Amazon Apparel Recommendations

In this project our objective is to recommend similar products/items in e-commerce website Amazon.So basically what we are doing here is contect based recommendation.

WHY IS IT IMPORTANT:-

- Around 35% of the total revenue at Amazon.com is generated using product recommendation which is close to 40 billion dollars,which is a whopping amount.That's why it becomes important to understand how will we use previous and existing data for recommneding the similar products.

[4.2] Data and Code:

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

[4.3] Overview of the data

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

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

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

In [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 w
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)

<table>
<tr><td><image src="dedupe/B00AQ4GMCK.jpeg" width="100" height="100">:B00AQ4GMCK</td><td><image src="dedupe/B00AQ4GMTS.jpeg" width="100" height="100">:B00AQ4GMT</td></tr>
<tr><td><image src="dedupe/B00AQ4GMLQ.jpeg" width="100" height="100">:B00AQ4GMLQ</td><td><image src="dedupe/B00AQ4GN3I.jpeg" width="100" height="100">:B00AQ4GN</td></tr>
</table>

These shirts exactly same except in color

<table>
<tr><td><image src="dedupe/B00G278GZ6.jpeg" width="100" height="100">:B00G278GZ6</td><td><image src="dedupe/B00G278W6O.jpeg" width="100" height="100">:B00G278W6C</td></tr>
<tr><td><image src="dedupe/B00G278Z2A.jpeg" width="100" height="100">:B00G278Z2A</td><td><image src="dedupe/B00G2786X8.jpeg" width="100" height="100">:B00G2786X8</td></tr>
</table>

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]:
```
1 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]:
```
1 # Remove All products with very few words in title
2 data_sorted = data[data['title'].apply(lambda x: len(x.split())>4)]
3 print("After removal of products with short description:", data_sorted.shape[
```

```
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	fc
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 Wh
ite
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 Ani
mal Print Head Shirt for woman Neon Wolf t-shirt
62. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow Ani
mal Print Head Shirt for woman Neon Wolf t-shirt
63. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow Ani
mal Print Head Shirt for woman Neon Wolf t-shirt
64. psychedelic colorful Howling Galaxy Wolf T-shirt/Colorful Rainbow Ani
mal Print Head Shirt for woman Neon Wolf t-shirt
```

In [0]:

```
1 indices = []
2 for i,row in data_sorted.iterrows():
3     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',
    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', 'T
        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
        count  = 0

        # itertools.zip_longest(a,b): will map the corresponding words in bot
        # example: a =['a', 'b', 'c', 'd']
        # b = ['a', 'b', 'd']
        # itertools.zip_longest(a,b): will give [('a','a'), ('b','b'), ('c','
        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 ar
        # if the number of words in which both strings differ are < 2 , we ar
        if (length - count) > 2: # number of words in which both sensences di
            # if both strings are differ by more than 2 words we include the
            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 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
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 [0]:
```
data = pd.read_pickle('pickels/17k_apperal_data')
```

one thing we must keep in mind here is that we are recommending a product of other brand and category,so color,size and price of two shirts of same

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',
    for j in indices:

        b = data['title'].loc[j].split()
        # store the list of words of jth string in b, ex: b = ['tokidoki', 'T

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

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

        # itertools.zip_longest(a,b): will map the corresponding words in bot
        # example: a =['a', 'b', 'c', 'd']
        # b = ['a', 'b', 'd']
        # itertools.zip_longest(a,b): will give [('a','a'), ('b','b'), ('c','
        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 ar
        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 [0]:
```
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 [0]:
```
# 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: {'such', 'and', 'hers', 'up', 'she', 'd', 'further', 'all',
'than', 'under', 'is', 'off', 'both', 'most', 'few', 'should', 're', 'very', 'j
ust', 'then', 'didn', 'myself', 'in', 'too', 's', 'shouldn', 'herself', 'becaus
e', 'how', 'itself', 'what', 'shan', 'weren', 'doing', 'them', 'couldn', 'thei
r', 'so', 'ain', 'haven', 'yourself', 'now', 'll', 'isn', 'about', 'over', 'int
o', 'before', 'during', 'on', 'as', 'aren', 'against', 'above', 'down', 'they',
'below', 'me', 'again', 'for', 'why', 'been', 'yourselves', 'more', 'her', 'tha
t', 'can', 'am', 'was', 'themselves', 'mightn', 'does', 'those', 'only', 'has
n', 'any', 'ma', 'are', 'nor', 'out', 'you', 'ourselves', 'the', 'an', 'has',
'where', 'i', 'while', 'ours', 'its', 'your', 'had', 'were', 'being', 'no', 'o
r', 'needn', 've', 'y', 'a', 'each', 'have', 'through', 'when', 'mustn', 'by',
'won', 'from', 'own', 'will', 'there', 't', 'him', 'these', 'doesn', 'theirs',
'my', 'did', 'of', 'who', 'until', 'wouldn', 'we', 'do', 'having', 'yours', 'ot
her', 'wasn', 'it', 'with', 'once', 'here', 'don', 'o', 'whom', 'this', 'if',
'but', 'hadn', 'our', 'some', 'm', 'not', 'between', 'himself', 'same', 'at',
'be', 'he', 'after', 'which', 'to', 'his'}
```

In [0]:
```
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")
```

```
3.5727220000000006 seconds
```

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

Out[6]:

	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 [0]:
```
1 data.to_pickle('pickels/16k_apperal_data_preprocessed')
```

Stemming

In [0]:
```
1 from nltk.stem.porter import *
2 stemmer = PorterStemmer()
3 print(stemmer.stem('arguing'))
4 print(stemmer.stem('fishing'))
5
6
7 # We tried using stemming on our titles and it didnot work very well.
8
```

```
argu
fish
```

[8] Text based product similarity

In [0]:
```
data = pd.read_pickle('pickels/16k_apperal_data_preprocessed')
data.head()
```

Out[10]:

	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 [33]:

```
# 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 occurer
        # labels: len(labels) == len(keys), the values of labels depends on t
                # if model == 'bag of words': labels(i) = values(i)
                # if model == 'tfidf weighted bag of words':labels(i) = tfidf
                # if model == 'idf weighted bag of words':labels(i) = idf(key
        # 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
        ax = plt.subplot(gs[0])
        # it displays a cell in white color if the word is intersection(lis c
        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
        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 contr
    intersection = set(vec1.keys()) & set(vec2.keys())

    # we set the values of non intersecting words to zero, this is just to sh
    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 o
    values = [vec2[x] for x in vec2.keys()]

    # 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(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
            # tfidf_title_features[doc_id, index_of_word_in_corpus] will give
            if x in  tfidf_title_vectorizer.vocabulary_:
                labels.append(tfidf_title_features[doc_id, tfidf_title_vector
            else:
                labels.append(0)
    elif model == 'idf':
        labels = []
        for x in vec2.keys():
            # idf_title_vectorizer.vocabulary_ it contains all the words in t
            # idf_title_features[doc_id, index_of_word_in_corpus] will give t
            if x in  idf_title_vectorizer.vocabulary_:
                labels.append(idf_title_features[doc_id, idf_title_vectorizer
            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 = te
    return Counter(words) # Counter counts the occurence of each word in list


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 [0]:

```
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


```

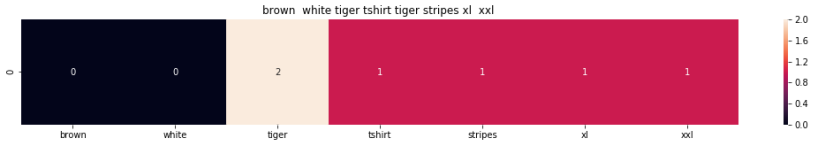
Out[17]: (16042, 12609)

In [0]:

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

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

#try 12566
#try 931
```

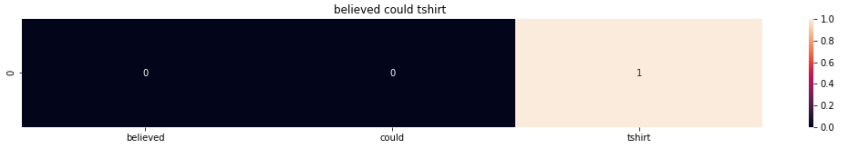
```
ASIN : B00JXQB5FQ
Brand: Si Row
Title: burnt umber tiger tshirt zebra stripes xl  xxl
Euclidean similarity with the query image : 0.0
============================================================
```

```
ASIN : B00JXQASS6
Brand: Si Row
Title: pink tiger tshirt zebra stripes xl  xxl
Euclidean similarity with the query image : 1.73205080757
============================================================
```

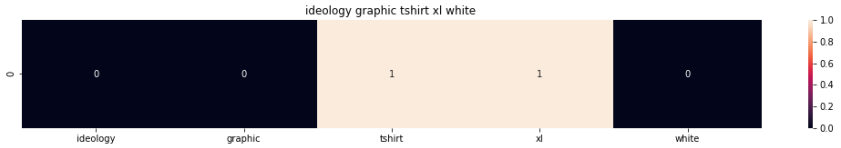


ASIN : B00JXQCWTO
Brand: Si Row
Title: brown white tiger tshirt tiger stripes xl xxl
Euclidean similarity with the query image : 2.44948974278
==========

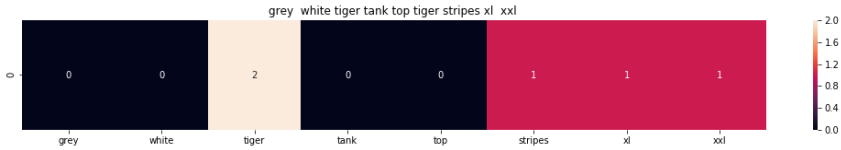
ASIN : B00JXQCUIC
Brand: Si Row
Title: yellow tiger tshirt tiger stripes l
Euclidean similarity with the query image : 2.64575131106
==========



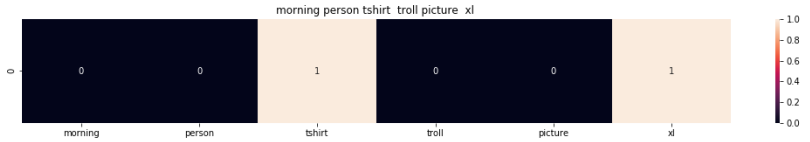
ASIN : B07568NZX4
Brand: Rustic Grace
Title: believed could tshirt
Euclidean similarity with the query image : 3.0
==========



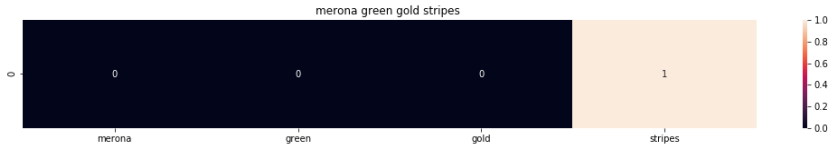
ASIN : B01NB0NKRO
Brand: Ideology
Title: ideology graphic tshirt xl white
Euclidean similarity with the query image : 3.0
==========



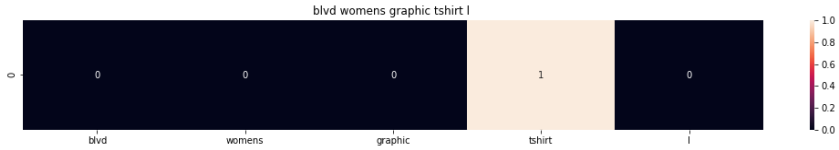
ASIN : B00JXQAFZ2
Brand: Si Row
Title: grey white tiger tank top tiger stripes xl xxl
Euclidean similarity with the query image : 3.0
==========



ASIN : B01CLS8LMW
Brand: Awake
Title: morning person tshirt troll picture xl
Euclidean similarity with the query image : 3.16227766017
==========

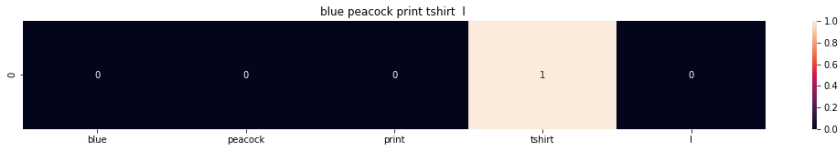


ASIN : B01KVZUB6G
Brand: Merona
Title: merona green gold stripes
Euclidean similarity with the query image : 3.16227766017
==========

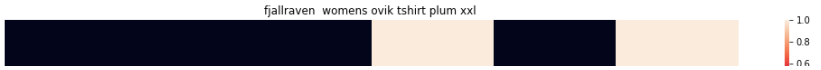


ASIN : B0733R2CJK
Brand: BLVD
Title: blvd womens graphic tshirt l
Euclidean similarity with the query image : 3.16227766017
==========

ASIN : B012VQLT6Y
Brand: KM T-shirt
Title: km tiger printed sleeveless vest tshirt
Euclidean similarity with the query image : 3.16227766017
==========

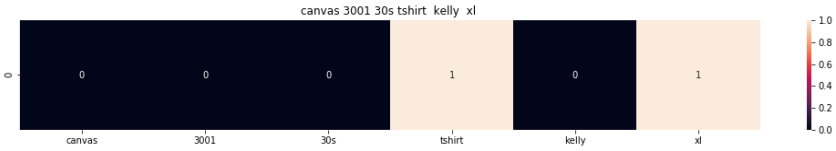


ASIN : B00JXQC8L6
Brand: Si Row
Title: blue peacock print tshirt l
Euclidean similarity with the query image : 3.16227766017
==========



ASIN : B06XC3CZF6
Brand: Fjallraven
Title: fjallraven womens ovik tshirt plum xxl
Euclidean similarity with the query image : 3.16227766017
==========

ASIN : B005IT8OBA
Brand: Hetalia
Title: hetalia us girl tshirt
Euclidean similarity with the query image : 3.16227766017
==========



ASIN : B0088PN0LA
Brand: Red House
Title: canvas 3001 30s tshirt kelly xl
Euclidean similarity with the query image : 3.16227766017
==========

ASIN : B06X99V6WC
Brand: Brunello Cucinelli
Title: brunello cucinelli tshirt women white xl
Euclidean similarity with the query image : 3.16227766017
==========

ASIN : B06Y1JPW1Q
Brand: Xhilaration
Title: xhilaration womens lace tshirt salmon xxl
Euclidean similarity with the query image : 3.16227766017
==========

