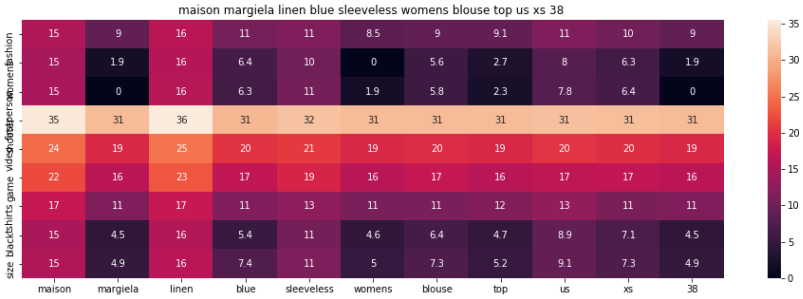

Product Title: fever womens sleeveless bright white blouse large
Euclidean Distance from input image: 10.707412902242192
Amazon Url: www.amzon.com/dp/B01M1MOBCA

Asin	Brand	Color	Pr
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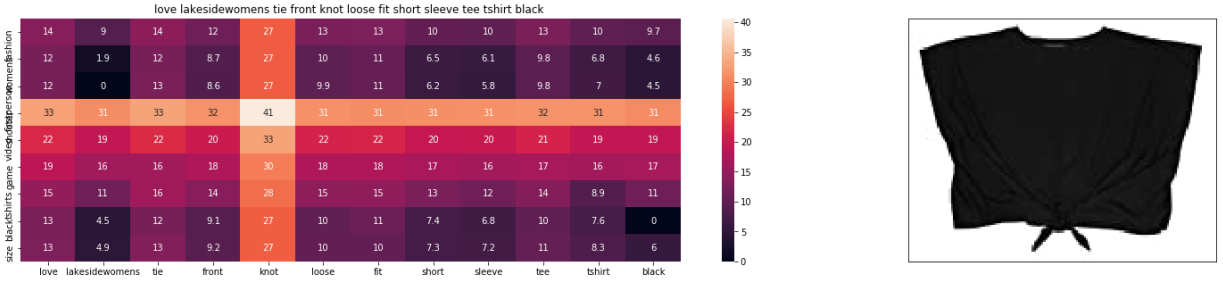

Product Title: frame navy sleeveless silk blouse
Euclidean Distance from input image: 10.709030944162105
Amazon Url: www.amzon.com/dp/B06XKYXBKP

Asin	Brand	Color	Pr
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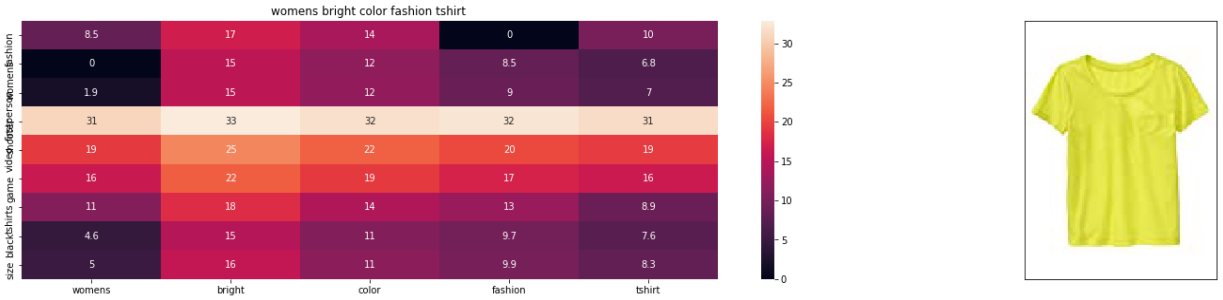
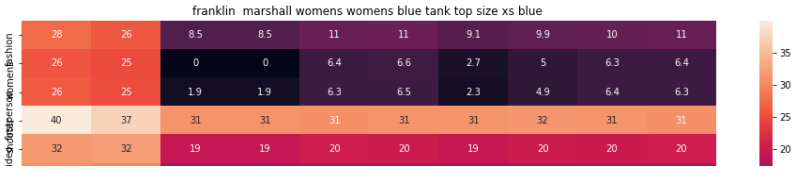


Product Title: j crew womens layered drapey silk hem tank top blouse dusty beg onia small
Euclidean Distance from input image: 10.719494174185515
Amazon Url: www.amzon.com/dp/B073VVS6DN

Asin	Brand	Color	Pr
B01INF7UVA	Aip-Yep-Novelty-Fashion	Black	BC



Product Title: society new york womens flutter sleeve lace trim blouse blackbl
ack l
Euclidean Distance from input image: 10.751124755269537
Amazon Url: www.amzon.com/dp/B014W2698I

Asin	Brand	Color	Pr
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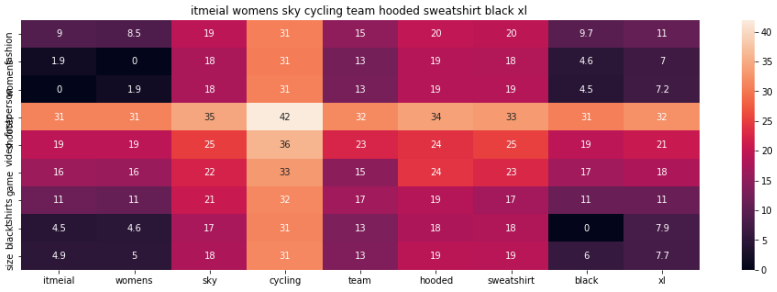
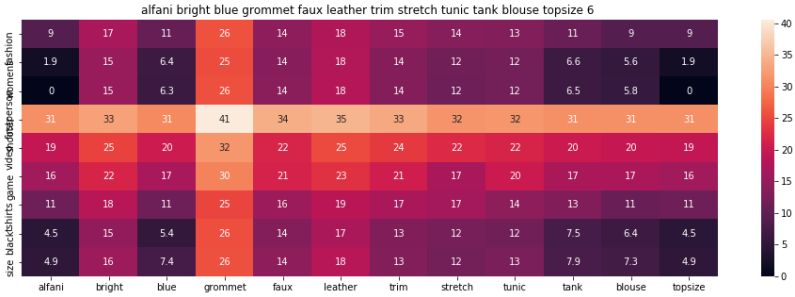


