

# Popeyes vs. Chick-Fil-A

## The Chicken Sandwich Wars



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### **Executive Summary:**

In early November of 2019, Popeyes announced they were re-releasing their new chicken sandwich which piqued public interest causing long wait times at the restaurants and a slew of violent incidents. Within a few days of the release, videos and tweets showing violence and unrest over this new chicken sandwich began to occur. In one circumstance, a man was stabbed to death for allegedly cutting in line while trying to order the new chicken sandwich. These events also occurred within the context of a broader “Chicken Sandwich War” that was occurring between Popeyes and Chick-Fil-A that could be seen on Twitter as well.

With this wide chamber of various sentiments available on the internet, we were interested to see how these events impacted people’s thoughts and opinions on the restaurants and if the controversies surrounding them had any impact on public sentiments. We then wanted to be able to leverage the sentiment and Twitter data in order to provide valuable feedback to the companies so they would be in a better position to deal with these types of events.

After obtaining the Twitter data for both Popeyes and Chick-Fil-A, we attempted to compare whether or not there was any significant difference in sentiment between Chick-Fil-A and Popeyes. Through the use of the R language and program, we were successfully able to both judge the sentiment of tweets based on targeted keywords.

After running sentiment analysis on our Twitter data set for each of the ten emotions (anger, anticipation, disgust, fear, joy, sadness, surprise, trust, negativity, and positivity), we found significant differences between these two companies. The two emotions most greatly affected were joy and positivity. In both cases, joy and positivity were much higher when looking at Chick-Fil-A compared to Popeye's.

After getting the sentiment visualization data of the Twitter dataset we then used machine learning analysis to prove the accuracy of our assessments. First we rated each tweet as positive, negative or neutral based on content and then we randomized our data set. We divided this data into two parts, a training set and a test set. Based on this, we determined the sentiment of test data and with accuracy between 70-85%.

We concluded that the differences in these emotions were primarily due to the violent incidents in regards to Popeyes. This becomes readily apparent when looking at the most frequent words along with Popeyes word associations, where instead of common food descriptors we instead see the words “fight, stab, brawl, embarrassed, jail, long line, wait and death.”

Based on our findings, we developed a course of action that Popeye's can take to improve sentiment regarding their restaurants. This includes increasing employee training and quality control measures as complaints regarding employees and employee behavior were readily apparent.

Next, we suggest increasing employees on staff during peak times to hopefully reduce the long wait. And finally, we suggest complementary snacks during these periods of long wait times to hopefully reduce hunger and improve customer morale. Our analysis and subsequent creation should help to improve positive sentiment in the short run, while allowing continued moderation of it in the long run.

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### **Introduction & Background:**

Popeyes is a multinational chain of fried chicken fast food restaurants, originally founded in 1972 as "Chicken On The Run". By 1975, the company was renamed to Popeye's Famous Fried Chicken, and due to the success, various franchises spawned off of that original restaurant. Today, over 3,000 restaurants in more than 40 different states operate under the Popeyes Brand. When it was first created, Popeyes was envisioned to directly compete with Kentucky Fried Chicken (KFC), but over the years has expanded its offerings significantly.

Chick-Fil-A likewise was founded in the 1940's as "Dwarf House" by S. Truett Cathy and after two decades the first Chick-Fil-A was opened in Atlanta, Georgia in 1967. The company present operates around 2,300 restaurants nationwide which is slightly smaller than the amount of Popeyes restaurants. The company was founded with a strong Christian identity and this has caused some controversy over the years related to their stance on same-sex marriage and other LGBT issues.

In August of 2019, Popeyes introduced a fried chicken sandwich in order to compete with other fast food restaurants, most namely Chick-Fil-A. The sandwich, which Popeyes describes as "a fried chicken patty on a brioche bun with several pickles and mayonnaise along with a spicy cajun sauce variation" was an instant hit, with the long wait times and unique branding of the new sandwich going viral.

Along with social media, the event was also widely covered by the national media. Some estimates suggest that Popeye's was able to gather over \$23 million dollars as a result of said publicity derived from social media and general news sites. The sandwich ended up being so popular that Popeyes, who had estimated having enough chicken sandwich inventory to last them 2 months, ended up completely selling out of their chicken sandwiches in just over two weeks by August 27th, 2019.

On October 25th, 2019, Popeyes once again announced that their chicken sandwich would be returning to stores nationwide on November 3rd, 2019. With this re-release, public interest again spiked, with long wait times again occurring and the story again going viral. However, this time public interest sparked different reactions. Videos and tweets showing violence and unrest over this new chicken sandwich began to occur. In one circumstance, a man was stabbed to death for allegedly cutting in line while trying to order the new chicken sandwich.

Other violent incidents occurred in the ensuing months, some of which we were able to capture during our analysis of random Twitter data based on keyword searches. Unexpectedly as well Chick-Fil-A decided to announce on November 18th, 2019 that they were divesting themselves from certain controversial charities which caused them to also go viral on Twitter. While we initially had sought to use Chick-Fil-A as a control group to monitor changes in Popeyes sentiment, suddenly data became available which we had to account for in our analysis.

With this wide chamber of various sentiments available on the internet, we were interested to see how these events impacted people's thoughts and opinions on the restaurants and if the controversies surrounding them had any impact on public sentiments. We then wanted to be able to leverage the sentiment and Twitter data in order to provide valuable feedback to the companies so they would be in a better position to deal with these types of events.