```
ASIN : B06X6GX6WG
Brand: Animal
Title: animal oceania tshirt  yellow
Euclidean similarity with the query image : 3.16227766017
============================================================
```

```
ASIN : B017X8PW9U
Brand: Diesel
Title: diesel tserraf tshirt black
Euclidean similarity with the query image : 3.16227766017
============================================================
```

```
ASIN : B00IAA4JIQ
Brand: I Love Lucy
Title: juniors love lucywaaaaahhhh tshirt size xl
Euclidean similarity with the query image : 3.16227766017
============================================================
```

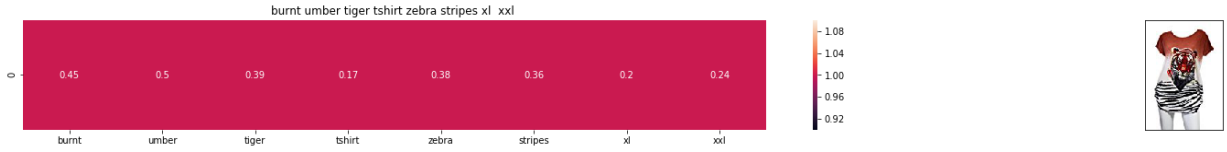
[8.5] TF-IDF based product similarity

In [0]:

```
1 tfidf_title_vectorizer = TfidfVectorizer(min_df = 0)
2 tfidf_title_features = tfidf_title_vectorizer.fit_transform(data['title'])
3 # tfidf_title_features.shape = #data_points * #words_in_corpus
4 # CountVectorizer().fit_transform(courpus) returns the a sparase matrix of di
5 # tfidf_title_features[doc_id, index_of_word_in_corpus] = tfidf values of the
```

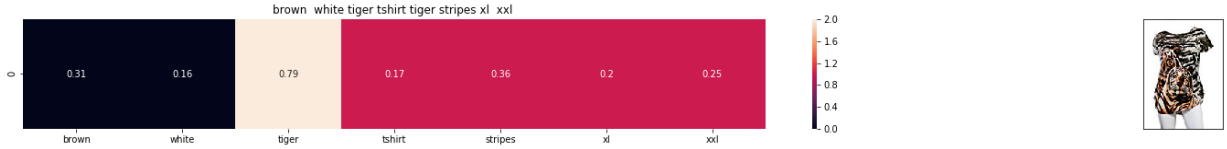
In [0]:

```
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 r
    # the metric we used here is cosine, the coside distance is mesured as K(
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(tfidf_title_features,tfidf_title_featu

    # 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'
        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
```



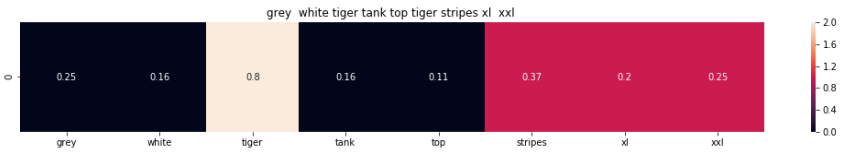

```
ASIN : B00JXQB5FQ
BRAND : Si Row
Eucliden distance from the given image : 0.0
=============================================================================
==============================================
```


```
ASIN : B00JXQASS6
BRAND : Si Row
Eucliden distance from the given image : 0.753633191245
=============================================================================
==============================================
```




```
ASIN : B00JXQCWTO
BRAND : Si Row
Eucliden distance from the given image : 0.935764394377
```

==========
==========

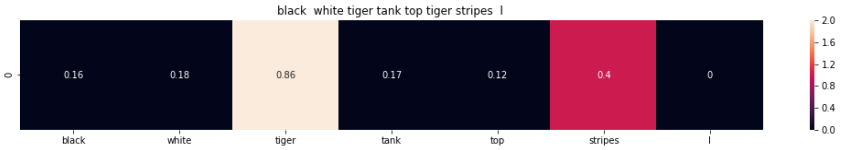


ASIN : B00JXQAFZ2
BRAND : Si Row
Eucliden distance from the given image : 0.95861535242

==========
==========

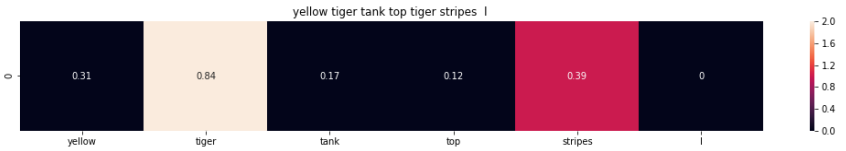
ASIN : B00JXQCUIC
BRAND : Si Row
Eucliden distance from the given image : 1.00007496145

==========
==========



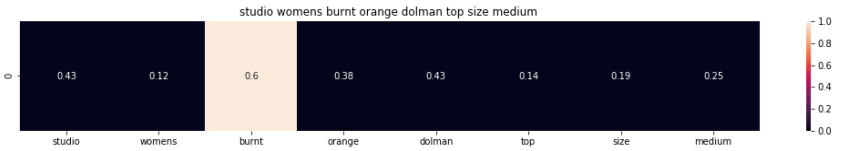
ASIN : B00JXQAO94
BRAND : Si Row
Eucliden distance from the given image : 1.02321555246

==========
==========



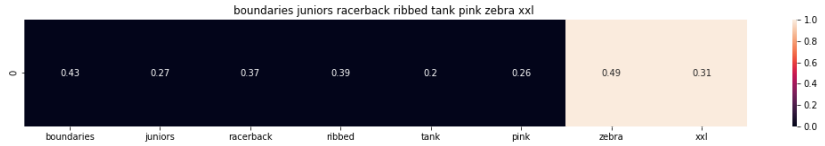
ASIN : B00JXQAUWA
BRAND : Si Row
Eucliden distance from the given image : 1.0319918463

==========
==========



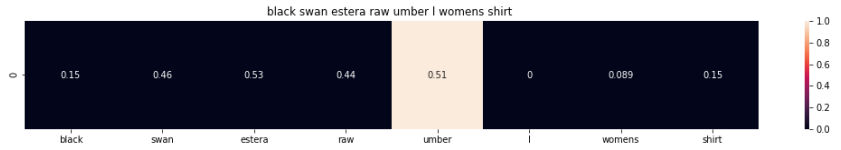
ASIN : B06XSCVFT5
BRAND : Studio M
Eucliden distance from the given image : 1.21068436704

==========
==========



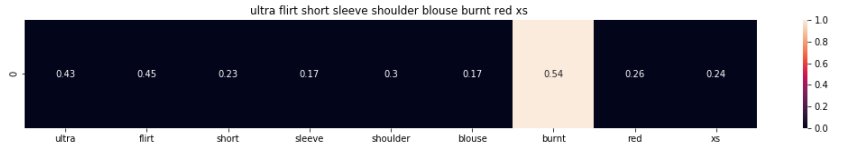
ASIN : B06Y2GTYPM
BRAND : No Boundaries
Eucliden distance from the given image : 1.21216838107
==========
==========

ASIN : B012VQLT6Y
BRAND : KM T-shirt
Eucliden distance from the given image : 1.21979064028
==========
==========

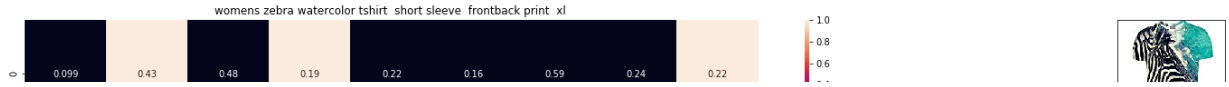


ASIN : B06Y1VN8WQ
BRAND : Black Swan
Eucliden distance from the given image : 1.220684966
==========
==========

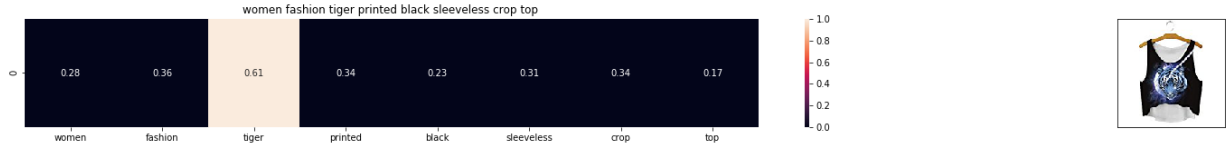
ASIN : B00Z6HEXWI
BRAND : Black Temptation
Eucliden distance from the given image : 1.22128139212
==========
==========



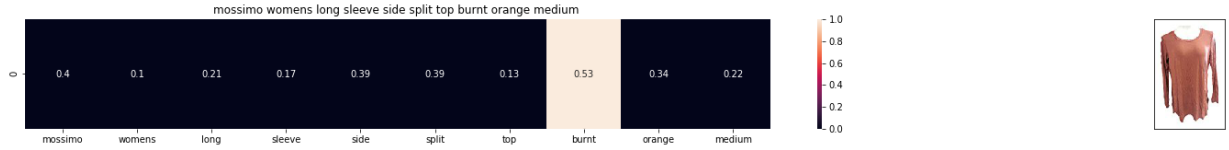
ASIN : B074TR12BH
BRAND : Ultra Flirt
Eucliden distance from the given image : 1.23133640946
==========
==========



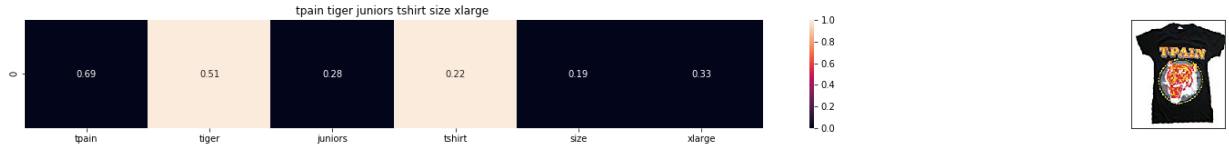
ASIN : B072R2JXKW
BRAND : WHAT ON EARTH
Eucliden distance from the given image : 1.23184519726
==========
==========



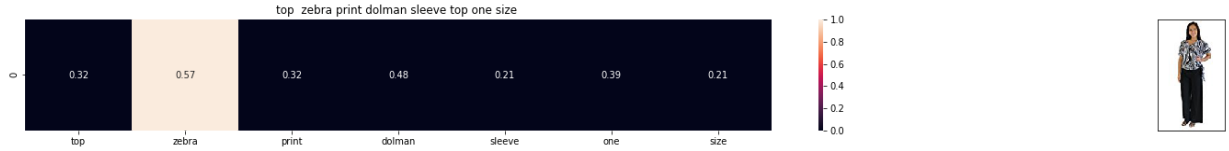
ASIN : B074T8ZYGX
BRAND : MKP Crop Top
Eucliden distance from the given image : 1.23406074574
==========
==========



ASIN : B071ZDF6T2
BRAND : Mossimo
Eucliden distance from the given image : 1.23527855777
==========
==========

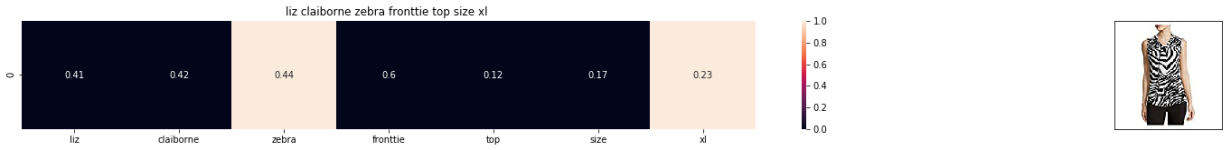


ASIN : B01K0H02OG
BRAND : Tultex
Eucliden distance from the given image : 1.23645729881
==========
==========



ASIN : B00H8A6ZLI
BRAND : Vivian's Fashions
Eucliden distance from the given image : 1.24996155053
==========
==========

```
ASIN : B010NN9RXO
BRAND : YICHUN
Eucliden distance from the given image : 1.25354614209
================================================================================
================================================
```




```
ASIN : B06XBY5QXL
BRAND : Liz Claiborne
Eucliden distance from the given image : 1.25388329384
================================================================================
================================================
```

[8.5] IDF based product similarity

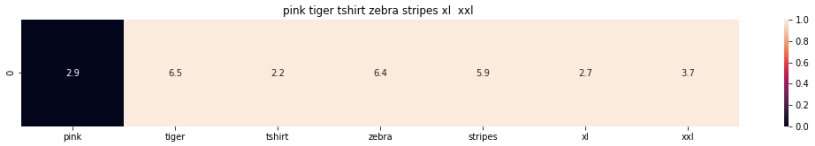
In [18]:
```
idf_title_vectorizer = CountVectorizer()
idf_title_features = idf_title_vectorizer.fit_transform(data['title'])

# idf_title_features.shape = #data_points * #words_in_corpus
# CountVectorizer().fit_transform(courpus) returns the a sparase matrix of di
# idf_title_features[doc_id, index_of_word_in_corpus] = number of times the w
```

In [19]:
```
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 [20]:
```
# 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 wit
    # idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()[0]
    for j in idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonze

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

```

In [0]:
```
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 r
    # the metric we used here is cosine, the coside distance is mesured as K(
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(idf_title_features,idf_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)):
        get_result(indices[i],data['title'].loc[df_indices[0]], data['title']
        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 wo
```

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



```
ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from the given image : 12.2050713112
=============================================================================
```

[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 [0]:

```
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
'''

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