Product Title: helmut lang womens black cowl neck top p
Euclidean Distance from input image: 10.772485201945269
Amazon Url: www.amzon.com/dp/B06VVMLRGR

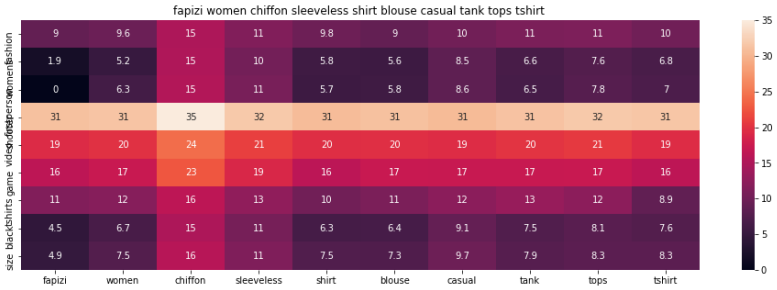
Asin	Brand	Color	Pr
B01INF7UVA	Aip-Yep-Novelty-Fashion	Black	BC



Product Title: annakaci sm fit blue denim floral pattern appliques sheer pan
el yoke blouse
Euclidean Distance from input image: 10.775239205011781
Amazon Url: www.amzon.com/dp/B00E7Z8G8M

Asin	Brand	Color	Pr

B01INF7UVA	Aip-Yep-Novelty-Fashion	Black	BC



Product Title: cauau47 womens irregular black longline paillette tshirt
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Amazon Url: www.amzon.com/dp/B01G8WU8DM

Asin	Brand	Color	Pr
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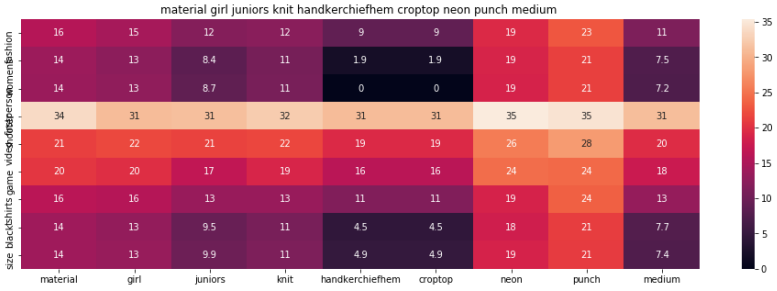

Product Title: vocal womens magenta floral lace scoopneck tank xl
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Amazon Url: www.amzon.com/dp/B06X9FPBVS

Asin	Brand	Color	Pr
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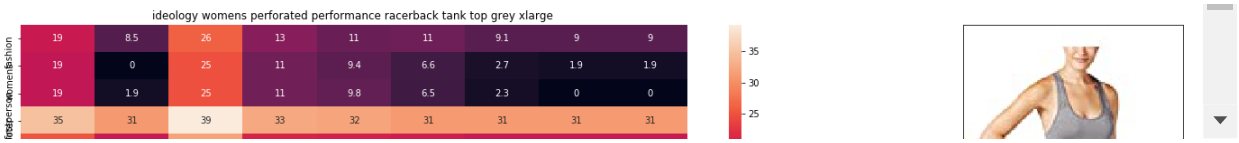

Product Title: theory womens low cut silk poplin tank blouse smoke large
Euclidean Distance from input image: 10.812771151724577
Amazon Url: www.amzon.com/dp/B01NBWNPCW

Asin	Brand	Color	Pr
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Product Title: lays sexy womens round neck racerback tank top vest casual sleeveless workout camisoleyellow
Euclidean Distance from input image: 10.832662814322234
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Asin	Brand	Color	Pr
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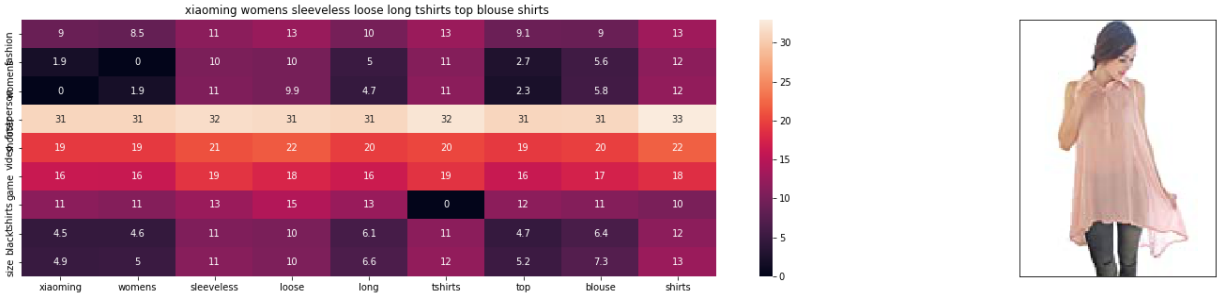

Product Title: almost famous juniors vneck capsleeve white small
Euclidean Distance from input image: 10.84001999205661
Amazon Url: www.amzon.com/dp/B071HKKXW2