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### **Research & Methods:**

#### **Twitter Developer Account & API:**

We began the project by setting up Twitter developer accounts and then creating applications that provided us with unique access codes that we could use to link R with Twitter using the rtweet package that gave us access to the Twitter API. After connecting to the Twitter API we then searched for tweets based on non-case-sensitive specific word queries for example:

Company	Tweet Query	Tweets (w/ Retweets)	Tweets (w/o Retweets)
Chick-Fil-A	chicfila OR chickfila	~ 183,000	~ 90,000
Popeyes	popeye OR popeyes	~ 150,000	~ 73,000

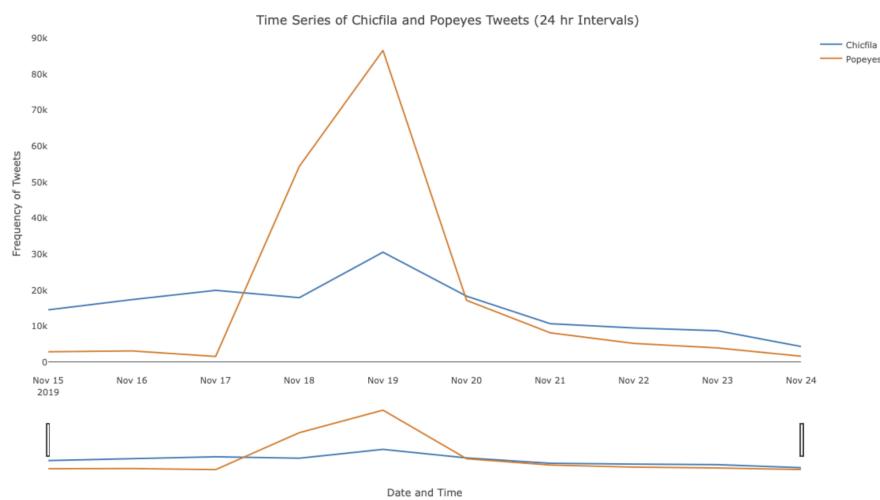
We ended up pulling around 250,000 tweets for our analysis before maxing out of the memory and processing power capacity of our available machines. (See Limitations)

#### **Frequency Distribution:**

After downloading the tweets for each company based on keywords we sorted them by date and time and plotted them on a frequency distribution. This allowed us to view how many tweets were occurring on each day and even hour to see if there were any patterns or differences between them. This helped us determine relevant information about the desired companies and that helped us narrow down when any relevant events were occurring.

Based on the chart below, it can be seen that there was a dramatic spike in tweets for Popeyes beginning on November 17th, 2019 and a smaller spike in data for Chick-Fil-A on November 18th, 2019. This gave us an initial clue of what to look for by giving us a specific time frame where tweet frequency increased dramatically, showing something had gone “viral”.

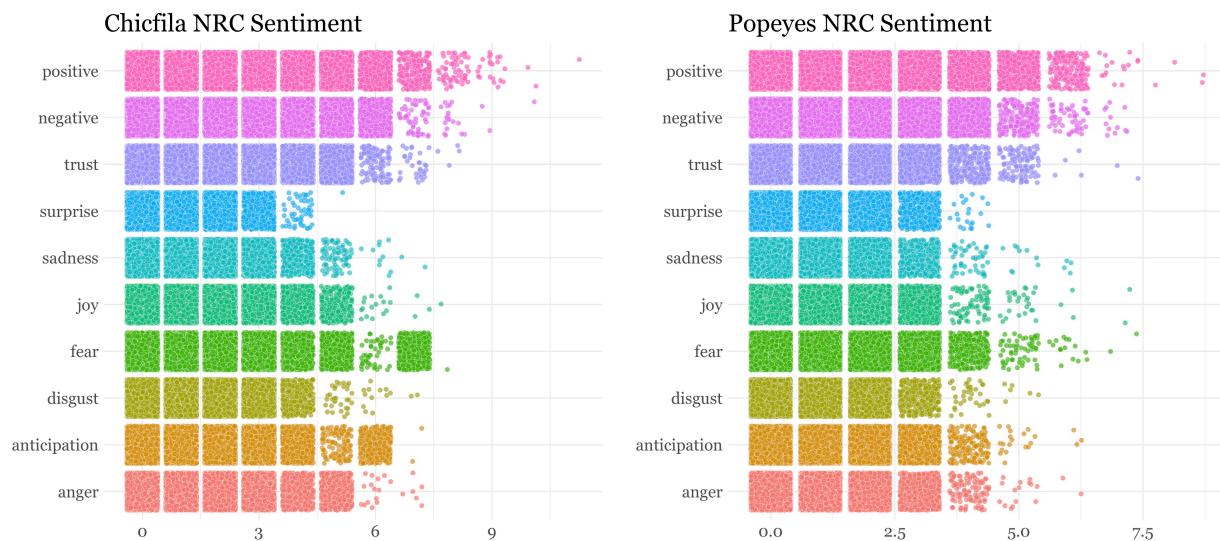
This spike for Popeyes was later correlated with the violent incident related to an employee fight in a Milwaukee, Wisconsin restaurant. The rise in Chick-Fil-A tweet frequency was related to their announcement they had divested themselves from controversial Christian charities.



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### Sentiment Analysis:

At this point, we ran sentiment analysis on our tweet data to gauge the emotions related to each company based on keywords during this time period. We created simple NRC sentiment plots to visualize the sentiment of tweets related to each company. The x scale on the graphs corresponds to the sentiment score between 0 (low) and 10 (high) that each tweet received.