```

In [31]:

```
# 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 representatio
        # if m_name == 'weighted', we will multiply each w2v[word] with the i
    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.vo
            elif m_name == 'avg':
                vec.append(model[i])
        else:
            # if the word in our courpus is not there in the google word2vec
            vec.append(np.zeros(shape=(300,)))
    # we will return a numpy array of shape (#number of words in title * 300
    # each row represents the word2vec representation of each word (weighted/
    return  np.array(vec)

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

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

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

```

```
57
58
59      # devide whole figure into 2 parts 1st part displays heatmap 2nd part dis
60      gs = gridspec.GridSpec(2, 2, width_ratios=[4,1],height_ratios=[2,1])
61      fig = plt.figure(figsize=(15,15))
62
63      ax = plt.subplot(gs[0])
64      # ploting the heap map based on the pairwise distances
65      ax = sns.heatmap(np.round(s1_s2_dist,4), annot=True)
66      # set the x axis labels as recommended apparels title
67      ax.set_xticklabels(sentence2.split())
68      # set the y axis labels as input apparels title
69      ax.set_yticklabels(sentence1.split())
70      # set title as recommended apparels title
71      ax.set_title(sentence2)
72
73      ax = plt.subplot(gs[1])
74      # we remove all grids and axis labels for image
75      ax.grid(False)
76      ax.set_xticks([])
77      ax.set_yticks([])
78      display_img(url, ax, fig)
79
80      plt.show()
```

In [0]:

```
1  # vocab = stores all the words that are there in google w2v model
2  # vocab = model.wv.vocab.keys() # if you are using Google word2Vec
3
4  vocab = model.keys()
5  # this function will add the vectors of each word and returns the avg vector
6  def build_avg_vec(sentence, num_features, doc_id, m_name):
7      # sentace: its title of the apparel
8      # num_features: the lenght of word2vec vector, its values = 300
9      # m_name: model information it will take two values
10         # if  m_name == 'avg', we will append the model[i], w2v representatio
11         # if m_name == 'weighted', we will multiply each w2v[word] with the i
12
13     featureVec = np.zeros((num_features,), dtype="float32")
14     # we will intialize a vector of size 300 with all zeros
15     # we add each word2vec(wordi) to this fetureVec
16     nwords = 0
17
18     for word in sentence.split():
19         nwords += 1
20         if word in vocab:
21             if m_name == 'weighted' and word in  idf_title_vectorizer.vocabul
22                 featureVec = np.add(featureVec, idf_title_features[doc_id, id
23             elif m_name == 'avg':
24                 featureVec = np.add(featureVec, model[word])
25     if(nwords>0):
26         featureVec = np.divide(featureVec, nwords)
27     # returns the avg vector of given sentance, its of shape (1, 300)
28     return featureVec
```

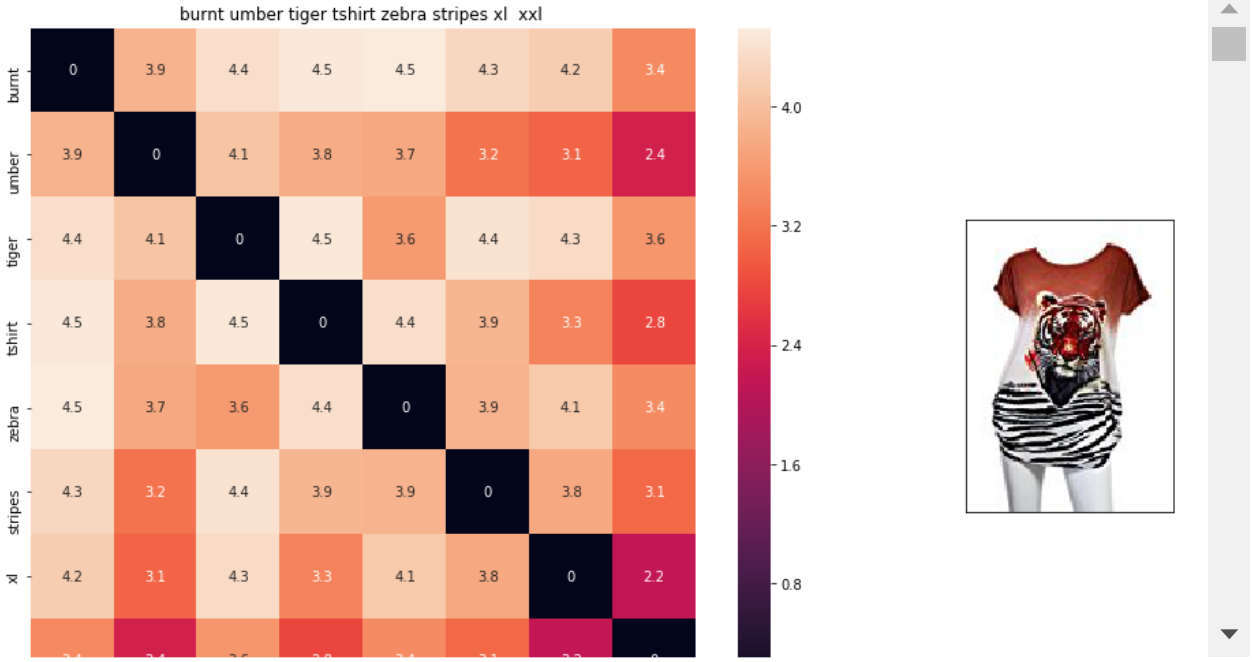
[9.2] Average Word2Vec product similarity.

In [0]:

```
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 correspond
w2v_title = np.array(w2v_title)

```

In [0]:

```
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

    # 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_in
        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 wor
```



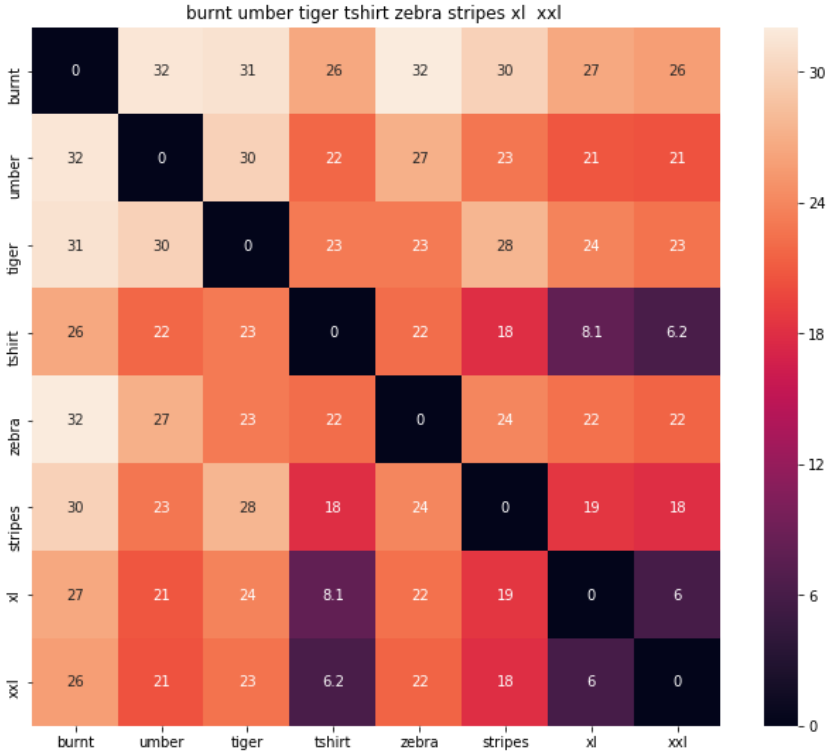
[9.4] IDF weighted Word2Vec for product similarity

In [0]:

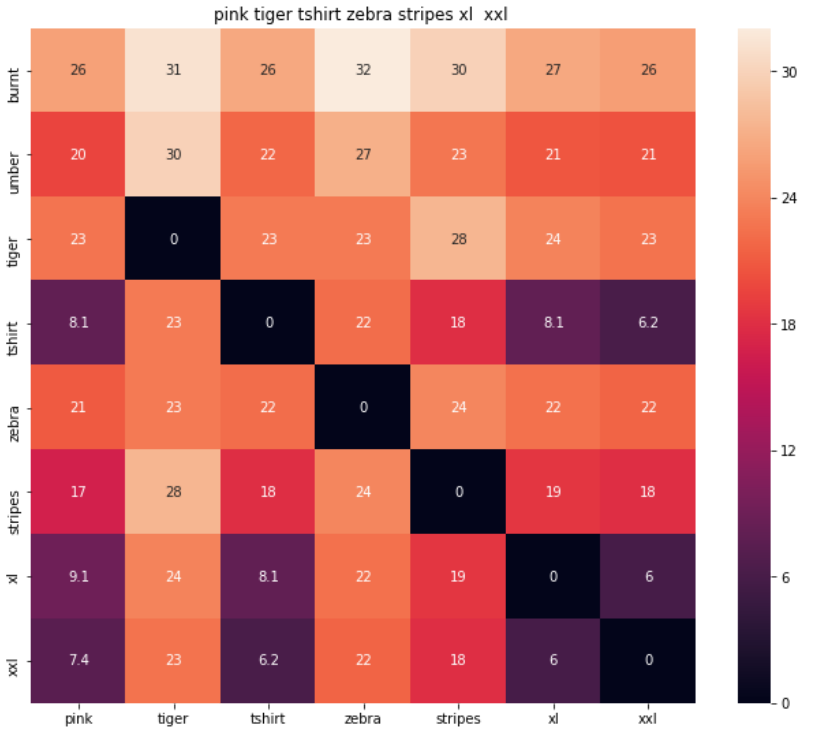
```
doc_id = 0
w2v_title_weight = []
# for every title we build a weighted vector representation
for i in data['title']:
    w2v_title_weight.append(build_avg_vec(i, 300, doc_id,'weighted'))
    doc_id += 1
# w2v_title = np.array(# number of doc in courpus * 300), each row correspond
w2v_title_weight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

In [0]:

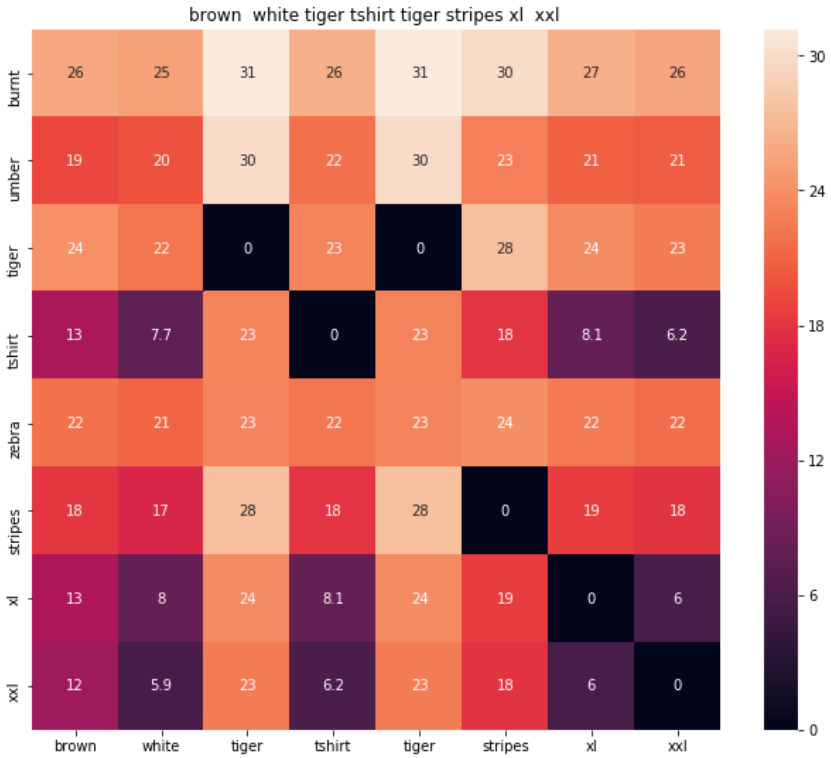
```
def weighted_w2v_model(doc_id, num_results):
    # doc_id: apparel's id in given corpus

