

AI Wars: Twitter Sentiment Analysis

CIS4914 - Final Report

Spring 2020

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Angelo Paparazzi
(apaparazzi0329@ufl.edu)

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4/20/2020

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Abstract

This project involved elements of software development, APIs, and AI sentiment analysis; more specifically, this project showcases the use of multiple AI services for comparative textual based sentiment analysis. Utilizing APIs from Twitter, Amazon, Google, and IBM the project was two-fold. First, a comparative analysis of over 500 tweets from 10 different companies was collected to discover not only the general sentiment of these companies but also how much variance could be found between each AI service. Second, an angular based application was created to allow anyone to gather tweets from popular companies and discover their sentiment scores across three different AI services. Results from collected data found, with large sets, there is very little variance between services; however, it was surprising to discover that individual tweets could be extremely misinterpreted

Introduction

This project is, in its completed form, an application that allows users to collect tweets about any company and analyze their sentiment; whether it be positive, negative, or neutral. The project goes even further by utilizing three AI sentiment analysis services provided by Amazon, Google, and IBM each with their own sentiment results. The main problem this project hopes to answer is whether AI sentiment analysis services can be trusted or if high variance between providers brings doubts on reliability. I chose this project because of my experience working with API services as well as my interest in AI and its capabilities. Being able to compare multiple AI services brings helpful insights for both users and the respective developers. In general, not much research was needed for this project since I did not need to know the internals of how the AI worked as is the nature of using API services. Nevertheless, I researched similar applications to mine that analyzed tweet sentiment [TalkWalker 2018] to see what kind of data they provided to users and I also researched the general structure and types of sentiment analysis algorithms [Medhat, Walaa 2014].

Body

Technical Approach

Here I will go in-depth on how results were interpreted as each AI service returned data in slightly different formats that needed to be standardized. The service model that was used as a base was the one provided by IBM because it was the simplest and it is much easier to simplify data from other providers than it is to complicate it. The object models returned by each service were as follows:

Amazon:

```
{
  "Sentiment": ["POSITIVE", "NEGATIVE", "NEUTRAL", "MIXED"],
  "SentimentScore": {
    "POSITIVE": 0.0 to 1.0,
    "NEGATIVE": 0.0 to 1.0,
    "NEUTRAL": 0.0 to 1.0,
    "MIXED": 0.0 to 1.0
  }
}
```

Google:

```
{
  "magnitude": 0.0 to pos(inf),
  "score": neg(1.0) to pos(1.0)
}
```

IBM:

```
{
  "sentiment": ["positive", "neutral", "negative"],
  "score": neg(1.0) to pos(1.0)
}
```

Changes to each response set are as follows:

Amazon: Amazon had the most complex and different response returns so to simplify it the MIXED category was treated as another NEUTRAL category. The sentiment score also doesn't go from -1 to 1 for a spectrum of negative to positive sentiment. Instead, 0 to 1 indicates confidence in that sentiment. To adjust for this, if the highest score was POSITIVE then the score would remain unchanged, if NEGATIVE then the score would simply be negated, if NEUTRAL or MIXED then a limit of -0.2 to 0.2 was placed as neutral "spectrum" limits and then the final value was determined by the formula: SCORE = (POSITIVE - NEGATIVE). However, if there was high confidence in NEUTRAL or MIXED ≥ 0.9 then a score of 0 was given.

Google: The magnitude value was ignored as it only differentiated between neutral and mixed sentiments which I decided to treat as the same. Google did not come with sentiment labels so the same spectrum of -0.2 to 0.2 was used to determine a neutral sentiment.

IBM: No changes

Summary of Results

The details of all my results will be discussed in detail in the next three sections. Overall, my the answer to this project's question of whether there is high variance between the AI services chosen is no. This result was discovered through the averaging and standardizing of all 500 tweets collected across all data sets. The variance of the three averages was then taken using the statistical formula for variance with a low total variance of 0.003.