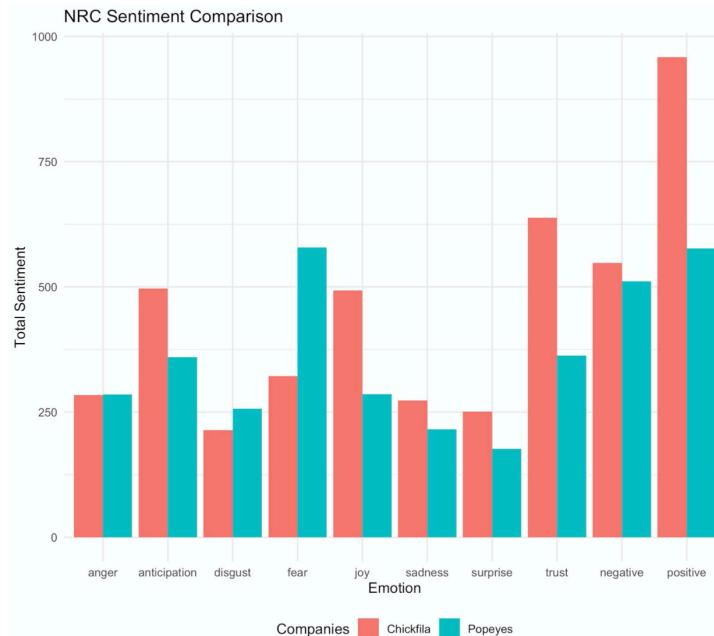


Based on these charts above it can be determined that the sentiment scores for the tweets related to Chick-Fil-A have a much stronger emotional score than the ones related to Popeyes. This is interesting because at this time Popeye's actually has a much more frequent number of tweets than Chick-Fil-A.

This trend can also be seen in the following graph which matches up each emotion between the two companies and compares them between each other.

Based on this graph it can be shown that Chick-Fil-A has a much more positive sentiment when compared with Popeyes.

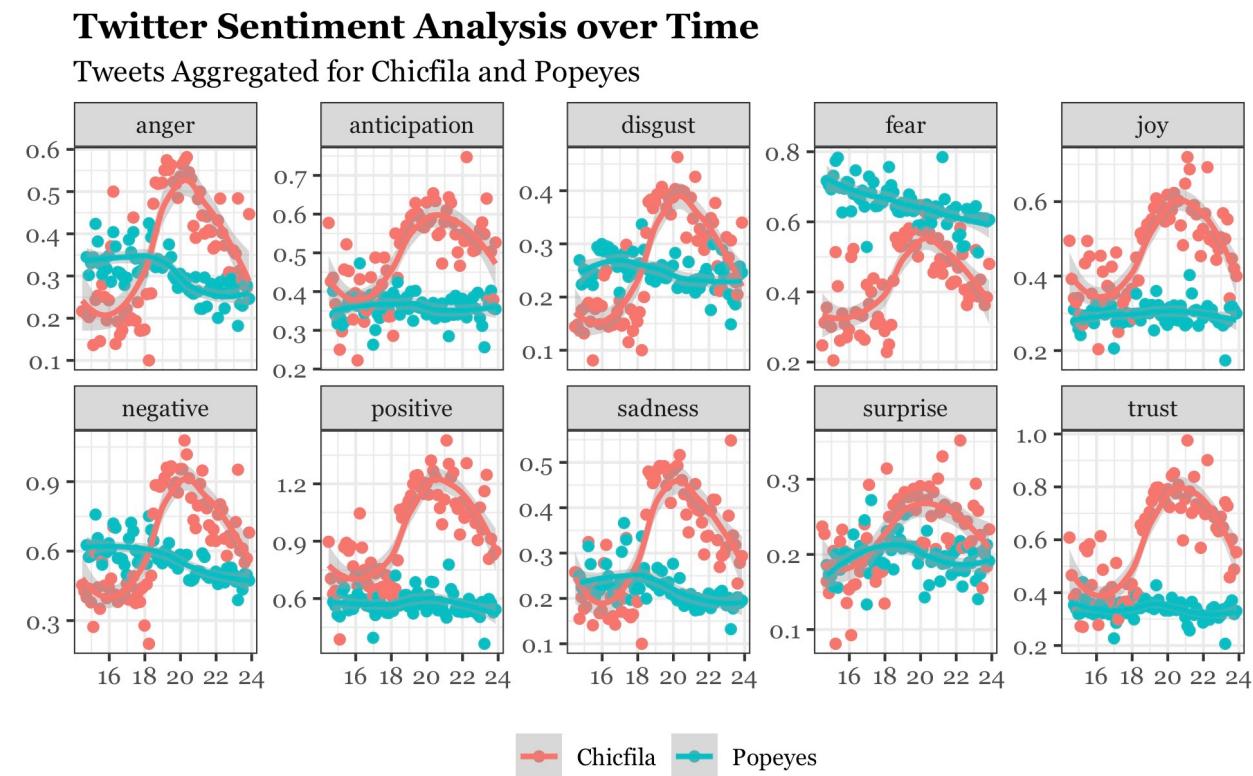
People also showed higher anticipation and trust with Chick-Fil-A. Other observations that can be made from these graphs show that Popeyes has a much higher fear emotion and a much lower trust score.



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### Time Series Sentiment Analysis:

We then proceeded to superimpose the sentiment for Popeyes and Chick-Fil-A as they changed over time and created a time series sentiment graph, as shown below.



As seen in the chart above, Chick-Fil-A experiences a dramatic rise and fall in sentiment across the spectrum on November 18th related to their announcement to divest from certain Christian charities. Interestingly enough there is not much change in sentiment with Popeyes despite having an increased number of tweets and a violent incident.