    # pairwise_dist will store the distance from given input apparel to all r
    # the metric we used here is cosine, the coside distance is mesured as K(
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    pairwise_dist = pairwise_distances(w2v_title_weight, w2v_title_weight[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)):
        heat_map_w2v(data['title'].loc[df_indices[0]],data['title'].loc[df_in
        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 wor
```



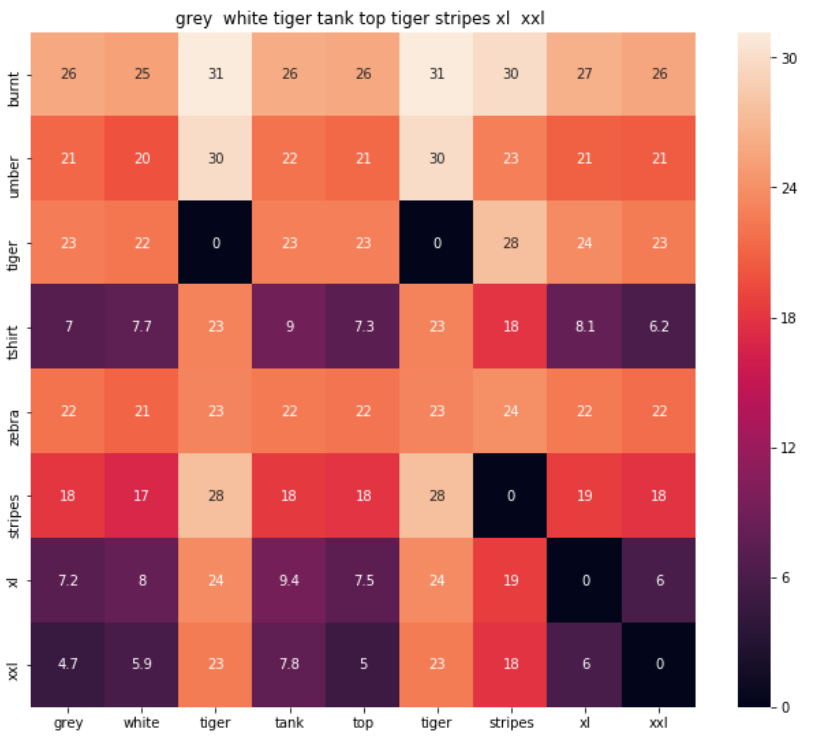
```
ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from input : 0.00390625
=============================================================================
===========================================
```



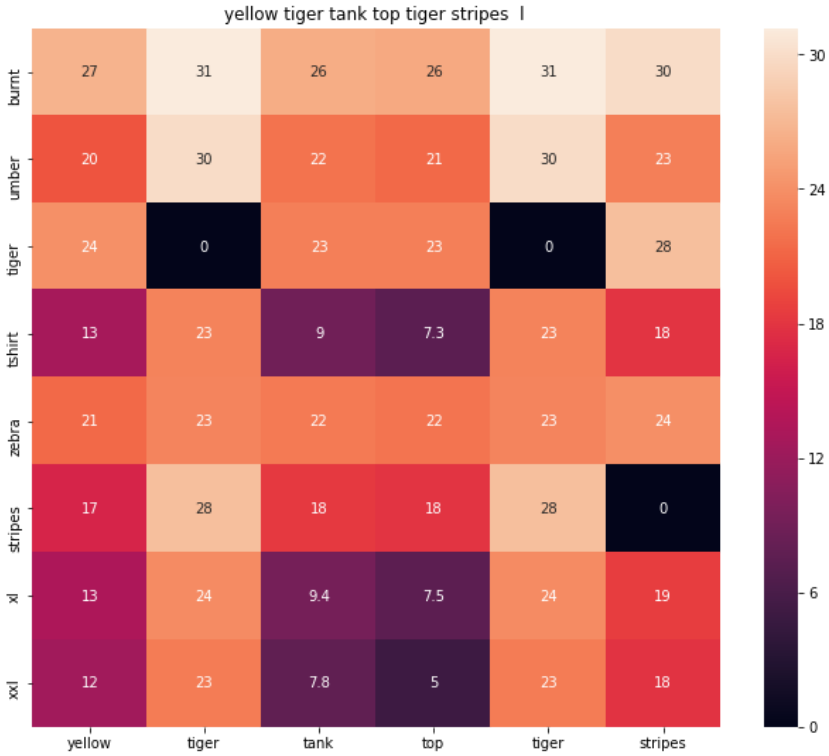
ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from input : 4.06389
==========
==========



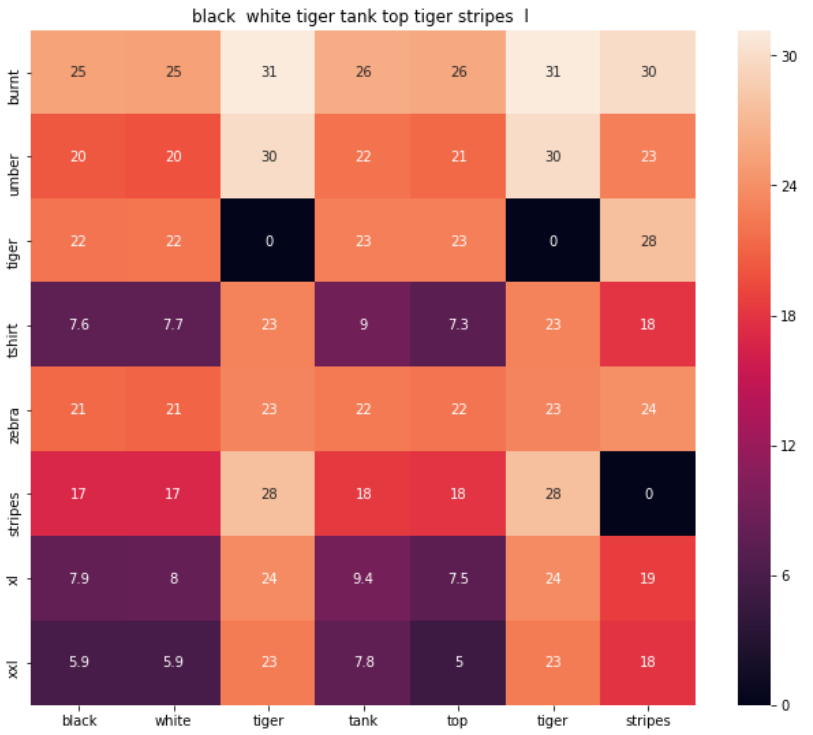
ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from input : 4.77094
==========
==========



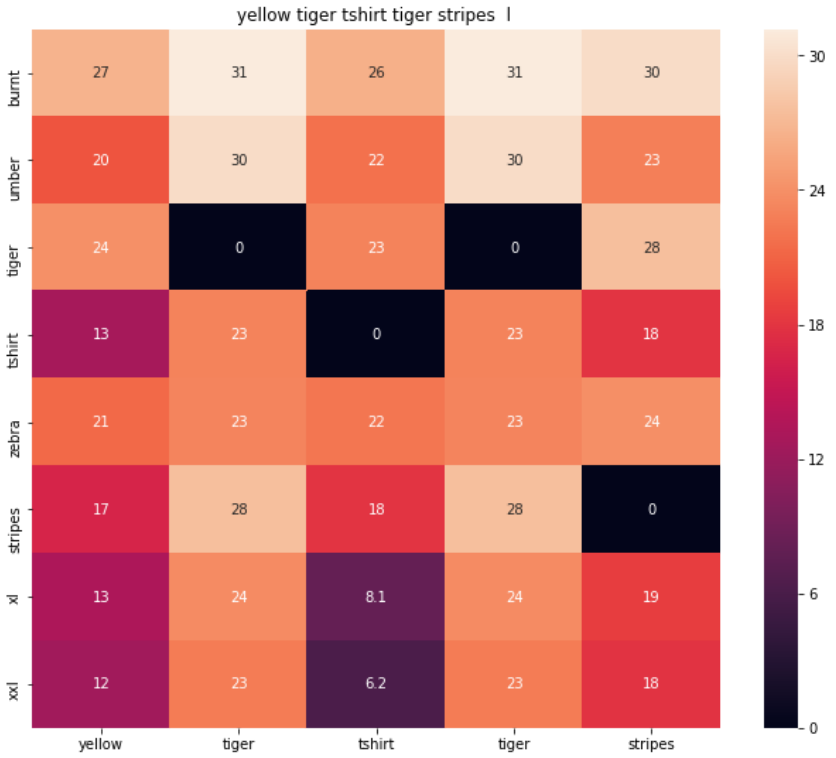
ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from input : 5.36016
==========
==========



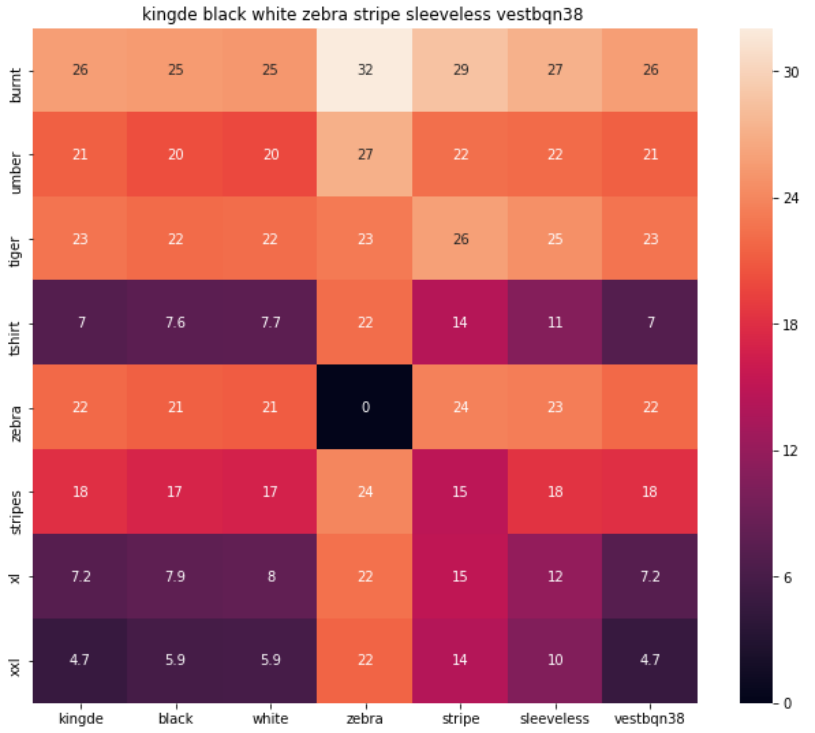
ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from input : 5.68952
==========
==========



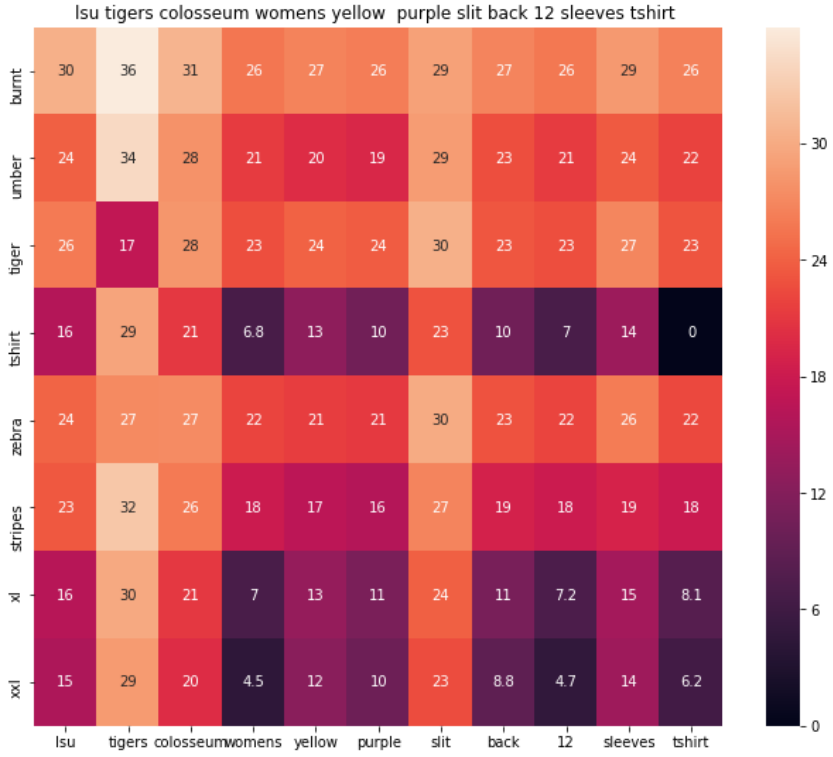
ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from input : 5.69302
==========
==========



ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from input : 5.89344
==========
==========

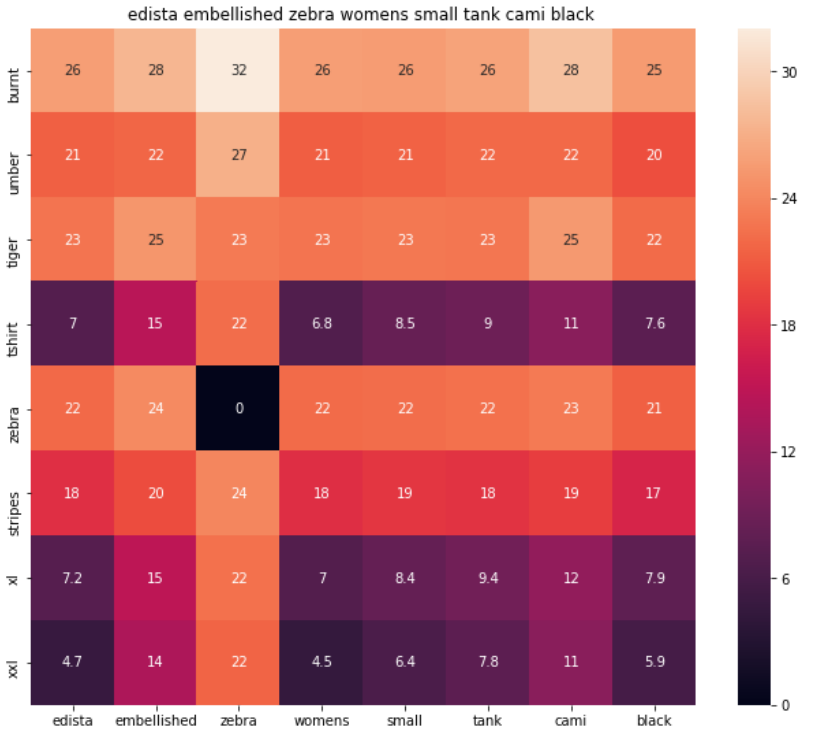


ASIN : B015H41F6G
Brand : KINGDE
euclidean distance from input : 6.13299



ASIN : B073R5Q8HD
Brand : Colosseum
euclidean distance from input : 6.25671

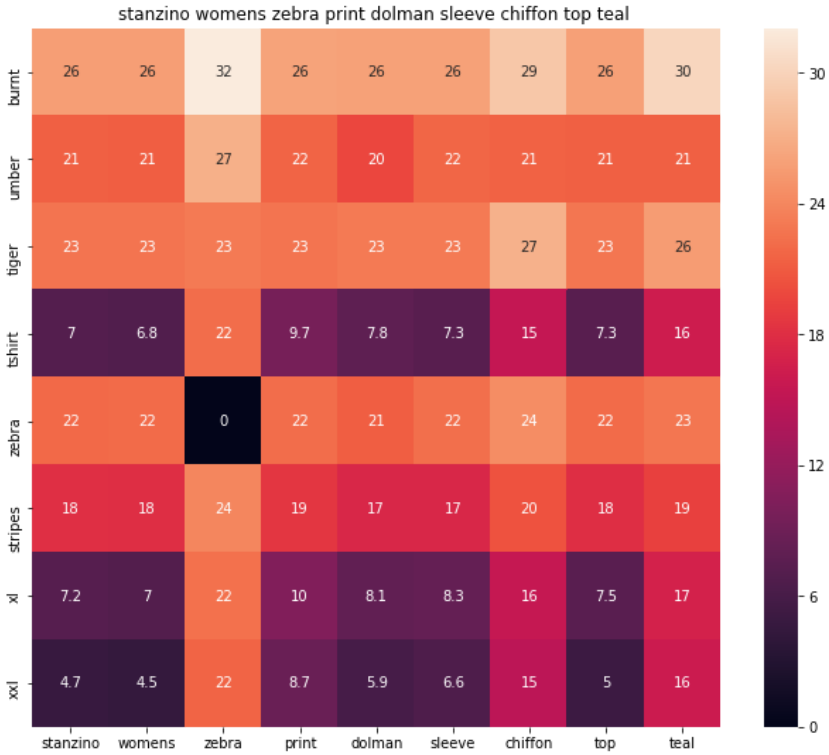
==========



ASIN : B074P8MD22
Brand : Edista
euclidean distance from input : 6.3922

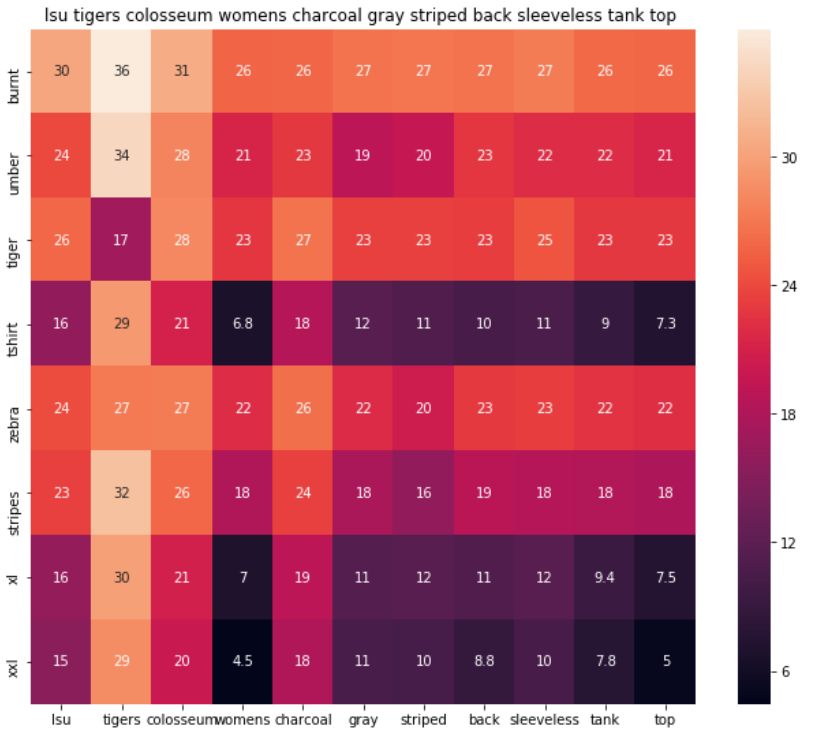
==========

==========

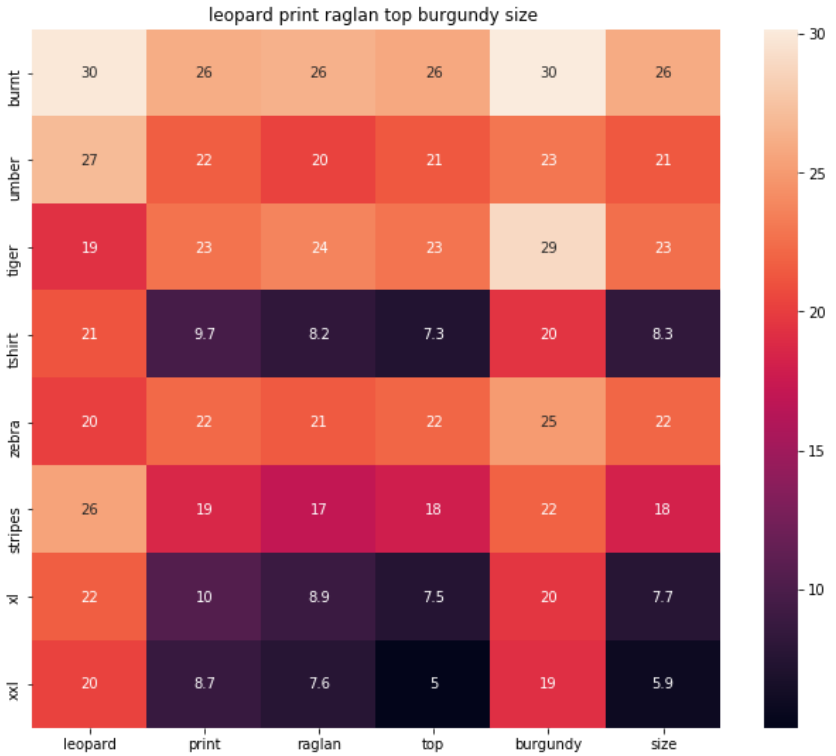


ASIN : B00C0I3U3E
Brand : Stanzino

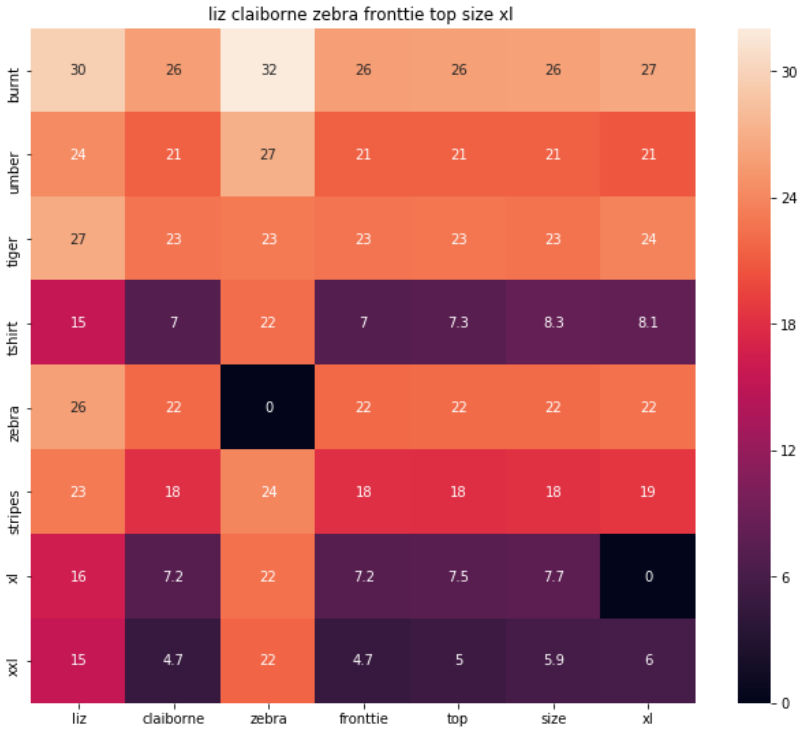
```
euclidean distance from input : 6.4149
================================================================================
================================================
```



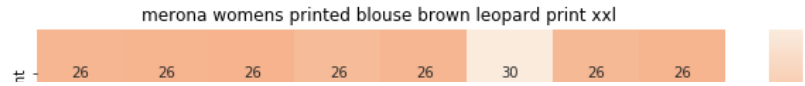
```
ASIN : B073R4ZM7Y
Brand : Colosseum
euclidean distance from input : 6.45096
================================================================================
================================================
```



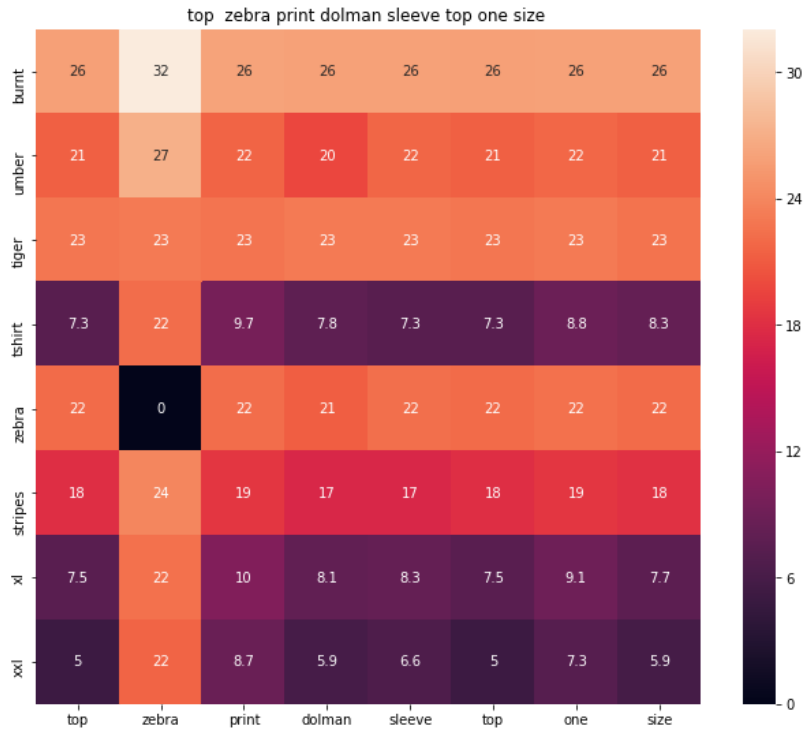
```
ASIN : B01C6ORLDQ
Brand : 1 Mad Fit
euclidean distance from input : 6.46341
================================================================================
================================================
```



