In [289…
```
import pandas as pd
import numpy as np
import seaborn as sns
import mysql.connector
import matplotlib.pyplot as plt
plt.style.use('ggplot')
```

Load Dataset

In [108…
```
log2_cols = [
    "sentiment", "publication_url", "product_url",
    "click", "gender" ,"age_group"
]

log2 = pd.read_csv("data/log2.csv", names = log2_cols)
print(log2.shape)
log2.head(2)
```

```
(10000, 6)
```

Out[108]:

	sentiment	publication_url	product_url	click	gender	age_group
0	positive	https://www.foxnews.com/	https://lees.com/jeans	0	female	juvenile
1	neutral	https://www.mirror.co.uk/news/	https://coach.com/purses	0	male	young

In [109…
```
product_categories = pd.read_csv("data/product_categories.csv")
print(product_categories.shape)
product_categories.head(2)
```

```
(25, 2)
```

Out[109]:

	product	category
0	blender	small kitchen appliances
1	pressure cooker	small kitchen appliances

In [110…
```
products = pd.read_csv("data/products.csv")
print(products.shape)
products.head(2)
```

```
(51, 3)
```

Out[110]:

	product	product_URL	product_type
0	Vitamix blender	https://vitamix.com/blenders	blender
1	Lenova laptop	https://lenova.com/laptops	computer

Data Cleaning

There are some extra spaces in front of some prodcut type. Will we remove them.

In [111…
```
new_prod_type = []
for x in products["product_type"].values:
    if x[0] == " ":
        new_prod_type.append(x[1:])
    else:
        new_prod_type.append(x)

products["product_type"] = new_prod_type
```

1. Identify corrupted URLs

In [112…
```
# correupted if Product_url does not occur in products table
corrupted_url = list()
url_l = np.unique(products["product_URL"])

for x in log2.itertuples():
    if x.product_url not in url_l:
        corrupted_url.append(x.product_url)

corrupted_url = np.unique(corrupted_url)
print("Number of corrupted URLs:", len(corrupted_url))
print("Some examples of corrupted URLs:")
for x in corrupted_url[:10]:
    print(x)
```

```
Number of corrupted URLs: 216
Some examples of corrupted URLs:
http://maybellije.com/lipstick
http://maybelline.com/lipstuck
http://maybelline.com/xipstick
http://nejoK.co/blenders
http://nemoK.co/blendess
http://nemoK.no/blenders
http://nemoK.wo/blenders
https://HamdltonBeach/blenders
https://HamilbonBeach/blenders
https://HamiloonBeach/blenders
```

2. Clean corrupted URLs

One way to correct the corrupted URLs is by finding if there is any similar URLs in the list of URLs provided by the products data. If there exists an similar enough URL in the products data, we can assume that the corrupted URL is a typo of the original URL. We can then correct it by replacing it with the similar URL. To find the similarity, we can use Jaccard similarity, which is a statistics used for computing similarity between sets. [1] After computing the Jaccard similrity between the corrupted URL and all URLs provided by

products.csv, we want to set a threshold high enough to filter out non-matching URLs so that we don't end up with many false positive matchings.

In practice, we would like to find this threshold by plotting the false positive rate against different level of thresohold and retrieve the optimal point. However, this requires first matching all corrupted URLs with the corresponding potential correct URLs, so for our convenience, we set an arbituary level of 0.85 as our threshold. Therefore, if the corrupted URL has a Jaccard similarity higher than 0.85 with any provided URL, we replace it with the correct version of the URL. Otherwise, we drop it from the dataset.

One limitation of this approach is that the method is not very scalable. If we have a larget set of URLs, for each corrupted URLs, we have to compute its Jaccard similarity with every potential URL.

In [113…
```
# https://stackoverflow.com/questions/46975929/how-can-i-calculate-the-jaccard-simi
def jaccard_similarity(list1, list2):
    """compute Jaccard similarity between 2 strings"""
    s1 = set(list1)
    s2 = set(list2)
    return float(len(s1.intersection(s2)) / len(s1.union(s2)))

def correct_url(x, url_l, threshold=0.85):
    """correct corrupted urls, return correct url if top Jaccard """
    """similarity is greater than threshold, otherwise return None """
    jaccard_l = list()
    for url in url_l:
        jaccard = jaccard_similarity(x, url)
        jaccard_l.append(jaccard)

    top_similarity = np.max(jaccard_l)
    if top_similarity > threshold:
        top_idx = np.argmax(jaccard_l)
        return url_l[top_idx]
    else:
        return None
```

In [114…
```
#Looking through some examples
for x in corrupted_url[:5]:
    print("Corrupted:", x, "| Cleaned:", correct_url(x, url_l))
```

```
Corrupted: http://maybellije.com/lipstick | Cleaned: http://maybelline.com/lipstic
k
Corrupted: http://maybelline.com/lipstuck | Cleaned: http://maybelline.com/lipstic
k
Corrupted: http://maybelline.com/xipstick | Cleaned: http://maybelline.com/lipstic
k
Corrupted: http://nejoK.co/blenders | Cleaned: http://nemoK.co/blenders
Corrupted: http://nemoK.co/blendess | Cleaned: http://nemoK.co/blenders
```

In [115…
```
# Apply to the dataset
cleaned_url = list()
for x in log2.itertuples():
    if x.product_url not in url_l:
```

```
        cleaned_url.append(correct_url(x.product_url, url_l))
    else:
        cleaned_url.append(x.product_url)
log2["product_url"] = cleaned_url
```

In [116…

```
cnt = 0
for x in log2.itertuples():
    if x.product_url not in url_l:
        cnt += 1
print(cnt)
```

```
0
```

3. Find all website that has an Ad for each product

In [326…

```
all_publications = list()
product_l = np.unique(products["product"].values)
for x in product_l:
    product_url = products[products["product"] == x]["product_URL"].values[0]
    #find matching product url
    subset = log2[log2["product_url"] == product_url]
    publication_url = np.unique(subset["publication_url"])
    all_publications.append(publication_url)


product_publication = {
    product_l[i]: all_publications[i] for i in range(len(product_l))
}

product_publication
```

Out[326]:
```
{'Apple computer': array(['https://abcnews.go.com/', 'https://nypost.com/',
       'https://techcrunch.com/', 'https://www.boston.com',
       'https://www.bostonglobe.com/', 'https://www.cbsnews.com/',
       'https://www.cnet.com/', 'https://www.cnn.com/',
       'https://www.dallasnews.com/', 'https://www.engadget.com/',
       'https://www.mirror.co.uk/news/', 'https://www.nj.com',
       'https://www.nydailynews.com/', 'https://www.upworthy.com/',
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       'https://www.businessinsider.com/',
       'https://www.chicagotribune.com/', 'https://www.cnn.com/',
       'https://www.examiner.com/', 'https://www.latimes.com/',
       'https://www.mirror.co.uk/news/', 'https://www.nj.com',
       'https://www.npr.org/', 'https://www.sfgate.com/',
       'https://www.slate.com/', 'https://www.telegraph.co.uk/',
       'https://www.theguardian.com/us', 'https://www.vice.com/en_us'],
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       'https://www.nytimes.com/', 'https://www.telegraph.co.uk/',
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       'https://www.independent.co.uk/', 'https://www.msn.com/en-us/news',
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       'https://www.npr.org/', 'https://www.nydailynews.com/',
       'https://www.salon.com/', 'https://www.theatlantic.com/',
       'https://www.upworthy.com/', 'https://www.usatoday.com/',
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m/',
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       'https://www.dallasnews.com/', 'https://www.engadget.com/',
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       'https://www.examiner.com/', 'https://www.huffingtonpost.com/',
```