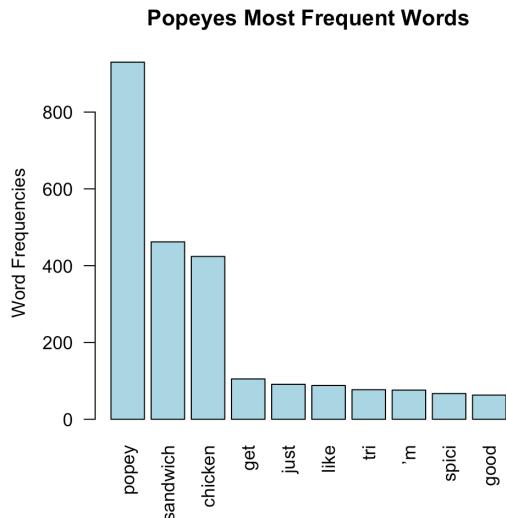
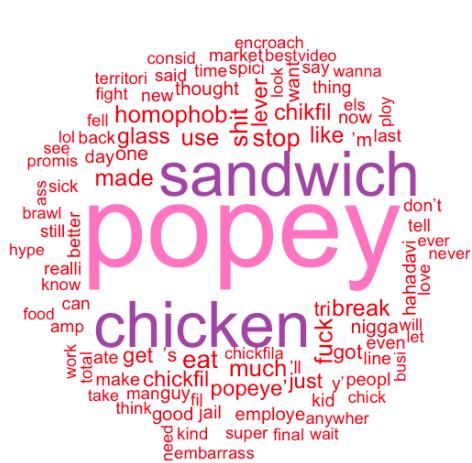
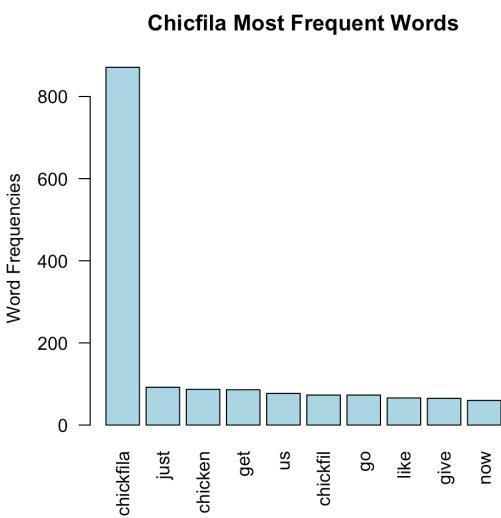
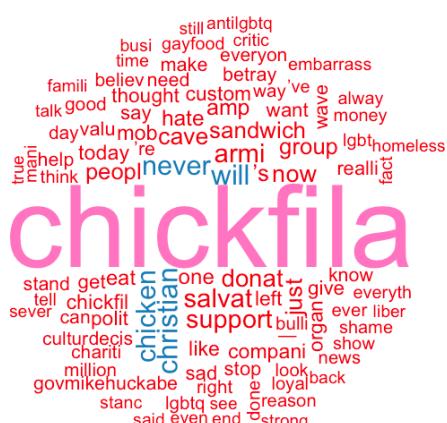
However, the fact that these emotions for Popeyes are also coming from a higher origination point than Chick-Fil-A suggests this is just a continuation of the data surrounding much more violent incidents than just an employee brawl caught on video. This corresponds with the decreasing fear sentiment which can be seen in our sentiment charts as well as Popeyes has a higher fear score than Chick-Fil-A by a large margin on the 16th of November. (See Limitations)



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## Word Frequency & Word Clouds

In order to see the words contained in the tweets visually, we first created a corpus and excluded elements such as stop words, spaces, foreign languages, stems, URLs and numbers, which are all irrelevant terms in doing text and sentiment analysis. After getting the word corpus we then used the data to show the words used most frequently. We plotted these using histograms and created visual devices such as word clouds and dendrograms to better visualize and understand the connections between various words.



One limitation during this part of our analysis was the inability of our code to properly remove all of the multiple words that we wish to exclude. While we managed to remove one major word from each, this resulted in similar words such as "Chickfila" and "Popeye" being included which slightly skewed our analysis. (See Limitations)

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### **Word Associations:**

In the initial days of doing our analysis on word frequency we came across many unique words such as “fight,” and “knife” that had no seeming relation to Popeyes or Chick-Fil-A. Upon doing a simple Google keyword search using these terms and Popeyes we came across many violent incidents at Popeyes that could be seen through the use of both sentiment charts and word associations.

Word association analysis was done by creating a term document matrix from our corpus and then we found the words associated with the keywords we chose to search for. In our initial analysis based on our outside research we chose to search for the following keywords based on a correlation limit of 0.25:

Word	Correlation Limit
<b>Knife</b>	0.25
<b>Stab</b>	0.25
<b>Fight</b>	0.25
<b>Brawl</b>	0.25
<b>Slam</b>	0.25

The following tables show a sample of various incidents at Popeyes that we were able to detect based on our word association analysis. We then corroborated each of these incidents with a relevant news article from a primary source media outlet.

### **Couples Brawling at California Popeyes [1]**

Run @ Thurs, Nov. 14th, 2019	
Word	Correlation Score
Coupl	0.36
California	0.36
Break	0.33
Drivethru	0.30

One of the incidents that we detected had the strongest correlation out of all of the events was related to the stabbing death of Kevin Tyrell Davis over an altercation related to cutting in line and a parking lot fight that ensued. While we did not start the project soon enough to detect the initial incident we actually were able to detect when the suspect who committed this murder was arrested and the Twitter reactions that followed.