```
ASIN : B06XBY5QXL
Brand : Liz Claiborne
euclidean distance from input : 6.53922
================================================================================
================================================
```

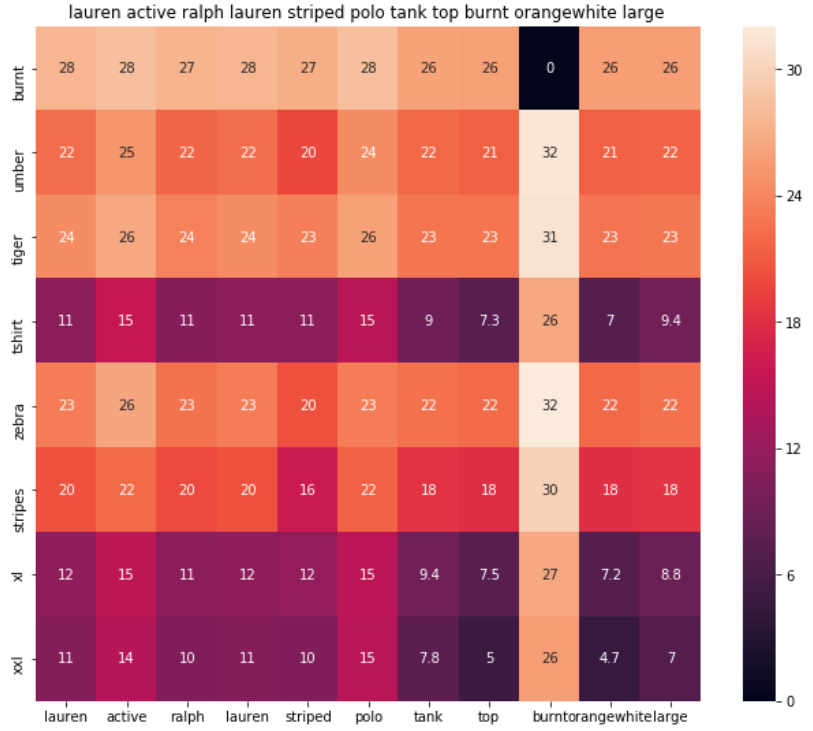


ASIN : B071YF3WDD
Brand : Merona
euclidean distance from input : 6.5755
==========
==========

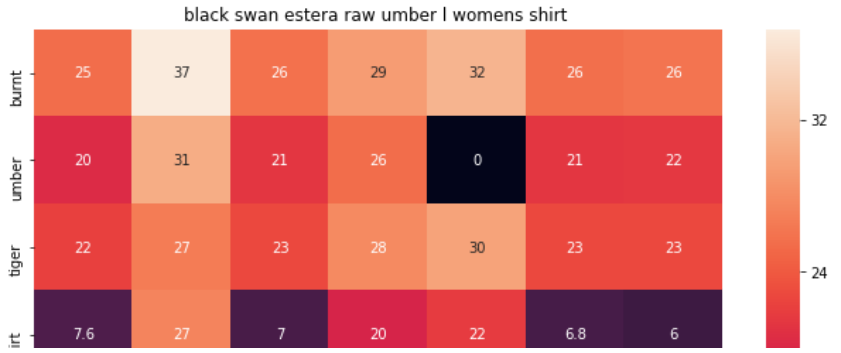


ASIN : B00H8A6ZLI
Brand : Vivian's Fashions
euclidean distance from input : 6.63821
==========
==========

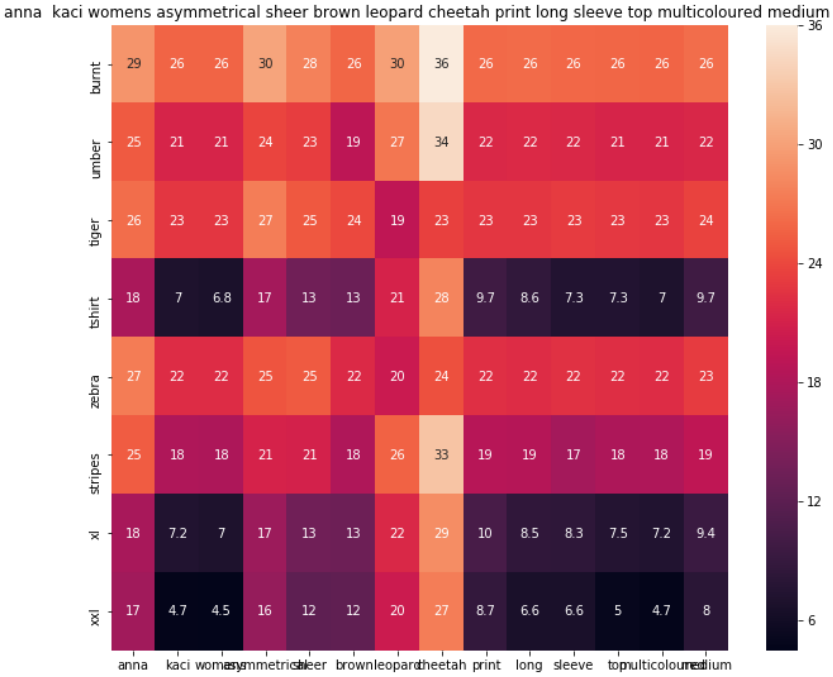
ASIN : B00Z6HEXWI
Brand : Black Temptation
euclidean distance from input : 6.66074
==========
==========



ASIN : B00ILGH5OY
Brand : Ralph Lauren Active
euclidean distance from input : 6.68391
==========
==========



ASIN : B06Y1VN8WQ
Brand : Black Swan
euclidean distance from input : 6.70576
==========
==========



ASIN : B00KSNTY7Y
Brand : Anna-Kaci
euclidean distance from input : 6.70612
==========
==========

[9.6] Weighted similarity using brand and color.

In [0]:

```
# 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)).tocs
```

In [27]:

```
def heat_map_w2v_brand(sentance1, sentance2, url, doc_id1, doc_id2, df_id1, d

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

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

    colorscale = [[0, '#1d004d'],[.5, '#f2e5ff'],[1, '#f2e5d1']] # to color t

    # 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()
```

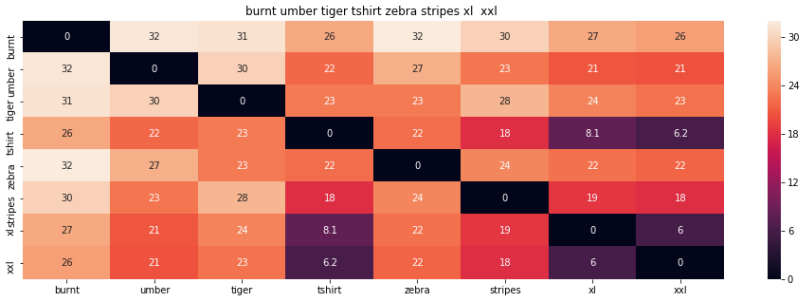
In [28]:

```
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 r
    # the metric we used here is cosine, the coside distance is mesured as K(
    # http://scikit-learn.org/stable/modules/metrics.html#cosine-similarity
    idf_w2v_dist  = pairwise_distances(w2v_title_weight, w2v_title_weight[doc
    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
        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 wor
```

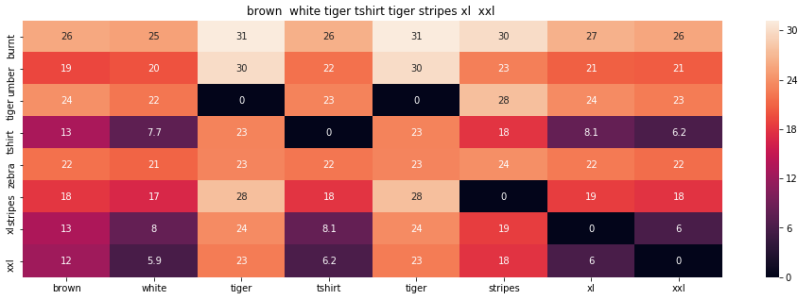
```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
<ipython-input-28-822d8df49624> in <module>()
     27         print('='*125)
     28
---> 29 idf_w2v_brand(12566, 5, 5, 20)
     30 # in the give heat map, each cell contains the euclidean distance bet
ween words i, j

<ipython-input-28-822d8df49624> in idf_w2v_brand(doc_id, w1, w2, num_results)
     21
     22     for i in range(0, len(indices)):
---> 23         heat_map_w2v_brand(data['title'].loc[df_indices[0]],data['tit
le'].loc[df_indices[i]], data['medium_image_url'].loc[df_indices[i]], indices
[0], indices[i],df_indices[0], df_indices[i], 'weighted')
     24         print('ASIN :',data['asin'].loc[df_indices[i]])
     25         print('Brand :',data['brand'].loc[df_indices[i]])

<ipython-input-27-ac9ce1dbaed2> in heat_map_w2v_brand(sentance1, sentance2, u
rl, doc_id1, doc_id2, df_id1, df_id2, model)
     11
     12     #s1_vec = np.array(#number_of_words_title1 * 300), each row is a
 vector(weighted/avg) of length 300 corresponds to each word in give title
---> 13     s1_vec = get_word_vec(sentance1, doc_id1, model)
```

```
    14     #s2_vec = np.array(#number_of_words_title2 * 300), each row is a
vector(weighted/avg) of length 300 corresponds to each word in give title
    15     s2_vec = get_word_vec(sentance2, doc_id2, model)

NameError: name 'get_word_vec' is not defined
```

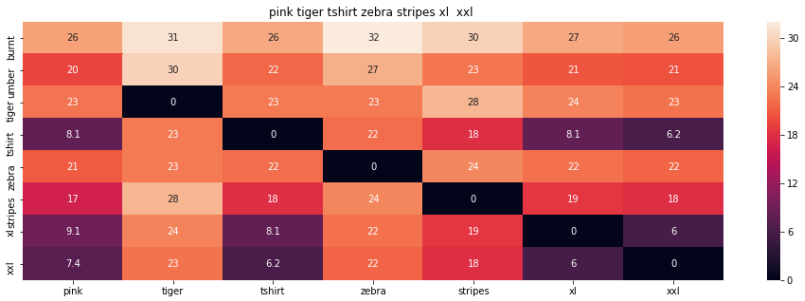
In [0]:
```
# brand and color weight =50
# title vector weight = 5

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



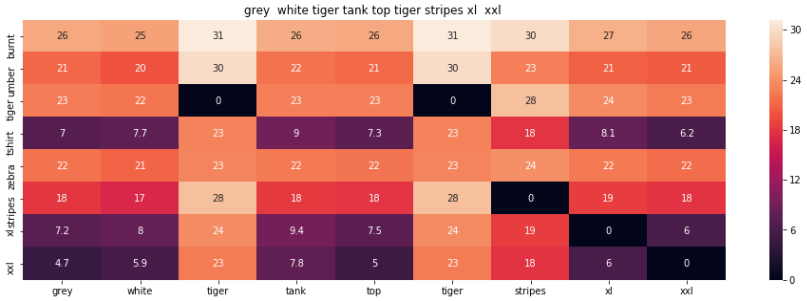
ASIN : B00JXQB5FQ
Brand : Si Row
euclidean distance from input : 0.000355113636364
==========
==========



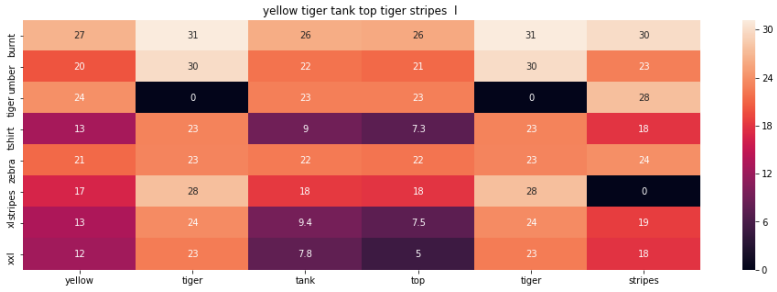
ASIN : B00JXQCWTO
Brand : Si Row
euclidean distance from input : 0.433722027865
==========
==========



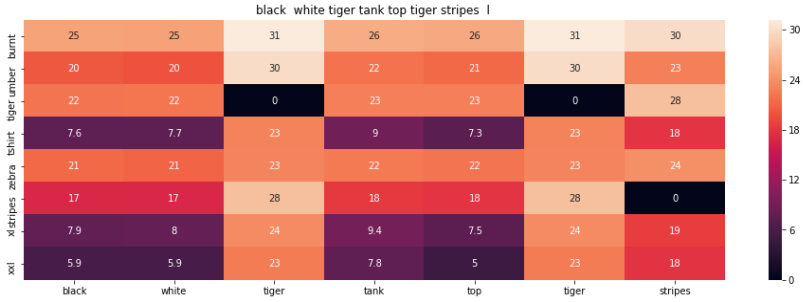
ASIN : B00JXQASS6
Brand : Si Row
euclidean distance from input : 1.65509310669
==========
==========



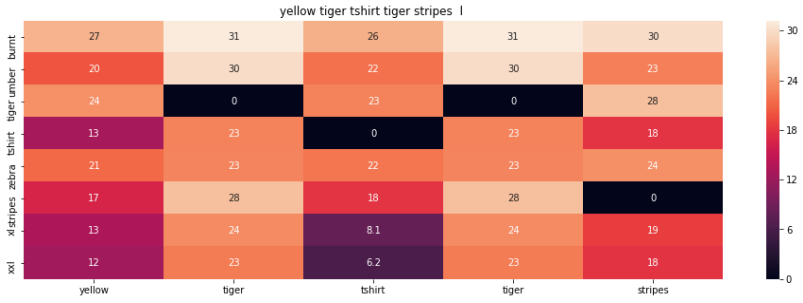
ASIN : B00JXQAFZ2
Brand : Si Row
euclidean distance from input : 1.77293604103
==========
==========



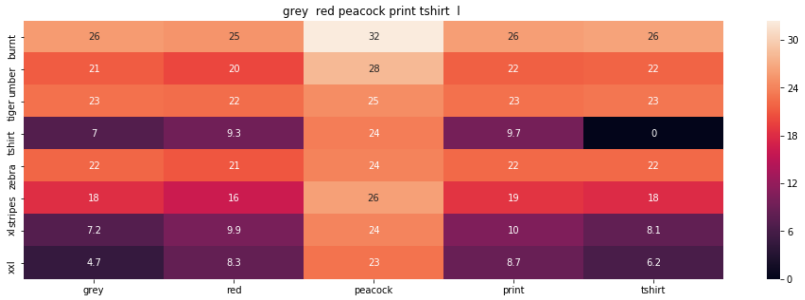
ASIN : B00JXQAUWA
Brand : Si Row
euclidean distance from input : 1.80287808538
==========
==========



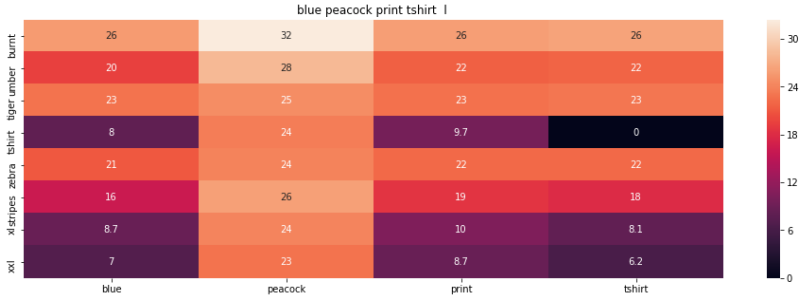
ASIN : B00JXQAO94
Brand : Si Row
euclidean distance from input : 1.80319609241
==========
==========



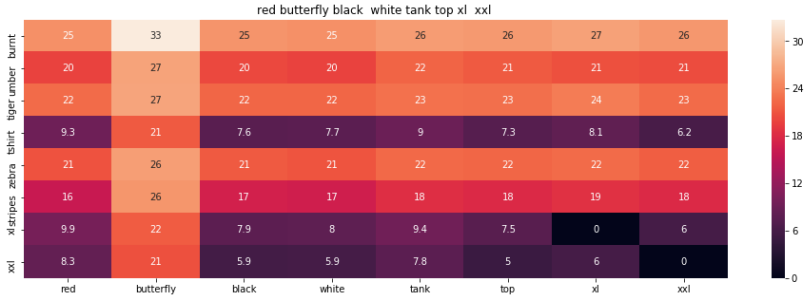
ASIN : B00JXQCUIC
Brand : Si Row
euclidean distance from input : 1.82141619628
==========
==========



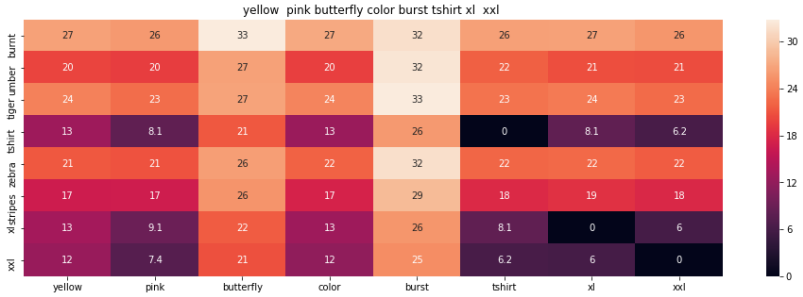
ASIN : B00JXQCFRS
Brand : Si Row
euclidean distance from input : 1.90777685025
==========
==========



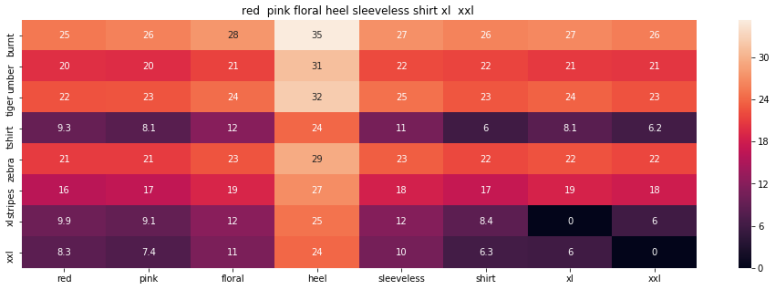
ASIN : B00JXQC8L6
Brand : Si Row
euclidean distance from input : 1.92142937433
==========
==========