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       'https://www.dallasnews.com/', 'https://www.msn.com/en-us/news',
       'https://www.nydailynews.com/', 'https://www.nytimes.com/',
       'https://www.salon.com/', 'https://www.sfgate.com/',
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       'https://www.cnn.com/', 'https://www.dallasnews.com/',
       'https://www.engadget.com/', 'https://www.examiner.com/',
       'https://www.nj.com', 'https://www.nydailynews.com/',
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       'https://www.dallasnews.com/', 'https://www.engadget.com/',
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```

```
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```

4. Find all website that has an Ad for each product type

In [118…

```python
def product_type_publication(product_type):
    """Find all publication urls for a product type"""
    #first find all the products in the product type
    subset = products[products["product_type"] == product_type]
    all_products = np.unique(subset["product_URL"])

    #next we find the subset of log2 that contains the products
    subset2 = log2[log2["product_url"].isin(all_products)]

    #find all publications
    all_publications = np.unique(subset2["publication_url"])

    return all_publications
```

In [119…

```python
product_type_pub = list()
product_type_l = np.unique(products["product_type"])

#find all publication sites for each product type
for product_type in product_type_l:
    all_publications = product_type_publication(product_type)
    product_type_pub.append(all_publications)

product_type_pub_d = {
    product_type_l[i]: product_type_pub[i] for i in range(len(product_type_l))
```

```
}

product_type_pub_d
```

```
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5. Saving to database

In the products dataset, many products share the same product type. To avoid data redundency, we will save the above data to a new table instead of adding it to the products dataset. We will use product type as the primary key in the new dataset and set foreign key constraint to the product_type column in the products dataset.

In [120…

```
#Create dataframe

product_type_publication = pd.DataFrame()
product_type_publication["product_type"] = product_type_l
product_type_publication["all_publication"] = product_type_pub
product_type_publication.head(2)
```

Out[120]:

	product_type	all_publication
0	blender	[https://abcnews.go.com/, https://mashable.com...
1	car	[https://mashable.com/, https://techcrunch.com...

In [121…

```
#Connect to database
mydb = mysql.connector.connect(
    host="localhost",
    user="root",
    password="data1050",
    database = "ads_r_us"
)

if mydb.is_connected():
    print("CONNECTION SUCCESSFUL")
```

```
CONNECTION SUCCESSFUL
```

In [122…

```
mycursor = mydb.cursor(buffered=True)

#Create tables
sql = (
    "CREATE TABLE IF NOT EXISTS ads_r_us.prod_type_pub("
    "product_type varchar(255),"
    "all_publication_url varchar(10000),"
    "PRIMARY KEY (product_type));"
)
mycursor.execute(sql)

sql = (
```

```
    "CREATE TABLE IF NOT EXISTS ads_r_us.products("
    "product varchar(255),"
    "product_URL varchar(255),"
    "product_type varchar(255),"
    "PRIMARY KEY (product),"
    "FOREIGN KEY (product_type) REFERENCES prod_type_pub(product_type));"
)
mycursor.execute(sql)
```

In [20]:
```
#Insert data
# https://www.w3schools.com/python/python_mysql_insert.asp
sql = "INSERT INTO prod_type_pub VALUES (%s, %s)"
val = list(zip(
    product_type_publication["product_type"],
    [str(x) for x in product_type_publication["all_publication"]]
))
mycursor.executemany(sql, val)
mydb.commit()
```

In [49]:
```
#check the result
# https://www.w3schools.com/python/python_mysql_select.asp
mycursor.execute("SELECT * FROM prod_type_pub")
myresult = mycursor.fetchall()
myresult
```

Out[49]:
```
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```

6. Compute click rate for each product

In [329…

```
def compute_click_rate(product):
    """compute click rate for each product"""
    #Find the product url
    product_url = products[
        products["product"] == product].product_URL.values[0]

    #subset data
    subset = log2[log2["product_url"] == product_url]

    #Compute click rate
    clicks = np.sum(subset["click"])
    click_rate = clicks/len(subset)

    return click_rate
```

In [330…

```
click_rate_d = dict()
for product in product_l:
    click_rate_d[product] = compute_click_rate(product)

click_rate_d
```

Out[330]:
```
{'Apple computer': 0.7902439024390244,
 'Apple iPad': 0.5019011406844106,
 'Apple laptop': 0.5645161290322581,
 'BasilBasel perfume': 0.6493506493506493,
 'Broyhill recliner': 0.5392156862745098,
 'Centrum MultiVitamins': 0.628099173553719,
 'Clinique moisturizer': 0.8055555555555556,
 'Coach purse': 0.388646288209607,
 'Cougar jeans': 0.2600732600732601,
 'Covergirl makeup': 0.2561576354679803,
 'Dell computer': 0.6545454545454545,
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 'Docker pants': 0.6815286624203821,
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 'Guess perfume': 0.40588235294117647,
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 'Ikea sofa': 0.5730337078651685,
 'InstantPot pressure cooker': 0.5,
 'Jaguar perfume': 0.4772727272727273,
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 'LG TV': 0.4807692307692308,
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 'NordicTrack rower': 0.22340425531914893,
 'NordicTrack treadmill': 0.4897119341563786,
 'Remington shaver': 0.34507042253521125,
 'Samsung TV': 0.73125,
 'Samsung dryer': 0.43312101910828027,
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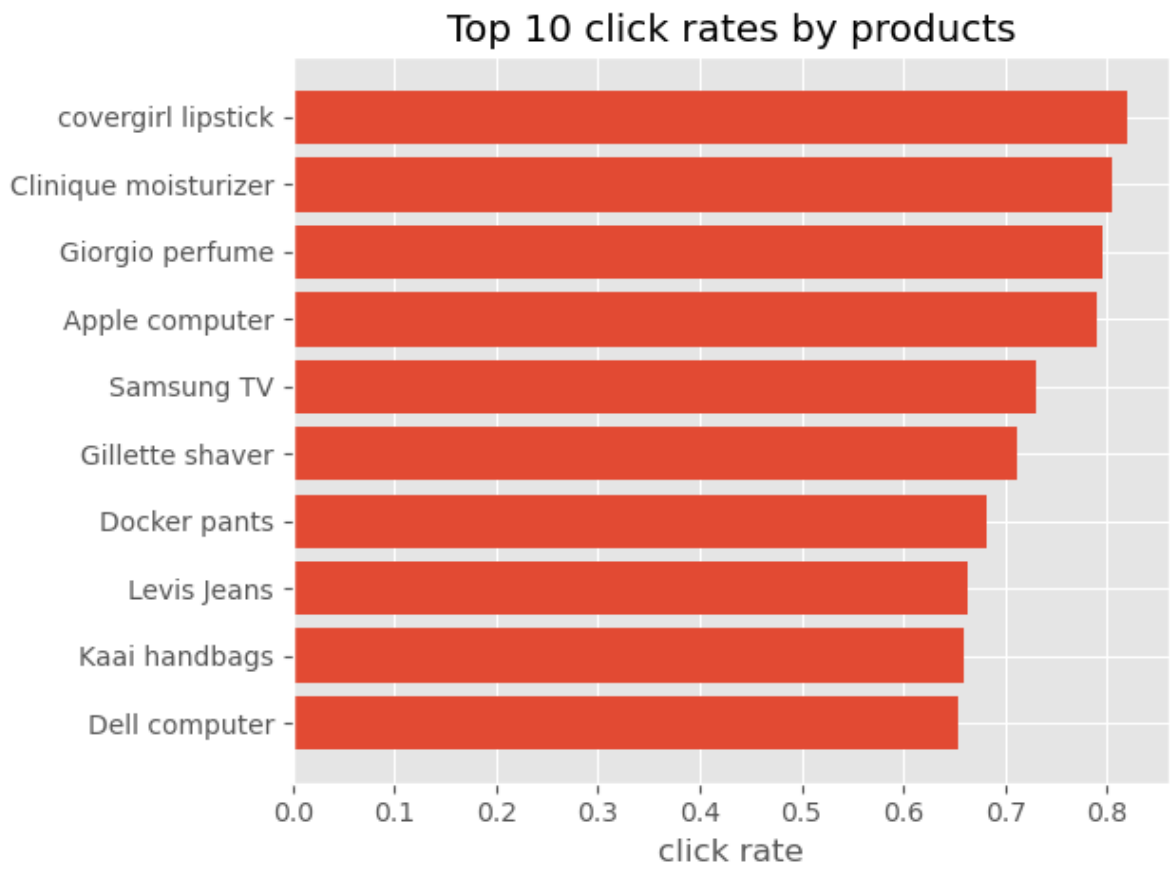
 'Soundwave speakers': 0.5458937198067633,
 'Starbucks Coffee': 0.275974025974026,
 'Tesla': 0.5882352941176471,
 'Vitamix blender': 0.5073170731707317,
 'bose speakers': 0.5255102040816326,
 'covergirl lipstick': 0.8201438848920863}
```

In [351…
```
#Graph the result
click_rate_df = pd.DataFrame()
click_rate_df["product"] = product_l
click_rate_df["click_rate"] = click_rate_d.values()
click_rate_df.sort_values(by="click_rate", ascending=False, inplace=True)
```