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### Arrest of Suspect in Fatal Stabbing of Kevin Tyrell Davis [2]

Run @ Thurs, Nov. 14th & Sun, Nov. 17th, 2019		
Word	Correlation Score (11/14)	Correlation Score (11/17)
Arrest	0.75	N/A
Fatal	0.74	0.42
Suspect	0.62	N/A
Polic	0.57	N/A
Maryland	0.46	N/A
Davi	N/A	0.36
Kevn	N/A	0.36
Tyrell	N/A	0.34
Argument	N/A	0.30

### 7 Employees Fired After Milwaukee Popeye's Brawl [3]

Run @ Sun, Nov. 17th, 2019	
Word	Correlation Score
Milwauke	0.45
Seven	0.49
Fire	0.43
Crew	0.29
Footag	0.55

### White Woman Body Slammed Outside Of A Tennessee Popeyes After Calling Staff The N-Word [4 & 5]

Run @ Mon, Nov. 18th, 2019	
Word	Correlation Score
Grand	0.64
Nword	0.54
Female	0.54
Bodi	0.52
White	0.25

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### **Analysis:**

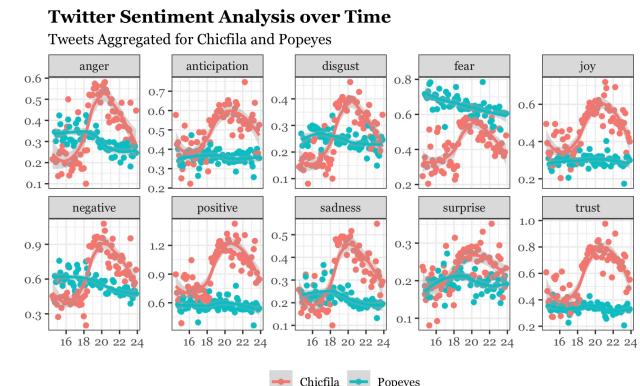
After doing internet research for current news related to these two companies we discovered several articles relating to violence at Popeye's since the re-release of their Chicken Sandwich. The following table summarizes the release of the Chicken Sandwich and the major subsequent incidents that followed.

Date	Incident
11/3/19	Relaunch of Popeye's Chicken Sandwich
11/4/19	Keven Tyrell Davis stabbed to death
11/8/19	Woman body-slapped by employees
11/13/19	California couple fights in drive-thru
11/14/19	McClain arrested for stabbing of Keven Tyrell Davis
11/16/19	Milwaukee employee brawl
11/18/19	Chick-Fil-A divests from Christian charities

However, these violent incidents at Popeyes were not the only unexpected change we detected during our analysis as shown by our frequency graphs not only for Popeyes but Chick-Fil-A as well. On November 18, 2019, Chick-Fil-A decided to step into the fray by publicly divesting itself from donating to certain controversial Christian charities related to LGBT protests which immediately picked up on Twitter with our sentiment and word associations. [6]

```
> p <- findAssocs(nk.tdm, "christian", 0.25)
> print(p)
$christian
  lgbtqxyz placat popul valu stanc claim anybodi crucifi extrem potenti
  0.46     0.46   0.46  0.43  0.43   0.32    0.30    0.30   0.30   0.30
  "sell" denounc righteous suit abandon now support salvat communiti armi
  0.30     0.30   0.30  0.30  0.30   0.29    0.28    0.27   0.27   0.26
  listenup boycott
  0.26     0.26
```

In fact, as can be shown based on the Tweet frequency graphs in addition to the time series sentiment graphs, emotions ran extremely high for Chick-Fil-A during this period across the spectrum. These high emotions were significant because Popeyes actually had more absolute Tweets during this period but based on every visualization tool the sharpest swings in mood were related to Chick-Fil-A.



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### **Statistical Analysis:**

#### **Two-Sample T-test between Popeyes & Chick-Fil-A**

From Tuesday 19th November 2019 to Sunday 24th November 2019, we collected sentiment scores from Twitter data related to our keyword queries for Popeyes and Chick-Fil-A. This data was then tested using ANOVA and T-Tests for statistical significance. We attempted to see if there was any variance between the columns which could be corroborated by our sentiment visualization tools. The following is a sample output from our sentiment data.

anger	anticipation	disgust	fear	joy	sadness	surprise	trust	negative	positive
1	0	0	3	0	0	0	2	2	2
1	0	1	3	0	1	1	1	2	1
2	0	1	2	0	1	1	0	3	0
0	1	0	1	0	0	0	0	1	0
0	0	0	0	0	0	0	0	0	0

We chose to eliminate all of the rows that contained a 0 sentiment score because this would have skewed our data. A summarization of the descriptive statistics related to each of these columns can be seen below.

#### **Popeyes Statistical Analysis:**

Popeyes	anger	anticipation	disgust	fear	joy	sadness	surprise	trust	negative	positive
Count	9815	9815	9815	9815	9815	9815	9815	9815	9815	9815
Mean	1.70	1.65	1.40	1.80	1.82	1.41	1.28	2.02	1.96	2.80
Max	7	6	7	8	7	7	5	8	10	10
Min	1	1	1	1	1	1	1	1	1	1
1	5076	5613	6793	3698	3641	6838	7422	2851	4488	1531
2	3069	2534	2322	4789	4658	2108	2012	5031	2648	2203
3	1337	1259	505	1016	1227	692	362	1170	1684	4143
4	265	353	182	248	236	141	18	438	660	1058
5	59	49	6	42	49	29	1	283	243	472
6	5	7	4	15	3	6	0	31	66	333
7	4	0	3	6	1	1	0	10	19	48
8	0	0	0	1	0	0	0	1	4	14
9	0	0	0	0	0	0	0	0	2	11
10	0	0	0	0	0	0	0	0	1	2

One of the limitations in this section of the analysis was that it was not calculated based on the complete dataset which we had around 100,000 rows for each company. The statistical analysis for our section was only done using a small sample of the data (~ 9,800) tweets. The following method was also applied to the data for Chick-Fil-A which yielded the results as summarized in the following table.