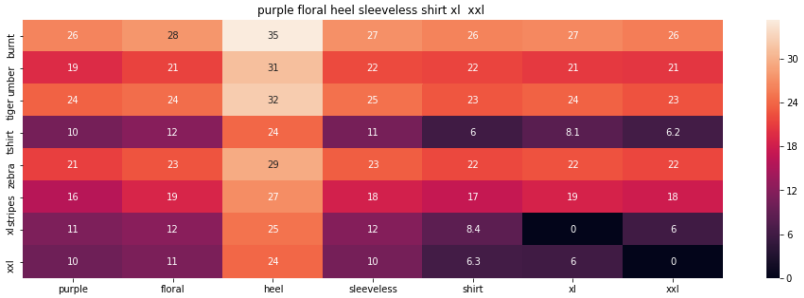
ASIN : B00JV63CW2
Brand : Si Row
euclidean distance from input : 1.93646323497
==========
==========



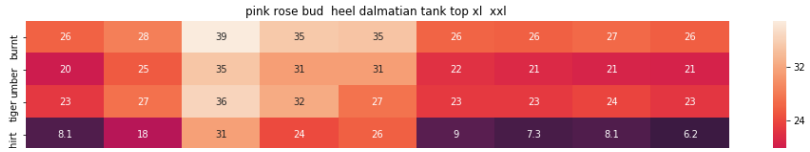
ASIN : B00JXQBBMI
Brand : Si Row
euclidean distance from input : 1.95670381059
==========
==========



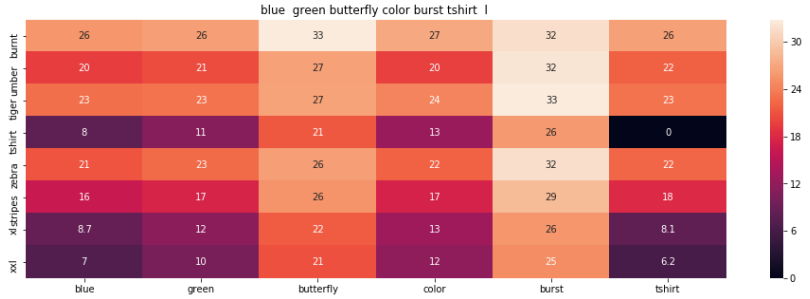
ASIN : B00JV63QQE
Brand : Si Row
euclidean distance from input : 1.9806066343
==========
==========



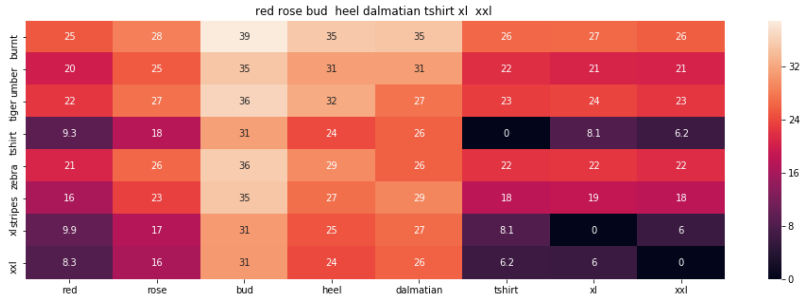
ASIN : B00JV63VC8
Brand : Si Row
euclidean distance from input : 2.01218559992
==========
==========



ASIN : B00JXQAX2C
Brand : Si Row
euclidean distance from input : 2.01335178755
==========
==========

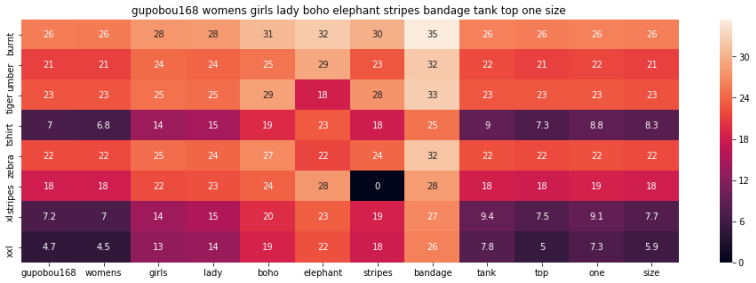


ASIN : B00JXQC0C8
Brand : Si Row
euclidean distance from input : 2.01388334827
==========
==========



ASIN : B00JXQABB0
Brand : Si Row
euclidean distance from input : 2.0367257555

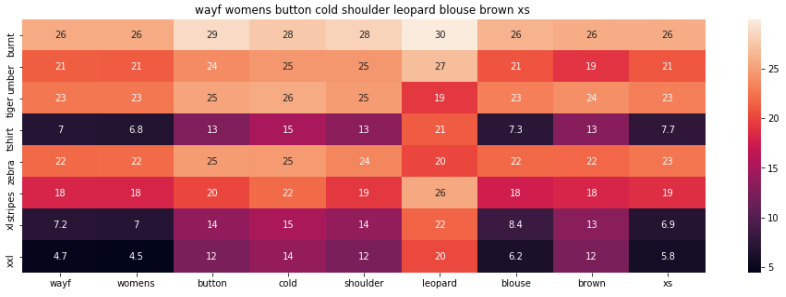
==========



ASIN : B01ER184O6
Brand : GuPoBoU168
euclidean distance from input : 2.65620416778

==========

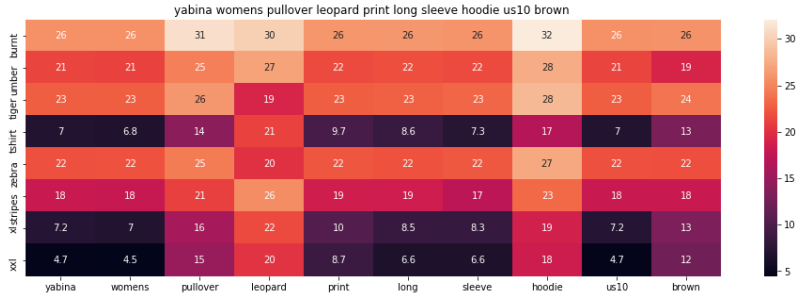
==========



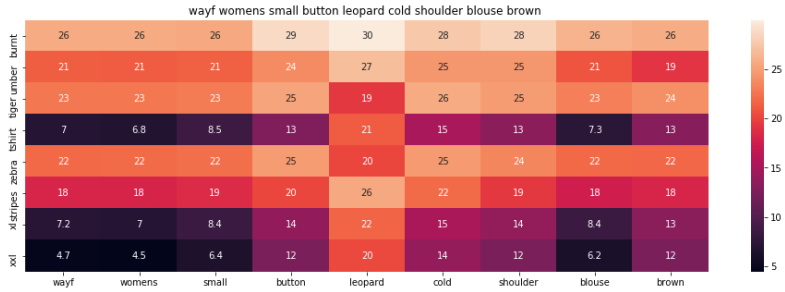
ASIN : B01LZ7BQ4H
Brand : WAYF
euclidean distance from input : 2.6849067823

==========

==========



ASIN : B01KJUM6JI
Brand : YABINA
euclidean distance from input : 2.68583819266
==========
==========



ASIN : B01M06V4X1
Brand : WAYF
euclidean distance from input : 2.69476194865
==========
==========

[10.2] Keras and Tensorflow to extract features

In [0]:

```
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-classificatio



# 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

# 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_s
    bottleneck_features_train = bottleneck_features_train.reshape((16042,2508

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


save_bottlebeck_features()

```

```
57 '''
```

[10.3] Visual features based product similarity.

In [2]:
```
1 b_features = np.load('16k_data_cnn_features.npy')
```

In [5]:
```
1 df_cnn = pd.DataFrame(b_features)
```

Out[5]: (25088,)

In [0]:

```
#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_

    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[ind
        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: 0.0
Amazon Url: www.amzon.com/dp/B00JXQB5FQ

Product Title: pink tiger tshirt zebra stripes xl xxl
Euclidean Distance from input image: 30.0501
Amazon Url: www.amzon.com/dp/B00JXQASS6

Product Title: yellow tiger tshirt tiger stripes l
Euclidean Distance from input image: 41.2611
Amazon Url: www.amzon.com/dp/B00JXQCUIC

Product Title: brown white tiger tshirt tiger stripes xl xxl
Euclidean Distance from input image: 44.0002
Amazon Url: www.amzon.com/dp/B00JXQCWTO

Product Title: kawaii pastel tops tees pink flower design
Euclidean Distance from input image: 47.3825
Amazon Url: www.amzon.com/dp/B071FCWD97

Product Title: womens thin style tops tees pastel watermelon print
Euclidean Distance from input image: 47.7184

Amazon Url: www.amzon.com/dp/B01JUNHBRM

Product Title: kawaii pastel tops tees baby blue flower design
Euclidean Distance from input image: 47.9021
Amazon Url: www.amzon.com/dp/B071SBCY9W

Product Title: edv cheetah run purple multi xl
Euclidean Distance from input image: 48.0465
Amazon Url: www.amzon.com/dp/B01CUPYBM0

Product Title: danskin womens vneck loose performance tee xsmall pink ombre
Euclidean Distance from input image: 48.1019
Amazon Url: www.amzon.com/dp/B01F7PHXY8

Product Title: summer alpaca 3d pastel casual loose tops tee design
Euclidean Distance from input image: 48.1189
Amazon Url: www.amzon.com/dp/B01I80A93G

Product Title: miss chievous juniors striped peplum tank top medium shadowpeac
h
Euclidean Distance from input image: 48.1313
Amazon Url: www.amzon.com/dp/B0177DM70S

Product Title: red pink floral heel sleeveless shirt xl xxl
Euclidean Distance from input image: 48.1695
Amazon Url: www.amzon.com/dp/B00JV63QQE

Product Title: moana logo adults hot v neck shirt black xxl
Euclidean Distance from input image: 48.2568
Amazon Url: www.amzon.com/dp/B01LX6H43D

Product Title: abaday multicolor cartoon cat print short sleeve longline shirt
large
Euclidean Distance from input image: 48.2657
Amazon Url: www.amzon.com/dp/B01CR57YY0

Product Title: kawaii cotton pastel tops tees peach pink cactus design
Euclidean Distance from input image: 48.3626
Amazon Url: www.amzon.com/dp/B071WYLBZS

Product Title: chicago chicago 18 shirt women pink
Euclidean Distance from input image: 48.3836
Amazon Url: www.amzon.com/dp/B01GXAZTRY

Product Title: yichun womens tiger printed summer tshirts tops
Euclidean Distance from input image: 48.4493
Amazon Url: www.amzon.com/dp/B010NN9RXO

Product Title: nancy lopez whimsy short sleeve whiteblacklemon drop xs
Euclidean Distance from input image: 48.4788
Amazon Url: www.amzon.com/dp/B01MPX6IDX

Product Title: womens tops tees pastel peach ice cream cone print
Euclidean Distance from input image: 48.558
Amazon Url: www.amzon.com/dp/B0734GRKZL

Product Title: uswomens mary j blige without tshirts shirt
Euclidean Distance from input image: 48.6144
Amazon Url: www.amzon.com/dp/B01M0XXFKK

Assignments

so we will concatenate the idf w2v features,one hot encoded brand and color features and the image based feature that we got using vgc16 model and then use them to find the similarity with weighted features

In [1]:

```
#import all the necessary packages.

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

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

from IPython.core.display import display, HTML
display(HTML("<style>.container { width:100% !important; }</style>"))
```

Loading the data

In [2]:
```
data = pd.read_pickle('pickels/16k_apperal_data_preprocessed')
data.head()
```

Out[2]:

	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...	

IDF Weighted W2V features

In [3]:
```
idf_title_vectorizer = CountVectorizer()
idf_title_features = idf_title_vectorizer.fit_transform(data['title'])
```

In [4]:
```
# idf_title_features.shape = #data_points * #words_in_corpus
# CountVectorizer().fit_transform(courpus) returns the a sparase matrix of di
# idf_title_features[doc_id, index_of_word_in_corpus] = number of times the w
def n_containing(word):
    # return the number of documents which has 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 [5]:
```
# 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 wit
    # idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonzero()[0]
    for j in idf_title_features[:, idf_title_vectorizer.vocabulary_[i]].nonze

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

Building the idf weigted w2v

In [6]:
```
import pickle
#if you do NOT have RAM >= 12GB, use the code below.
with open('word2vec_model', 'rb') as handle:
    model = pickle.load(handle)
```

In [7]:
```
# 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
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 representatio
        # if m_name == 'weighted', we will multiply each w2v[word] with the i

    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.vocabul
                featureVec = np.add(featureVec, idf_title_features[doc_id, id
            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
```

In [8]:
```
import datetime as dt
```

In [9]:
```
start = dt.datetime.now()
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 correspond
w2v_title_weight = np.array(w2v_title_weight)
print('time taken for execution is:',dt.datetime.now() - start)
```

```
time taken for execution is: 0:00:04.014132
```

In [10]:
```
w2v_title_weight.shape
```

Out[10]: (16042, 300)

ONe hot encoding for brand and color

In [13]:
```
# 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)