```
plt.figure()
plt.title("Top 10 click rates by products")
plt.barh(
    range(10), click_rate_df["click_rate"].values[:10][::-1],
    tick_label=click_rate_df["product"].values[:10][::-1]
)
plt.xlabel("click rate")
plt.tight_layout()

plt.savefig("figures/top_product_click_rate.png")
plt.show()
```



7. Compute click rate for each product/sentiment type

In [261…

```
def compute_click_rate_sent(product, sentiment):
    """compute the click rate for each product conditioned on sentiment type"""
    #Find the product url
    product_url = products[
        products["product"] == product].product_URL.values[0]

    #subset data
    subset = log2[log2["product_url"] == product_url]

    # subset by sentiment type
```

```
    subset2 = subset[subset["sentiment"] == sentiment]

    #Compute click rate
    clicks = np.sum(subset2["click"])
    click_rate = clicks/len(subset2)

    return click_rate
```

In [376…

```
prod_l = list()
sent_l = list()
click_l = list()
sentiment_l = ["positive", "negative", "neutral"]

for p in product_l:
    for s in sentiment_l:
        prod_l.append(p)
        sent_l.append(s)
        click_l.append(compute_click_rate_sent(p,s))

click_sentiment_df = pd.DataFrame()
click_sentiment_df["product"] = prod_l
click_sentiment_df["sentiment"] = sent_l
click_sentiment_df["click_rate"] = click_l

click_sentiment_df.sort_values(
    by="click_rate", ascending=False, inplace=True)
click_sentiment_df.head()
```

Out[376]:

	product	sentiment	click_rate
149	covergirl lipstick	neutral	1.000000
147	covergirl lipstick	positive	1.000000
140	Tesla	neutral	0.987654
106	NemoK blender	negative	0.978261
47	Giorgio perfume	neutral	0.969697

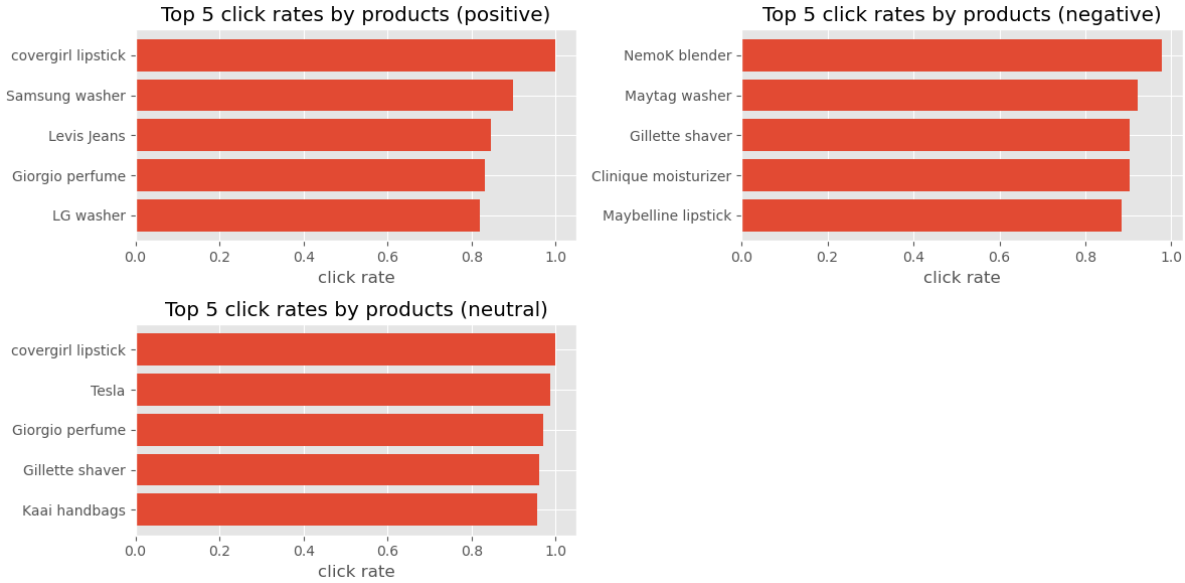
In [377…

```
sentiment_l = ["positive", "negative", "neutral"]

plt.figure(figsize=(12,6))
for i in range(len(sentiment_l)):
    s = sentiment_l[i]
    sub_df = click_sentiment_df[click_sentiment_df["sentiment"] == s]
    sub_df.sort_values(by="click_rate", ascending=False)

    plt.subplot(2,2,i+1)
    title = "Top 5 click rates by products (" + str(s) +")"
    plt.title(title)
    plt.barh(
        range(5), sub_df["click_rate"].values[:5][::-1],
        tick_label=sub_df["product"].values[:5][::-1]
    )
    plt.xlabel("click rate")
```

```
plt.tight_layout()
plt.savefig("figures/prod_click_sent.png")
```



8. Compute click rate for each product type

In [378…

```
def compute_click_rate_ptype(product_type):
    """compute click rate for each product type"""
    #subset data
    subset = products[products["product_type"] == product_type]
    urls = np.unique(subset["product_URL"])

    #find all products within the product type
    subset2 = log2[log2["product_url"].isin(urls)]