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### Chick-Fil-A Statistical Analysis:

Chickfila	anger	anticipation	disgust	fear	joy	sadness	surprise	trust	negative	positive
Count	9234	9234	9234	9234	9234	9234	9234	9234	9234	9234
Mean	1.70	1.66	1.40	1.79	1.85	1.42	1.29	2.04	1.97	2.85
Max	7	6	7	8	7	7	5	8	10	10
Min	1	1	1	1	1	1	1	1	1	1
1	4799	5202	6370	3475	3213	6398	6966	2535	4260	1268
2	2834	2391	2208	4561	4547	1987	1894	4835	2424	2021
3	1276	1238	465	911	1189	674	357	1132	1589	4076
4	260	347	178	224	232	140	16	438	636	1031
5	56	49	6	41	49	28	1	252	234	465
6	5	7	4	15	3	6	0	31	65	301
7	4	0	3	6	1	1	0	10	19	46
8	0	0	0	1	0	0	0	1	4	14
9	0	0	0	0	0	0	0	0	2	11
10	0	0	0	0	0	0	0	0	1	1

Next, we performed a T-Test analysis on both samples for each emotion. We ended up performing ten total tests based on each emotions on both samples. Our hypothesis was similar for each emotion test:

**Null hypothesis (H0): Mean1 is equal to Mean2**

**Alternative hypothesis (H1): Mean1 is not equal to Mean2**

For example, in Anger emotion test, we compared means of Chick-Fil-A and Popeyes's samples to see if there is any noticeable difference between them.

#### Method

$\mu_1$ : mean of anger Chickfila

$\mu_2$ : mean of anger Popeyes

Difference:  $\mu_1 - \mu_2$

*Equal variances are not assumed for this analysis.*

#### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
anger Chickfila	9234	1.697	0.868	0.0090
anger Popeyes	9815	1.695	0.861	0.0087

#### Test

##### Estimation for Difference

Difference	95% CI for Difference
0.0022 (-0.0224, 0.0267)	

Null hypothesis  $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis  $H_1: \mu_1 - \mu_2 \neq 0$

T-Value DF P-Value

0.17 18956 0.864

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In the following, we see that P-value is out of the range (from -0.25 to 0.25) so we cannot reject the null hypothesis, which means there is no noticeable difference in anger toward any chicken-sandwich brand. In other words, Chick-Fil-A and Popeyes have the same anger level from Twitter users. This can also be corroborated by viewing our sentiment comparison graph.

After performing 10 tests on 10 emotions, we only rejected null hypotheses in 2 tests while maintaining null hypotheses in remaining 8 tests. Only Joy and Positive emotion tests showed apparent differences between Chick-Fil-A and Popeyes.

The test results for the joy emotion are displayed below;

### Method

$\mu_1$ : mean of joy Chickfila

$\mu_2$ : mean of joy Popeyes

Difference:  $\mu_1 - \mu_2$

*Equal variances are not assumed for this analysis.*

### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
joy Chickfila	9234	1.849	0.781	0.0081
joy Popeyes	9815	1.819	0.782	0.0079

### Test

#### Estimation for Difference

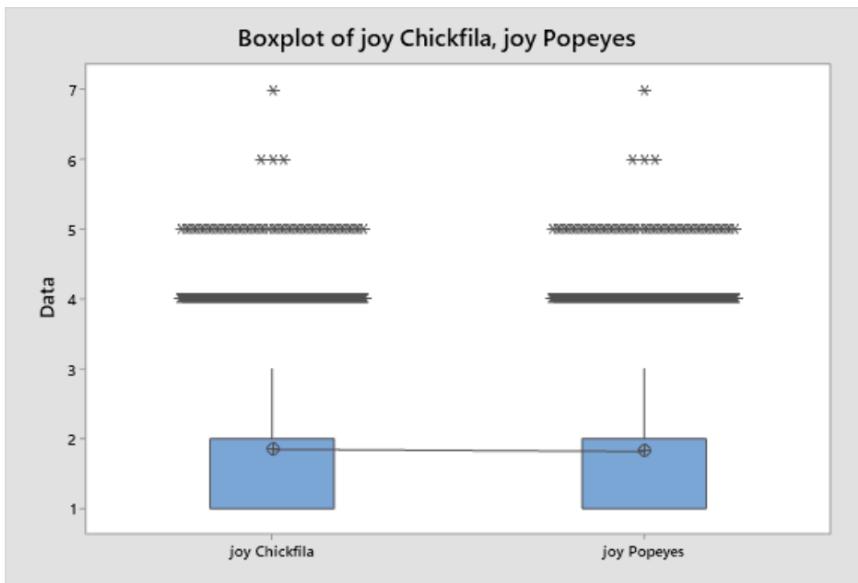
Difference	95% CI for Difference
0.0300 (0.0078, 0.0522)	

Null hypothesis  $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis  $H_1: \mu_1 - \mu_2 \neq 0$

T-Value DF P-Value

2.64 18979 0.008



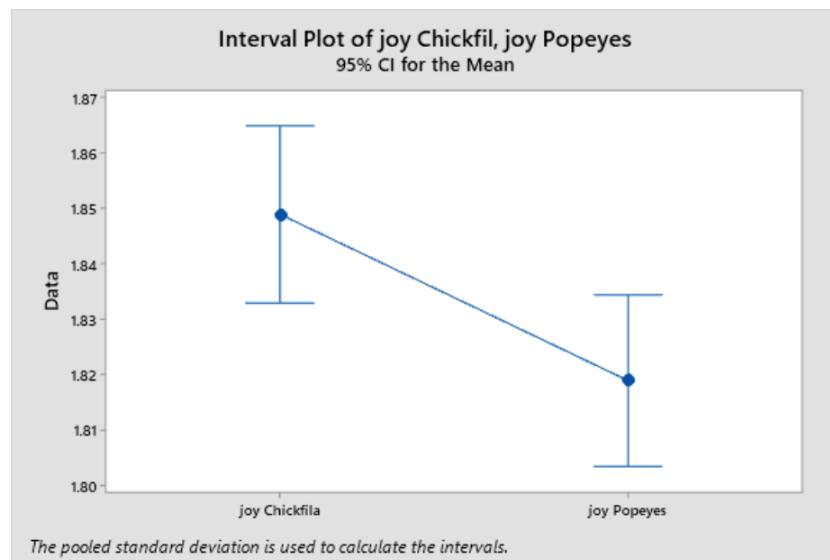
### ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	4.273729	1	4.273729	6.995158	0.00818	3.841947
Within Groups	11636.87	19047	0.610955			
Total	11641.14	19048				