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

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

In [14]:

```
## final features being concatenated
from IPython.display import display, SVG, Math, YouTubeVideo

#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)

# 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 representatic
        # if m_name == 'weighted', we will multiply each w2v[word] with the t
    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.vo
            elif m_name == 'avg':
                vec.append(model[i])
        else:
            # if the word in our courpus is not there in the google word2vec
            vec.append(np.zeros(shape=(300,)))
    # we will return a numpy array of shape (#number of words in title * 300
    # each row represents the word2vec representation of each word (weighted/
    return  np.array(vec)

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

    final_dist = []
    # for each vector in vec1 we caluclate the distance(euclidean) to all vec
    for i in vec1:
        dist = []
        for j in vec2:
            # np.linalg.norm(i-j) will result the euclidean distance between
            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
    # final_dist[i,j] = euclidean distance between vectors i, j
    return np.array(final_dist)

def create_table(df_id1, df_id2, doc_id1,doc_id2):
    import plotly
    import plotly.figure_factory as ff
    from plotly.graph_objs import Scatter, Layout
    plotly.offline.init_notebook_mode(connected=False)

    data_matrix = [['Asin','Brand', 'Color'],
```

```
                    [data['asin'].loc[df_id1],brands[doc_id1], colors[doc_id1]
                    [data['asin'].loc[df_id2],brands[doc_id2], colors[doc_id2]

    colorscale = [[0, '#1d004d'],[.5, '#f2e5ff'],[1, '#f2e5d1']] # to color t

    # 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')


def heat_map_idf_brand_col_img(sentance1, sentance2, url, doc_id1, doc_id2, d

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

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

    #Create a table
    #create_table(df_id1, df_id2, doc_id1,doc_id2)
    '''Extremely high ram consumption. Try to avoid running the above line''


    # 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([])
```

```
114
115     # pass the url it display it
116     display_img(url, ax2, fig)
117
118     plt.show()
```

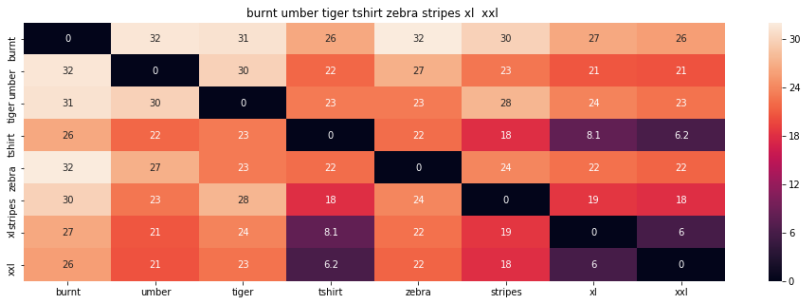
CNN features and concatenating all the features

In [15]:
```
1 cnn_features = np.load('16k_data_cnn_features.npy')
2 cnn_features_asins = list(np.load('16k_data_cnn_feature_asins.npy'))
```

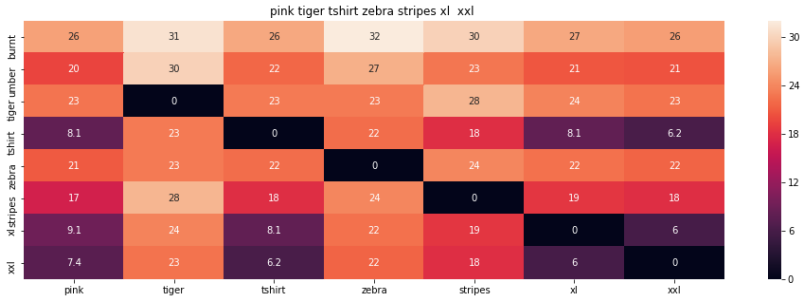
In [16]:
```
1  def idf_w2v_final(doc_id, w1, w2,w3, num_results):
2      # doc_id: apparel's id in given corpus
3      # w1: weight for  w2v features
4      # w2: weight for brand and color features
5      #w3 :weight for cnn features
6
7
8
9      # pairwise_dist will store the distance from given input apparel to all r
10     # the metric we used here is cosine, the coside distance is mesured as K(
11     idf_w2v_dist  = pairwise_distances(w2v_title_weight, w2v_title_weight[doc
12     ex_feat_dist = pairwise_distances(extra_features, extra_features[doc_id])
13     cnn_dist = pairwise_distances(cnn_features,cnn_features[doc_id].reshape(1
14     pairwise_dist   = (w1 * idf_w2v_dist +  w2 * ex_feat_dist) + w3 * cnn_dis
15
16     # np.argsort will return indices of 9 smallest distances
17     indices = np.argsort(pairwise_dist.flatten())[0:num_results]
18     #pdists will store the 9 smallest distances
19     pdists  = np.sort(pairwise_dist.flatten())[0:num_results]
20
21     #data frame indices of the 9 smallest distace's
22     df_indices = list(data.index[indices])
23
24
25     for i in range(0, len(indices)):
26         heat_map_idf_brand_col_img(data['title'].loc[df_indices[0]],data['tit
27         print('ASIN :',data['asin'].loc[df_indices[i]])
28         print('Brand :',data['brand'].loc[df_indices[i]])
29         print('Color :',data['color'].loc[df_indices[i]])
30         print('Product Type : ',data['product_type_name'].loc[df_indices[i]])
31         print('Euclidean distance from input :', pdists[i])
32
33         print('='*125)
```

Giving equal weights to all

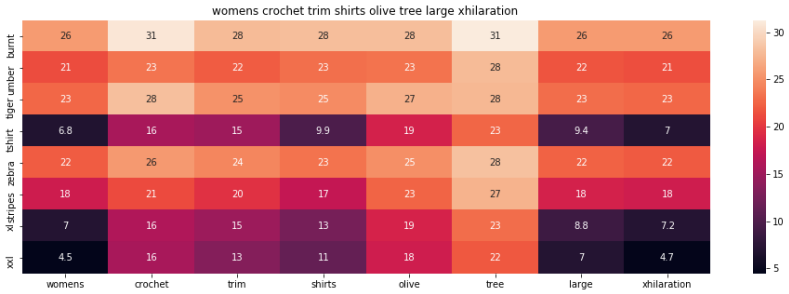
In [19]:
```
1 idf_w2v_final(12566, 1, 1,1, 5)
```



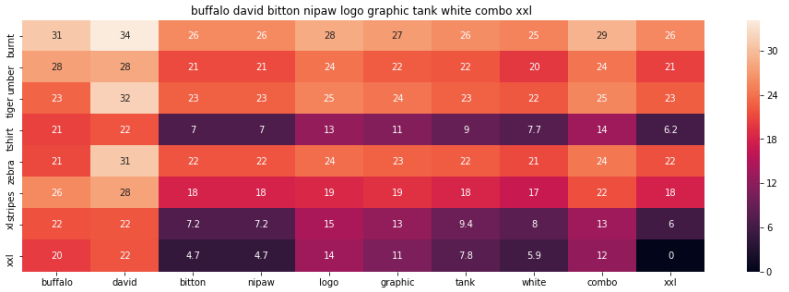
ASIN : B00JXQB5FQ
Brand : Si Row
Color : Brown
Product Type : TOYS_AND_GAMES
Euclidean distance from input : 0.018637641333
==========
==========



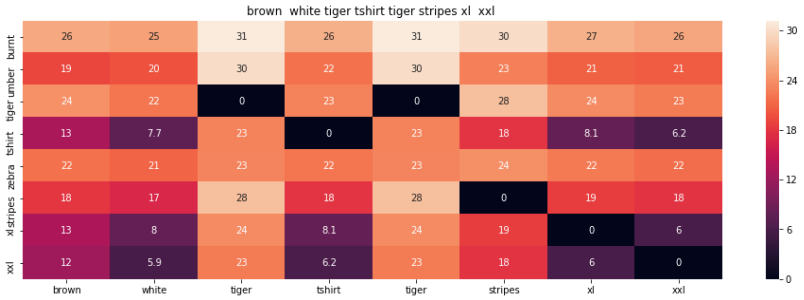
ASIN : B00JXQASS6
Brand : Si Row
Color : Pink
Product Type : TOYS_AND_GAMES
Euclidean distance from input : 21.6480869297
==========
==========



ASIN : B06XBHNM7J
Brand : Xhilaration
Color : Olive Tree
Product Type : SHIRT
Euclidean distance from input : 22.7769724431



ASIN : B018H5AZXQ
Brand : Buffalo
Color : White Combo
Product Type : SHIRT
Euclidean distance from input : 23.0580307546

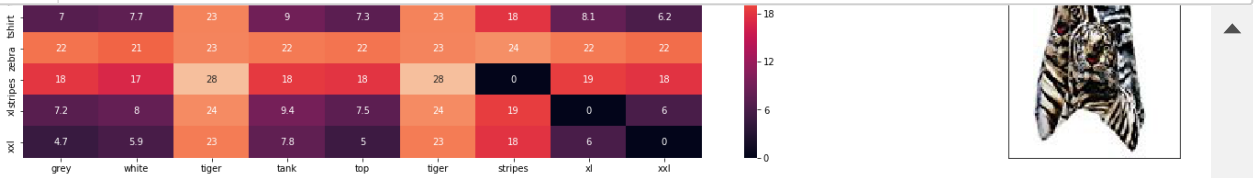


ASIN : B00JXQCWTO
Brand : Si Row

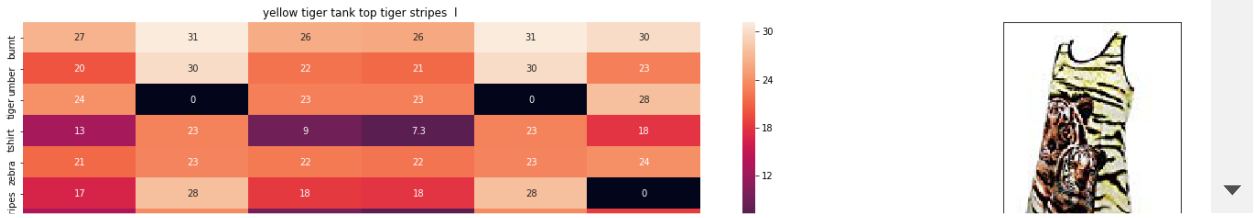
```
Color : Brown
Product Type :  TOYS_AND_GAMES
Euclidean distance from input : 23.2869067192
================================================================================
==========================================
```

Givning more weight to brand+color features

In [20]:
```
## Giving more weightage to brand an color features
idf_w2v_final(12566, 1, 20,1, 10)
```

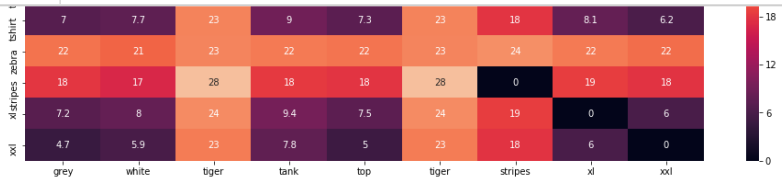



```
ASIN : B00JXQAFZ2
Brand : Si Row
Color : Grey
Product Type :  TOYS_AND_GAMES
Euclidean distance from input : 36.0956416202
================================================================================
==================================================
```

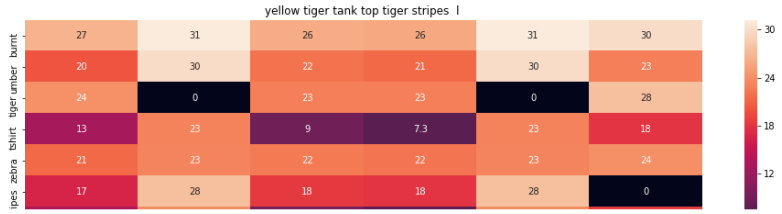


Giving more weightage to idf w22v features

In [21]:
```
## Giving more weightage to idf-w2v features

idf_w2v_final(12566, 20,1,1, 10)
```

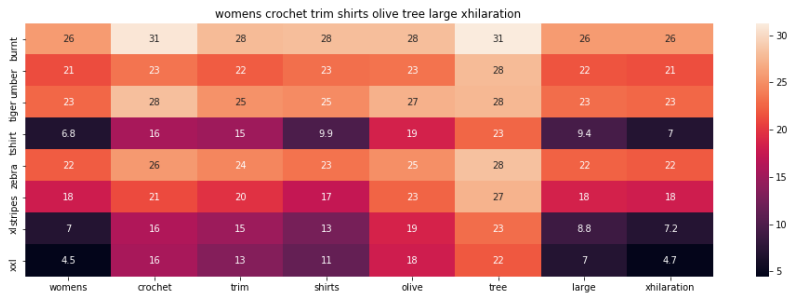


```
ASIN : B00JXQAFZ2
Brand : Si Row
Color : Grey
Product Type :  TOYS_AND_GAMES
Euclidean distance from input : 111.06863966
================================================================================
================================================
```

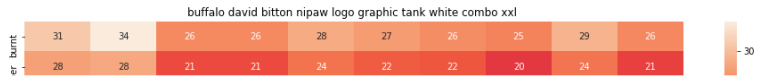


Giving more weight to cnn based features

In [22]:
```
## Giving more weightage to cnn features
idf_w2v_final(12566, 1,1,20, 10)
```



```
ASIN : B06XBHNM7J
Brand : Xhilaration
Color : Olive Tree
Product Type :  SHIRT
Euclidean distance from input : 44.1881395879
================================================================================
================================================
```



Observation and conclusion

There is a wide range of suggestions that pop up when we use equal weights for each of our four features. There is a healthy combination of Brand names, Colors and Textual similarity with the title. In general, what we observe mostly is that the suggestions are mostly related to animal names like zebra, tiger and a few other animals.

Giving more weight to IDF vectors has resulted in most of the recommendations belonging to the same brand and almost 90% of the top 20 recommendations had tiger and zebra prints specifically!

Giving more weights to brand names has resulted in suggestions which belong to the input brand, in our case we have Si Row. Almost 90% of the recommendations have the same brand name.

Here we have given more weights to colors and not to our surprise we see that most of the recommendations belonged to the same color, in our case the input color is Brown. Here again, 90% of the recommendations belonged to apparels having the same color as the query data point, i.e. Brown color.

Lastly, we have tried giving more weights to the CNN features and see how the system behaves! As we can see based solely on the CNN features, the model has picked up some really nice and diverse collections for recommendation purpose. Out query data point had a tiger image, it was white in color. The recommendations that were shown also had more or less the same features. We can see lots of diversity here including zebra stripes, tiger images, white images etc!