    #Compute click rate
    clicks = np.sum(subset2["click"])
    click_rate = clicks/len(subset2)

    return click_rate
```

In [379…

```
click_rate_ptype_d = dict()
for x in product_type_l:
    click_rate_ptype_d[x] = compute_click_rate_ptype(x)
click_rate_ptype_d
```

Out[379]:
```
{'blender': 0.49923664122137407,
 'car': 0.3693304535637149,
 'coffee': 0.3552941176470588,
 'computer': 0.56,
 'dryer': 0.4529058116232465,
 'elliptical trainer': 0.5284090909090909,
 'face cream': 0.8055555555555556,
 'furniture': 0.5549738219895288,
 'jeans': 0.45174825174825173,
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 'makeup': 0.2561576354679803,
 'pants': 0.6815286624203821,
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 'pressure cooker': 0.5,
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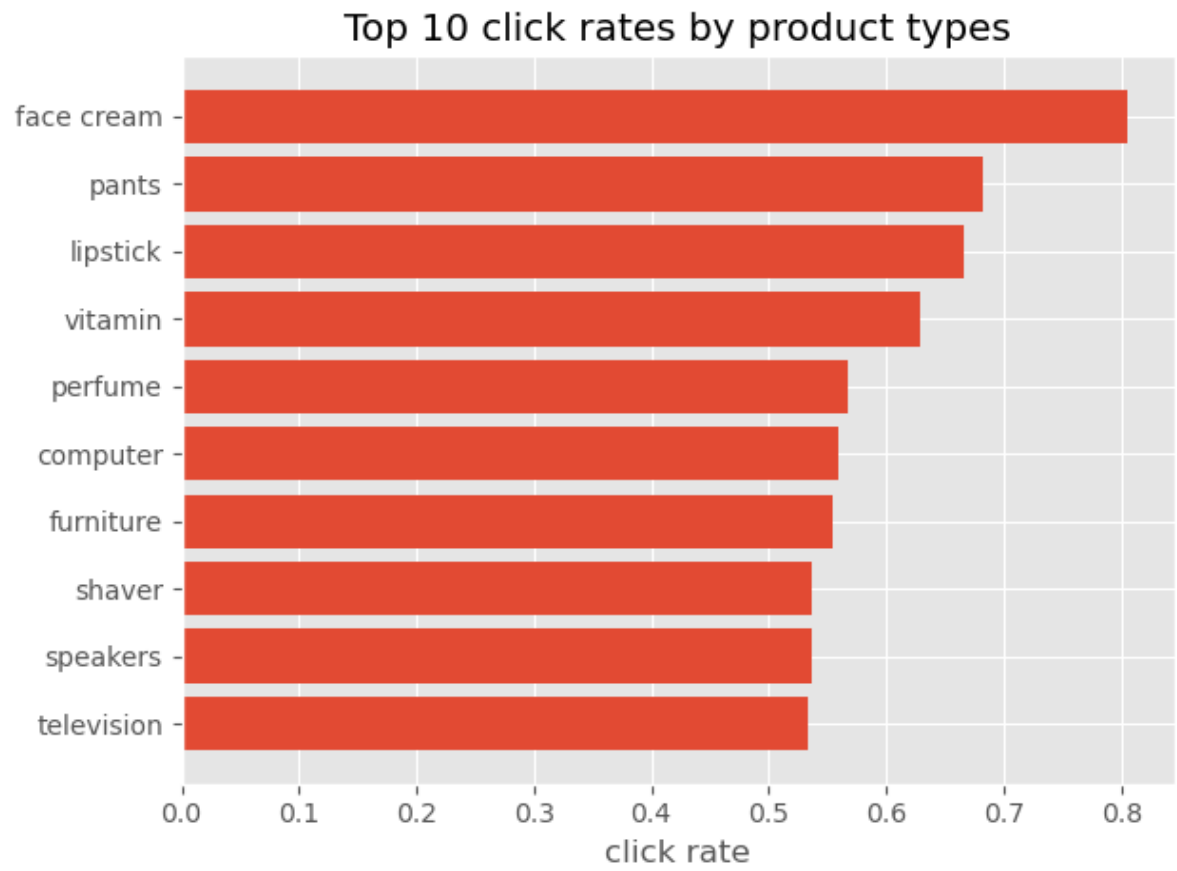
 'vitamin': 0.628099173553719,
 'washer': 0.5182767624020888,
 "women's purse": 0.5151515151515151}
```

In [380…
```
click_rate_ptype_df = pd.DataFrame()
click_rate_ptype_df["product_type"] = product_type_l
click_rate_ptype_df["click_rate"] = click_rate_ptype_d.values()
click_rate_ptype_df.sort_values(by="click_rate", ascending=False, inplace=True)

plt.figure()
plt.title("Top 10 click rates by product types")
plt.barh(
    range(10), click_rate_ptype_df["click_rate"].values[:10][::-1],
    tick_label=click_rate_ptype_df["product_type"].values[:10][::-1]
)
plt.xlabel("click rate")
plt.tight_layout()
plt.savefig("figures/top_product_type_click_rate.png")
plt.show()
```



9. Click rate for each product type by sentiment type

In [381…

```
def compute_click_rate_sent_ptype(product_type, sentiment):
    """compute the click rate for each product type conditioned on sentiment type""
    #Subset by product type
    subset = products[products["product_type"] == product_type]
    urls = np.unique(subset["product_URL"])

    #subset by product url
    subset2 = log2[log2["product_url"].isin(urls)]

    #subset by sentiment
    subset3 = subset2[subset2["sentiment"] == sentiment]

    #Compute click rate for each sentiment type
    clicks = np.sum(subset3["click"])
    click_rate = clicks/len(subset3)

    return click_rate
```

In [382…

```
prod_l = list()
sent_l = list()
click_l = list()
sentiment_l = ["positive", "negative", "neutral"]
```

```
for p in product_type_l:
    for s in sentiment_l:
        prod_l.append(p)
        sent_l.append(s)
        click_l.append(compute_click_rate_sent_ptype(p,s))

click_sentiment_ptype_df = pd.DataFrame()
click_sentiment_ptype_df["product_type"] = prod_l
click_sentiment_ptype_df["sentiment"] = sent_l
click_sentiment_ptype_df["click_rate"] = click_l

click_sentiment_ptype_df.sort_values(
    by="click_rate", ascending=False, inplace=True)
click_sentiment_ptype_df.head()
```

Out[382]:

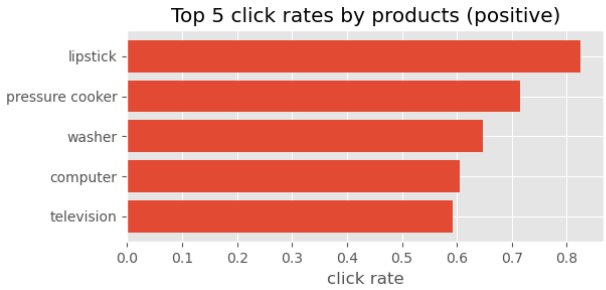
	product_type	sentiment	click_rate
20	face cream	neutral	0.930556
19	face cream	negative	0.902778
41	pressure cooker	neutral	0.864407
34	pants	negative	0.835821
64	vitamin	negative	0.835294

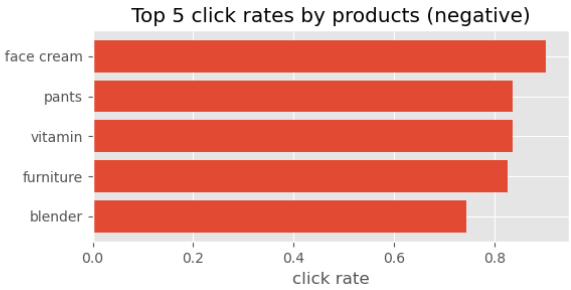
In [383…

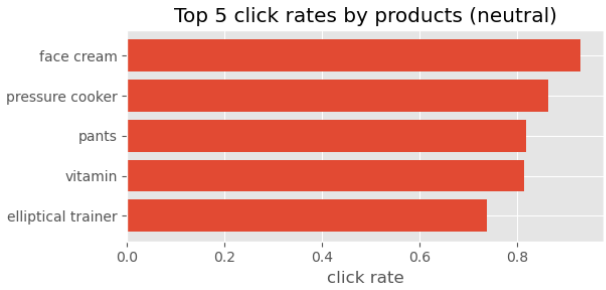
```
sentiment_l = ["positive", "negative", "neutral"]