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As we can see the absolute value of p-value is smaller than alpha (2.5%) and T-value is higher than T-half-alpha (1.960) so we reject  $H_0$  and conclude there is a definite difference in Twitter users' Joy emotion toward Chick-Fil-A and Popeyes. In this case, we notice that Chick-Fil-A has a higher rating of Joy emotion than Popeyes.

In the similar patterns, we also have Chick-Fil-A has higher rating at Positive reactions than Popeyes with the following results:



### Method

$\mu_1$ : mean of positive Chickfila

$\mu_2$ : mean of positive Popeyes

Difference:  $\mu_1 - \mu_2$

*Equal variances are not assumed for this analysis.*

### Descriptive Statistics

Sample	N	Mean	StDev	SE Mean
positive Chickfila	9234	2.85	1.23	0.013
positive Popeyes	9815	2.80	1.26	0.013

### Test

#### Estimation for Difference

Difference	95% CI for Difference
0.0479 (0.0125, 0.0833)	

Null hypothesis  $H_0: \mu_1 - \mu_2 = 0$

Alternative hypothesis  $H_1: \mu_1 - \mu_2 \neq 0$

T-Value	DF	P-Value
2.65	19014	0.008

### ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	10.91236	1	10.91236	7.039112	0.007981	3.841947
Within Groups	29527.55	19047	1.550247			
Total	29538.47	19048				

In conclusion, after performing two-sample T-test between two brands, Chick-Fil-A and Popeyes we can show major difference in 2 emotion tests: Joy and Positive. In both tests, we can see that Chick-Fil-A has higher ratings than Popeyes. In other words, Chick-Fil-A seemingly receives better public perception than Popeyes on Twitter platforms. This results showed consistency with our previous observations of sentiments toward these two brands.

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### **Tweet Ratings & Machine Learning:**

To further our understanding of the sentiment analysis on Popeye's and Chick-Fil-A, we used our software to rate each tweet as positive, negative or neutral using a sentiment library. This library assigns each text a score from -5 to +5. In our analysis, we take -5 to 0 as negative and 0 to +5 as positive and neutral. After doing this, we had a new dataset listing the tweet and its corresponding rating. After rating the tweets, we give the name to both of the column so that we can easily read the file into the machine learning code that we wrote.

We then created a machine learning program where we divided the twitter data into a randomized training set and test set. The training data contained 90% of the tweets and the test data contained the remaining 10%. Based on the 90% of the tweets, we predicted the sentiment (positive, negative or neutral) of the other 10% of tweet and proceeded to achieve an accuracy rating of 70-85% when applying the training data to the test data to predict the sentiment of those tweets.

```
> conf.mat$overall
  Accuracy           Kappa AccuracyLower AccuracyUpper
8.404706e-01  1.374738e-01  8.291110e-01  8.513601e-01
> conf.mat$overall['Accuracy']
Accuracy
0.8404706
> |
```

---

In our machine learning script we made each word in a document a token and each document was developed as a vector. Next, we created 90:10 partitions of the data set, for training and testing purposes. Next we trained the model using our software to be able to accurately predict which tweets would be positive, neutral or negative based on our training set.

One of the interesting aspects based on running the machine learning analysis was the variation in the accuracy rating we achieved each time. Since we ran this program on various sets of Twitter data of varying degrees of size, our accuracy rating differed each time creating a range between 70% to 85%. Other factors that affected the accuracy of our machine learning was the use of different relative percentages of frequent terms and also dividing the test and train set in ratios such as 75:25 ratio and 90:10.

One of the major limitations in running the machine learning on our data was we were limited to running it on smaller data sets due to memory and processing power constraints. (See Limitations) However, despite this our accuracy ratings are still significant given we were working with live data sets resulting from Tweets streamed directly from the Twitter API.

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### **Improvements & Future Work:**

In the future, there would be a lot of value in determining if public sentiments had any impact on stock prices or revenues the company generated during the period under study. Unfortunately for this project, this data is not available for either of our companies in question. Popeyes is owned under the Restaurant Brands International Company (RBI), which also oversees restaurants like Burger King and Tim Horton's.

While RBI is a publicly traded company, changes in stock price were not solely because of the Popeye's Brand, and as such could lead to conflicting results. We would love to go to RBI and see daily revenue for Popeye's during this period, and see if public sentiments had any impact on daily revenue. Again, unfortunately RBI announces revenues as a total publicly, and does not break it down by each company they own.

In addition to this, we would love to be able to go farther back in time in regards to looking at public sentiments. Twitter only allowed us to pull data 7-10 days in the past and we would need a more advanced developer account to view further back. If we have the proper access it would be highly beneficial to view data from August to October to view these trends in the proper long term context.

Based on a longer set of historical Twitter data it would be interesting to look at and see how public sentiments changed as the sandwich was originally announced, to when it was announced as sold out and gone, to when it was re-announced as officially coming back. We are sure we would see wide swings in regards to prevailing public opinion, and it would be interesting to see that change over time.