plt.figure(figsize=(12,6))
for i in range(len(sentiment_l)):
    s = sentiment_l[i]
    sub_df = click_sentiment_ptype_df[click_sentiment_ptype_df["sentiment"] == s]
    sub_df.sort_values(by="click_rate", ascending=False)

    plt.subplot(2,2,i+1)
    title = "Top 5 click rates by products (" + str(s) +")"
    plt.title(title)
    plt.barh(
        range(5), sub_df["click_rate"].values[:5][::-1],
        tick_label=sub_df["product_type"].values[:5][::-1]
    )
    plt.xlabel("click rate")
plt.tight_layout()
plt.savefig("figures/ptype_click_sent.png")
```







10. Save into database

Since we have both sentiment and the click rate features, appending to any existing tables will cause data redundancy issues. As a solution, we will create a new table, with product_type and sentiment as primary key. Since no other table uses product_type and sentiment type as primary key, and no other table uses the combination of the two features, we do not have any foreign key constraint.

In [169…

```
#Create dataframe
prod_type_click_df = pd.DataFrame()
prod_type_l = list()
sentiment_l = list()
click_rate_l = list()

for k, v in click_rate_ptype_sent_d.items():
    for k1, v1 in v.items():
        prod_type_l.append(k)
        sentiment_l.append(k1)
        click_rate_l.append(v1)

prod_type_click_df["product_type"] = prod_type_l
prod_type_click_df["sentiment"] = sentiment_l
prod_type_click_df["click_rate"] = click_rate_l

prod_type_click_df.head(2)
```

Out[169]:

	product_type	sentiment	click_rate
0	blender	positive	0.378788
1	blender	negative	0.742739

In [171…
```
#Create table
sql = (
    "CREATE TABLE IF NOT EXISTS ads_r_us.prod_click_rate("
    "product_type varchar(255),"
    "sentiment varchar(255),"
    "click_rate float(5),"
    "PRIMARY KEY (product_type, sentiment));"
)
mycursor.execute(sql)
```

In [173…
```
for x in prod_type_click_df.itertuples():
    sql = "INSERT INTO prod_click_rate VALUES (%s, %s, %s)"
    val = [x.product_type, x.sentiment, x.click_rate]
    mycursor.execute(sql, val)
mydb.commit()
```

In [175…
```
#check the result
# https://www.w3schools.com/python/python_mysql_select.asp
mycursor.execute("SELECT * FROM prod_click_rate")
myresult = mycursor.fetchall()
myresult
```

Out[175]:
```
[('blender', 'negative', 0.742739),
 ('blender', 'neutral', 0.337963),
 ('blender', 'positive', 0.378788),
 ('car', 'negative', 0.387755),
 ('car', 'neutral', 0.585526),
 ('car', 'positive', 0.152439),
 ('coffee', 'negative', 0.465278),
 ('coffee', 'neutral', 0.357143),
 ('coffee', 'positive', 0.241135),
 ('computer', 'negative', 0.505435),
 ('computer', 'neutral', 0.569106),
 ('computer', 'positive', 0.606061),
 ('dryer', 'negative', 0.327586),
 ('dryer', 'neutral', 0.730061),
 ('dryer', 'positive', 0.308642),
 ('elliptical trainer', 'negative', 0.491228),
 ('elliptical trainer', 'neutral', 0.737705),
 ('elliptical trainer', 'positive', 0.344828),
 ('face cream', 'negative', 0.902778),
 ('face cream', 'neutral', 0.930556),
 ('face cream', 'positive', 0.583333),
 ('furniture', 'negative', 0.825),
 ('furniture', 'neutral', 0.578947),
 ('furniture', 'positive', 0.27907),
 ('jeans', 'negative', 0.262745),
 ('jeans', 'neutral', 0.61165),
 ('jeans', 'positive', 0.511811),
 ('lipstick', 'negative', 0.692308),
 ('lipstick', 'neutral', 0.51145),
 ('lipstick', 'positive', 0.825688),
 ('makeup', 'negative', 0.125),
 ('makeup', 'neutral', 0.384615),
 ('makeup', 'positive', 0.245283),
 ('pants', 'negative', 0.835821),
 ('pants', 'neutral', 0.818182),
 ('pants', 'positive', 0.326087),
 ('perfume', 'negative', 0.555556),
 ('perfume', 'neutral', 0.610561),
 ('perfume', 'positive', 0.532646),
 ('pressure cooker', 'negative', 0.0),
 ('pressure cooker', 'neutral', 0.864407),
 ('pressure cooker', 'positive', 0.714286),
 ('refrigerator', 'negative', 0.122222),
 ('refrigerator', 'neutral', 0.388889),
 ('refrigerator', 'positive', 0.347368),
 ('rowing machine', 'negative', 0.2),
 ('rowing machine', 'neutral', 0.142857),
 ('rowing machine', 'positive', 0.297297),
 ('shaver', 'negative', 0.524194),
 ('shaver', 'neutral', 0.651685),
 ('shaver', 'positive', 0.435294),
 ('speakers', 'negative', 0.348837),
 ('speakers', 'neutral', 0.705882),
 ('speakers', 'positive', 0.543478),
 ('tablet', 'negative', 0.391304),
 ('tablet', 'neutral', 0.627907),
```

```
 ('tablet', 'positive', 0.494118),
 ('television', 'negative', 0.319277),
 ('television', 'neutral', 0.701987),
 ('television', 'positive', 0.592814),
 ('treadmill', 'negative', 0.316456),
 ('treadmill', 'neutral', 0.58427),
 ('treadmill', 'positive', 0.56),
 ('vitamin', 'negative', 0.835294),
 ('vitamin', 'neutral', 0.814815),
 ('vitamin', 'positive', 0.197368),
 ('washer', 'negative', 0.374502),
 ('washer', 'neutral', 0.518987),
 ('washer', 'positive', 0.647482),
 ("women's purse", 'negative', 0.386364),
 ("women's purse", 'neutral', 0.694444),
 ("women's purse", 'positive', 0.457516)]
```

11. Determine the effects of viewer's gender

In [384…

```
# Calculate the click rate for each product_type, sentiment, and gender
def calculate_click_gender(product_type, sentiment):
    #subset by product_type
    subset = products[products["product_type"] == product_type]
    urls = np.unique(subset["product_URL"])

    #find all matching products
    subset2 = log2[log2["product_url"].isin(urls)]

    subset3 = subset2[subset2["sentiment"] == sentiment]