Finally, on a more general note, we would be extremely interested in trying to map out this data based on geographical tags attached to each tweet. Using this data we could be able to view tweets in certain areas and see if this correlates with the event going on in that area. Mapping this data out based on geographic location could allow us to see which areas are problem areas which are receiving higher than average negative sentiment. This could be extremely vital to law enforcement or government employees in determining "problem areas" that may need more of a police presence.

However, one major limitation in this is that not every tweet has proper geographic data so this analysis is circumstantial at best. Also this raises certain privacy issues about users sharing their location and we understand why people are reluctant to share this information on a public platform such as Twitter.

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### **Limitations:**

There were many limitations in this project that developed over time that provide valuable insight into running this project more successfully next time. The first major limitation is that the free Twitter developer accounts only allows tweets to be pulled 7-10 days into the past which does not allow one to see these trends in context to the rest of the tweet history.

One of the limitations in our text and sentiment analysis itself was that we do not have adequate dictionaries to accommodate for things like slang and emoticons and these could provide valuable avenues of development in the future. The emoticon library is currently in production but we recommend possibly using a source such as Urban Dictionary (<https://www.urbandictionary.com>) in order to accurately understand all of the different slang terms that are used on the grammatically incorrect platform of Twitter.



The screenshot shows an RStudio interface with the 'Console' tab selected. The code in the console is as follows:

```
Console Terminal x
~/
>
> convert_count <- function(x) {
+   y <- ifelse(x > 0, 1, 0)
+   y <- factor(y, levels=c(0,1), labels=c("No", "Yes"))
+   y
+ }
>
> trainNB1 <- apply(dtm1.train.nb, 2, convert_count)
Error: vector memory exhausted (limit reached?)
> testNB1 <- apply(dtm1.test.nb, 2, convert_count)
```

The error message 'vector memory exhausted (limit reached?)' is displayed in red text, indicating a memory limitation in R.

Another major limitation that we had with running our data had to do with the memory capabilities and processing power of our available machines. The R language is structured so that there are problems when running massive data sets because the language reads the entire data set into RAM all at once. Other languages can read file sections on demand but R objects live in the memory entirely so we are limited to what our machines can process.

This limitation actually affected many facets of our project and we were unable to get the most accurate word cloud and other graphs for the largest data set we collected which included retweets. Instead due to machine limitations some of the graphs such as the sentiment comparison were actually based on smaller data sets excluding retweets than the tweet frequency. Other graphs such as the tweet frequency and the time series sentiment were based on the larger dataset.

One final limitation that we had was errors in the R language code that did not allow us to remove multiple keywords for each company from the corpus. This resulted in certain words displaying in the frequent word histograms and the word cloud that could have been otherwise removed from the analysis to get more accurate results.

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### **Recommendations:**

What we have created is a real time updating text and sentiment analysis device that Popeye's can use to correctly identify customer trends and reactions in real time to understand the impact of their actions. Popeye's can use this to receive real time thoughts and opinions into the mind of their customer base.

Based on sentiment we have collected over our two weeks of study, we subsequently tracked and identified a significant and meaningful difference in sentiment between both you (Popeye's) and Chick-Fil-A. At a significant level, we have seen an Chick-Fil-A perform much better in regards to both positivity and joy. We believe this significance to arise due to inappropriate events happening in the Popeye's community. While not all of this feedback is within Popeye's control, we have identified steps that you as a company can take to limit this negative blowback.

The first major item we suggest is to increase employee training and quality control measures. In our sentiment analysis, we identified multiple events in which customers complained about employee behavior, creating blowback to the company. In one circumstance in particular, we identified an event where employees were quite literally fighting and brawling amongst themselves. This, obviously, can not happen in a successfully run company. Employees need to understand that this sort of arguing and fighting can not happen, and if it does, obviously can not be within view of the customers.

The second major item we suggest is an uptick in employee hours in times in which the company projects excess demand. We received significant feedback regarding long wait times for the new Popeye's chicken sandwich. In one circumstance, the long wait time led to a person trying to cut in line, and ended with that person being stabbed to death. By no means do we suggest that that was Popeye's fault, but our sentiment analysis suggests these long wait times are contributing to negative feedback and general unrest amongst our customers. Increasing the number of employees on staff, especially during these busy times, should cut down on lines and increase positive sentiment.

In addition to increasing the number of employees on staff, providing customers with some sort of complementary beverages or drinks to offset for the long wait would also go a long way in decreasing feelings of being unsatisfied. For example, at Five Guys, they provide customers with free peanuts while they wait. This could go a long way in appeasing customers and increasing positive feedback to offset for the negative feelings associated with long wait times.

These suggestions, along with the sentiment analysis device we will leave you with, will go a long way in increasing positive sentiment for the company. The suggestions we have left you with should help appease the widespread negativity in the short run, while the program and scripts we have created will allow you to monitor sentiment to make sure it remains strong in the long run.

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### **Conclusion:**

Based on the above data and analysis we can conclude that we are able to accurately view current events and judge emotions related to these current events as they correspond to the company as a whole through analysis of live Twitter data.

We were able to see major trends corresponding to tweet frequency and changing sentiment over time that allowed us to corroborate these trends with current events for each company. We then used word association analysis to actually prove that these events were what people were talking about in their tweets.

However, there were many limitations and errors in our project that we would wish to improve for the next time including having more advanced machines for running larger data sets as well as having a longer historical time frame with which to view tweets.

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[6] CNBC (18 November, 2019) "Chick-fil-A no longer donates to controversial Christian charities after LGBTQ protests" <https://www.cnbc.com/2019/11/18/chick-fil-a-drops-donations-to-christian-charities-after-lgbt-protests.html>

[7] Twitter Developer Account "<https://developer.twitter.com>"