    #subset by gender
    female = subset3[subset3["gender"] == "female"]
    male = subset3[subset3["gender"] == "male"]

    clicks_female = np.sum(female["click"])
    click_rate_f = clicks_female/len(female)

    clicks_male = np.sum(male["click"])
    click_rate_m = clicks_male/len(male)

    return (click_rate_f, click_rate_m)
```

In [385…

```
#Create dataframe
prod_l = list()
sent_l = list()
click_rate_f_l = list()
click_rate_m_l = list()

sentiment_l = ["positive", "negative", "neutral"]

for p in product_type_l:
    for s in sentiment_l:
        click_rate_f, click_rate_m = calculate_click_gender(p, s)
```

```
        prod_l.append(p)
        sent_l.append(s)
        click_rate_f_l.append(click_rate_f)
        click_rate_m_l.append(click_rate_m)

clicks_gender_df = pd.DataFrame()
clicks_gender_df["product_type"] = prod_l
clicks_gender_df["sentiment"] = sent_l
clicks_gender_df["click_rate_f"] = click_rate_f_l
clicks_gender_df["click_rate_m"] = click_rate_m_l

clicks_gender_df.head(6)
```

Out[385]:

	product_type	sentiment	click_rate_f	click_rate_m
0	blender	positive	0.377358	0.380435
1	blender	negative	0.695652	0.785714
2	blender	neutral	0.375000	0.291667
3	car	positive	0.128205	0.174419
4	car	negative	0.375000	0.397590
5	car	neutral	0.533333	0.636364

In [386…

```
# Compute difference
clicks_gender_df["click_rate_diff"] = abs(clicks_gender_df[
    "click_rate_f"] - clicks_gender_df["click_rate_m"])

clicks_gender_df.head(3)
```

Out[386]:

	product_type	sentiment	click_rate_f	click_rate_m	click_rate_diff
0	blender	positive	0.377358	0.380435	0.003076
1	blender	negative	0.695652	0.785714	0.090062
2	blender	neutral	0.375000	0.291667	0.083333

We define arbitrary threshold for difference as 5%. That is, if the absolute difference between the click rate for females and the click rate for males is greater than 0.05, then we say that there is a significant different.

In [387…

```
significant_gender = clicks_gender_df[
    clicks_gender_df["click_rate_diff"] > 0.05]

significant_gender.sort_values(
    by="click_rate_diff", ascending=False, inplace=True)
print(significant_gender.shape)
significant_gender.head()
```

```
(41, 5)
```

```
C:\Users\Home\AppData\Local\Temp\ipykernel_880\3535858583.py:4: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  significant_gender.sort_values(
```

Out[387]:

	product_type	sentiment	click_rate_f	click_rate_m	click_rate_diff
32	makeup	neutral	0.270270	0.487805	0.217535
48	shaver	positive	0.312500	0.509434	0.196934
15	elliptical trainer	positive	0.240000	0.424242	0.184242
44	refrigerator	neutral	0.477273	0.304348	0.172925
43	refrigerator	negative	0.192308	0.026316	0.165992

12. Determine the effects of viewer's age groups

In [388…

```
# Calculate the click rate for each product_type, sentiment, and age group
def calculate_click_age(product_type, sentiment, age_group):
    #subset by product_type
    subset = products[products["product_type"] == product_type]
    urls = np.unique(subset["product_URL"])

    #find all matching products
    subset2 = log2[log2["product_url"].isin(urls)]

    subset3 = subset2[subset2["sentiment"] == sentiment]

    #subset by age
    subset4 = subset3[subset3["age_group"] == age_group]

    clicks = np.sum(subset4["click"])
    click_rate = clicks/len(subset4)

    return click_rate
```

In [389…

```
#Create dataframe
prod_l = list()
sent_l = list()
click_rate_young_l = list()
click_rate_middle_l = list()
click_rate_senior_l = list()
click_rate_juvenile_l = list()

for p in product_type_l:
    for s in sentiment_l:
        click_young = calculate_click_age(p, s, "young")
        click_middle = calculate_click_age(p, s, "middle-age")
```

```
        click_senior = calculate_click_age(p, s, "senior")
        click_juvenile = calculate_click_age(p, s, "juvenile")

        prod_l.append(p)
        sent_l.append(s)
        click_rate_young_l.append(click_young)
        click_rate_middle_l.append(click_middle)
        click_rate_senior_l.append(click_senior)
        click_rate_juvenile_l.append(click_juvenile)

clicks_age_df = pd.DataFrame()
clicks_age_df["product_type"] = prod_l
clicks_age_df["sentiment"] = sent_l
clicks_age_df["click_rate_young"] = click_rate_young_l
clicks_age_df["click_rate_middle"] = click_rate_middle_l
clicks_age_df["click_rate_senior"] = click_rate_senior_l
clicks_age_df["click_rate_juvenile"] = click_rate_juvenile_l


clicks_age_df.head(6)
```

Out[389]:

	product_type	sentiment	click_rate_young	click_rate_middle	click_rate_senior	click_rate_juvenile
0	blender	positive	0.461538	0.297872	0.428571	0.320000
1	blender	negative	0.803279	0.738462	0.672727	0.750000
2	blender	neutral	0.316667	0.300000	0.418182	0.313725
3	car	positive	0.187500	0.106383	0.300000	0.051282
4	car	negative	0.361111	0.404762	0.416667	0.363636
5	car	neutral	0.523810	0.500000	0.720930	0.571429

In [390…

```
# Compute the pairwise difference
age_cols = [
    "click_rate_young", "click_rate_middle",
    "click_rate_senior", "click_rate_juvenile"
]

for i in range(len(age_cols)):
    for j in range(i+1, len(age_cols)):
        col1 = age_cols[i]
        col2 = age_cols[j]

        pairwise_diff = np.abs(
            clicks_age_df[col1] - clicks_age_df[col2]
        )
        col_name = col1.split("_")[-1] + "_" + col2.split("_")[-1]

        clicks_age_df[col_name] = pairwise_diff

clicks_age_df.head(6)
```

Out[390]:

	product_type	sentiment	click_rate_young	click_rate_middle	click_rate_senior	click_rate_juvenile
0	blender	positive	0.461538	0.297872	0.428571	0.320000
1	blender	negative	0.803279	0.738462	0.672727	0.750000
2	blender	neutral	0.316667	0.300000	0.418182	0.313725
3	car	positive	0.187500	0.106383	0.300000	0.051282
4	car	negative	0.361111	0.404762	0.416667	0.363636
5	car	neutral	0.523810	0.500000	0.720930	0.571429

In [391…

```
# Decide if there is significant difference between pairs
age_diff_cols = [
    "young_middle", "young_senior", "young_juvenile",
    "middle_senior", "middle_juvenile", "senior_juvenile"
]

significant_age_l = list()
for x in age_diff_cols:
    significant_age = clicks_age_df[["product_type", "sentiment", x]]
    significant_age = significant_age[significant_age[x] > 0.05]
    significant_age.sort_values(by=x, ascending=False, inplace=True)
    significant_age_l.append(significant_age)
```

In [392…

```
for x in significant_age_l:
    print(x.head())
```

```
       product_type sentiment  young_middle
39  pressure cooker  positive      0.343874
51         speakers  positive      0.305305
45   rowing machine  positive      0.305195
30           makeup  positive      0.295238
46   rowing machine  negative      0.283333
          product_type sentiment  young_senior
45      rowing machine  positive      0.603175
17  elliptical trainer   neutral      0.283333
42        refrigerator  positive      0.258312
49              shaver  negative      0.222222
5                  car   neutral      0.197121
      product_type sentiment  young_juvenile
45  rowing machine  positive        0.664286
63         vitamin  positive        0.375000
30          makeup  positive        0.337662
51        speakers  positive        0.286787
21       furniture  positive        0.284193
          product_type sentiment  middle_senior
17  elliptical trainer   neutral       0.400000
32              makeup   neutral       0.318182
51            speakers  positive       0.313840
71       women's purse   neutral       0.298738
45      rowing machine  positive       0.297980
      product_type sentiment  middle_juvenile
35           pants   neutral         0.363636
45  rowing machine  positive         0.359091
6           coffee  positive         0.312331
60       treadmill  positive         0.310458
71   women's purse   neutral         0.230415
          product_type sentiment  senior_juvenile
17  elliptical trainer   neutral         0.375439
70       women's purse  negative         0.306723
51            speakers  positive         0.295322
33               pants  positive         0.285714
48              shaver  positive         0.265882
```

13. Recommendations

a. which ads generate most clicks given sentiment context?

In [395…

```
plt.figure(figsize=(10,5))
for i in range(len(sentiment_l)):
    plt.subplot(2,2,i+1)
    plt.title("Top5 click rate (" + str(sentiment_l[i]) + ")")

    sub_df = click_sentiment_df[
        click_sentiment_df["sentiment"] == sentiment_l[i]]
    sub_df.sort_values(by="click_rate", ascending=False, inplace=True)

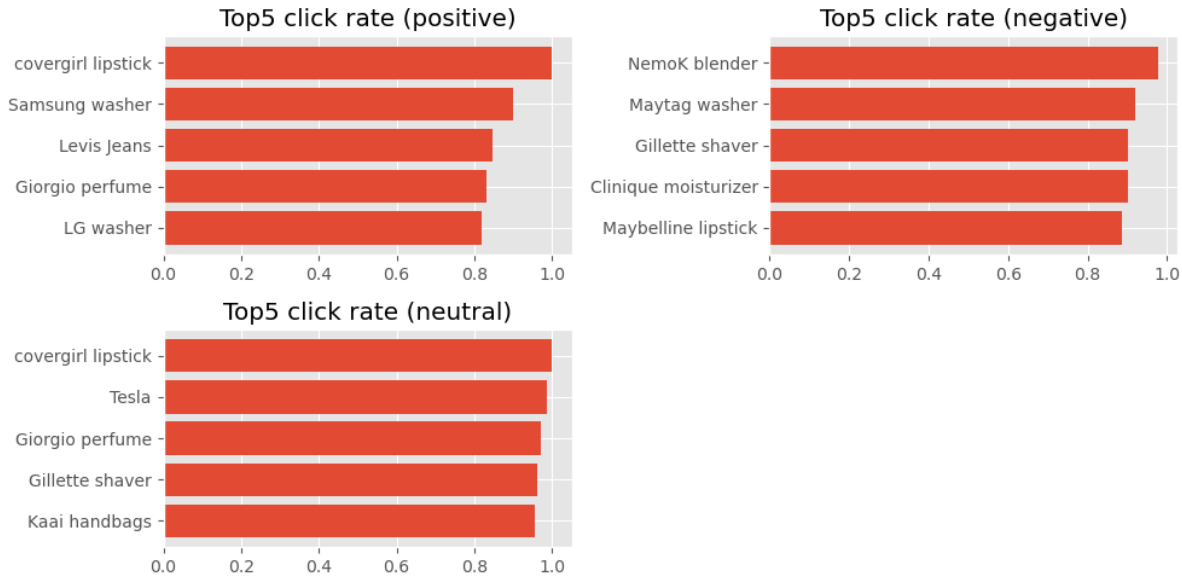
    plt.barh(
```

```
        range(5),
        sub_df["click_rate"].values[:5][::-1],
        tick_label=sub_df["product"].values[:5][::-1])

plt.tight_layout()
plt.show()
```

```
C:\Users\Home\AppData\Local\Temp\ipykernel_880\3967573601.py:8: SettingWithCopyWar
ning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/stabl
e/user_guide/indexing.html#returning-a-view-versus-a-copy
  sub_df.sort_values(by="click_rate", ascending=False, inplace=True)
```



Based on the above figure, top products with the highest click rate in positive context are covergirl lipstick, samsung washer, and Levis jeans. The products with the top click rate in negative context are NemoK blender, Maytag washer, and Gillete shaver. The products with the top click rate in neutral context are the covergirl lipstick, Tesla, and Giorgio perfume. I recommend taht the company place ads for covergirl lipstick within positive and neutral contexts, and NemoK blender within neutral contexts.

b.which ads generate most clicks given sentiment context and viewer genders?

In [400…

```
gender_l = ["female", "male"]

plt.figure(figsize=(12,6))
cnt = 1
for i in range(len(sentiment_l)):
    for j in range(len(gender_l)):
        plt.subplot(3,2,cnt)
        plt.title(
            "Top5 click rate (" +
            str(sentiment_l[i]) + "/" +
```

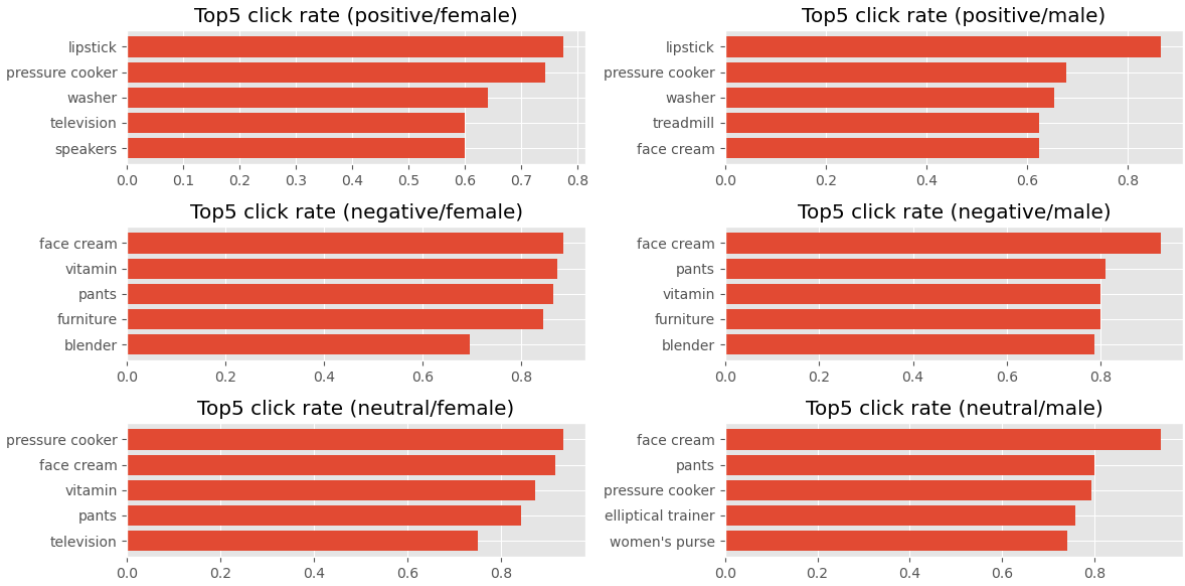
```
            str(gender_l[j]) + ")"
        )

        gender = gender_l[j]
        if gender == "female":
            sub_df = clicks_gender_df[[
                "product_type", "sentiment", "click_rate_f"]]
        if gender == "male":
            sub_df = clicks_gender_df[[
                "product_type", "sentiment", "click_rate_m"]]

        sub_df = sub_df[(sub_df["sentiment"] == sentiment_l[i])]
        sub_df.sort_values(
            by=sub_df.columns[-1], ascending=False, inplace=True)

        plt.barh(
            range(5),
            sub_df[sub_df.columns[-1]].values[:5][::-1],
            tick_label=sub_df["product_type"].values[:5][::-1])
        cnt += 1

plt.tight_layout()
plt.savefig("figures/click_rate_gender.png")
plt.show()
```



For females, the product type with the top click rate is lipstick within positive context, face cream within negative context, and pressure cooker within neutral context. For males, the product with the highest click rate is lipstick within positive context and face cream within negative context and neutral context. I recommend that the company choose those product types and sentiment context when targeting the specific demographic groups.

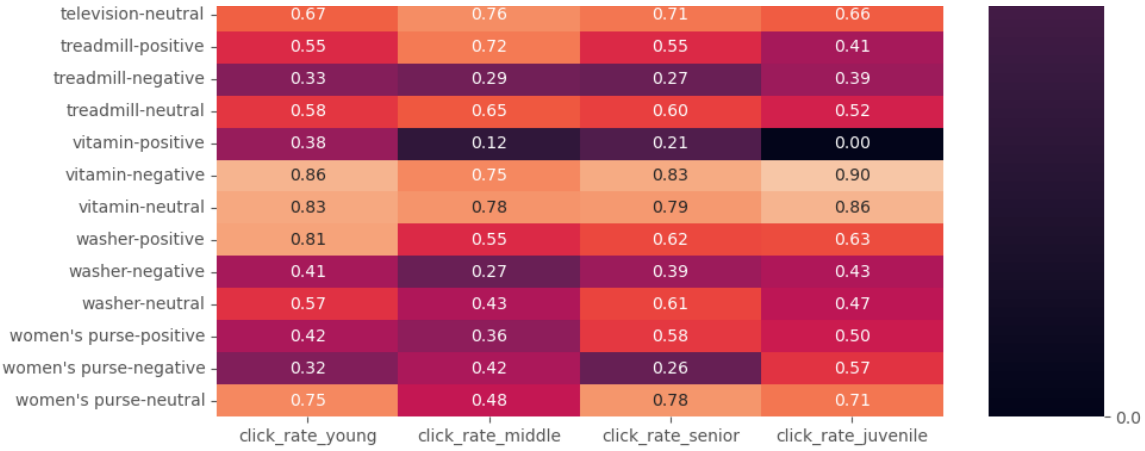
c.which ads generate most clicks given sentiment context and viewer age groups?

In [320…

```
heat_map_df = pd.DataFrame()
heat_map_df["product_sentiment"] = (
    clicks_age_df["product_type"] + "-" + clicks_age_df["sentiment"]
).values
heat_map_df.set_index("product_sentiment", inplace=True)
heat_map_df["click_rate_young"] = clicks_age_df["click_rate_young"].values
heat_map_df["click_rate_middle"] = clicks_age_df["click_rate_middle"].values
heat_map_df["click_rate_senior"] = clicks_age_df["click_rate_senior"].values
heat_map_df["click_rate_juvenile"] = clicks_age_df["click_rate_juvenile"].values

plt.figure(figsize=(10, 20))
sns.heatmap(heat_map_df, annot=True, fmt=".2f")
plt.tight_layout()
plt.show()
```


product_sentiment
blender-positive 0.46 0.30 0.43 0.32
blender-negative 0.80 0.74 0.67 0.75
blender-neutral 0.32 0.30 0.42 0.31
car-positive 0.19 0.11 0.30 0.05
car-negative 0.36 0.40 0.42 0.36
car-neutral 0.52 0.50 0.72 0.57
coffee-positive 0.29 0.36 0.30 0.05
coffee-negative 0.45 0.58 0.43 0.43
coffee-neutral 0.33 0.32 0.43 0.36
computer-positive 0.65 0.56 0.70 0.52
computer-negative 0.47 0.57 0.48 0.51
computer-neutral 0.58 0.57 0.60 0.53
dryer-positive 0.35 0.18 0.35 0.35
dryer-negative 0.47 0.27 0.28 0.29
dryer-neutral 0.76 0.67 0.75 0.75
elliptical trainer-positive 0.36 0.28 0.33 0.41
elliptical trainer-negative 0.50 0.44 0.55 0.50
elliptical trainer-neutral 0.75 0.87 0.47 0.84
face cream-positive 0.57 0.69 0.59 0.50
face cream-negative 0.90 0.94 0.82 0.95
face cream-neutral 1.00 0.86 0.93 0.94
furniture-positive 0.41 0.34 0.22 0.12
furniture-negative 0.79 0.87 0.82 0.81
furniture-neutral 0.67 0.51 0.67 0.44
jeans-positive 0.56 0.44 0.61 0.43
jeans-negative 0.26 0.18 0.29 0.33
jeans-neutral 0.66 0.58 0.63 0.58
lipstick-positive 0.87 0.81 0.92 0.69
lipstick-negative 0.66 0.61 0.81 0.70
lipstick-neutral 0.55 0.44 0.68 0.42
makeup-positive 0.43 0.13 0.31 0.09
makeup-negative 0.11 0.20 0.11 0.10
makeup-neutral 0.45 0.23 0.55 0.29
pants-positive 0.33 0.31 0.43 0.14
pants-negative 0.88 0.90 0.81 0.69
pants-neutral 0.78 1.00 0.82 0.64
perfume-positive 0.51 0.51 0.62 0.46
perfume-negative 0.52 0.56 0.62 0.53
perfume-neutral 0.69 0.54 0.65 0.56
pressure cooker-positive 0.91 0.57 0.76 0.75
pressure cooker-negative 0.00 0.00 0.00 0.00
pressure cooker-neutral 0.81 0.91 0.83 0.90
refrigerator-positive 0.43 0.33 0.18 0.39
refrigerator-negative 0.04 0.12 0.17 0.17
refrigerator-neutral 0.48 0.27 0.47 0.30
rowing machine-positive 0.71 0.41 0.11 0.05
rowing machine-negative 0.33 0.05 0.33 0.19
rowing machine-neutral 0.14 0.18 0.25 0.00
shaver-positive 0.46 0.37 0.56 0.29
shaver-negative 0.59 0.55 0.37 0.56
shaver-neutral 0.74 0.54 0.68 0.70
speakers-positive 0.68 0.37 0.68 0.39
speakers-negative 0.26 0.47 0.36 0.33
speakers-neutral 0.76 0.67 0.68 0.69
tablet-positive 0.50 0.40 0.56 0.47
tablet-negative 0.43 0.35 0.43 0.33
tablet-neutral 0.65 0.75 0.58 0.52
television-positive 0.67 0.49 0.72 0.47
television-negative 0.28 0.30 0.31 0.41
1.0
0.8
0.6
0.4
0.2



From the figure above, we see that the product with the highest click rate is face cream in a neutral sentiment setting for young an dsenior audiences, pants in neutral sentiment for middle-age audiences, and face cream in a negative sentiment for juvenile audiences. To best target each demographic group, the ads company should place the highest-clicked ads in each age category in the corresponding sentiment environment.

Reference

https://en.wikipedia.org/wiki/Jaccard_index [1]

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