Raw Data

The table shown below is what raw data for an analyzed company would look like:

	A	B	C	D	E	F	G	H	I	J
1	Tweet	URL Endpoint	Amazon Row	Google	Amazon	Google	IBM	Amazon	Google	IBM
2	Where is Walmart employees hazard pay @WalmarttoWalmart	"244720686359372"	(Positive: "0.0002068373440388362," Negative: "0.8860012232861938," Neutral: "0.1	0.5	negative	negative	neutral	-0.886001	-0.5	0
3	Even during a global pandemic @Walmart can't have more than 2 cashiers	"2447193609764904"	(Positive: "0.193791547576537," Negative: "0.49570402425766," Neutral: "0.43235	0.3	negative	negative	negative	-0.495701	-0.3	-0.836486
4	Find your best and see if TikTok's viral #Walmart #ad. (what	"2447184043593694"	(Positive: "0.4555228055058197," Negative: "0.5868120794230694," Neutral: "0.4856	0.6	neutral	neutral	neutral	0	0.1	0
5	Thanks @Walmart for the false hope that I was going to get Final Fantasy VII Remake ea	"2447183035383644"	(Positive: "0.14659472610559702," Negative: "0.103607734761655," Neutral: "0.0423	1.4	negative	negative	negative	-0.103601	0	-0.753834
6	I witnessed immature teenagers going around coughing on employees at @Walmart i	"2447180860134891"	(Positive: "0.00253782654818228," Negative: "0.315337637470563," Neutral: "0.0820	1	negative	negative	negative	-0.315334	-0.3	-0.3839
7	Hey @Walmart do you all have the capacity to send me a few bags of those delicious Gr	"2447176130206828"	(Positive: "0.4309081378534445," Negative: "0.08150623738765717," Neutral: "0.5093	0.3	neutral	positive	positive	0.2	0.4	0.853197
8	I'm at @Walmart Supercenter in Miami, OK	"2447174603235661"	(Positive: "0.0185781834815178," Negative: "0.0007186160522441894," Neutral: "0.382	0	neutral	neutral	positive	0	0	0.538071
9	To keep up with a surge in demand due to the coronavirus, employees like @Amazon, @	"24471713163040302"	(Positive: "0.213164821267128," Negative: "0.541565546685212," Neutral: "0.6325776	0.1	neutral	neutral	negative	0.0500082	0	0.618686
10	carlyssae @Walmart @Walmartinc @Walmartworld Thanks to each of you and the man	"2447172100666572"	(Positive: "0.3830386638641357," Negative: "0.00036939126028530584," Neutral: "0.0	1.1	positive	positive	positive	0.3830387	0.3	0.379471
11	Just did @Walmart grocery pickup. The service itself is a godsend, but my 15 small items	"2447171548547824"	(Positive: "0.4488484202610016," Negative: "0.2394578603466553," Neutral: "0.25189	2.0393593	positive	neutral	positive	0.4488448	0.1	0.353385
12	I want to see more LEDS at Walmart Pickup. Tap below to Tweet and @Walmart will sho	"2447170573233002"	(Positive: "0.4881832382268388," Negative: "0.0008016587134848943," Neutral: "0.53	0.2	neutral	neutral	negative	0.2	-0.1	-0.335848
13	Last night I had a dream that Danielle Staub found post-RHONJ employment at @Walm	"2447168433417625"	(Positive: "0.17582534364881516," Negative: "0.01833555335483551," Neutral: "0.6658	0.6	neutral	neutral	negative	0.09749	0.1	-0.602186
14	@PVMHCorp and @hm are doing the right thing, in contrast to the long list of brands refus	"2447163163643582"	(Positive: "0.077448041100388," Negative: "0.1641653140586653," Neutral: "0.758375	1	neutral	neutral	negative	-0.086724	-0.2	-0.816715
15	6 friends, 6 series (in no order) The @Walmart.O51Throne@WalmartTime @Walmart	"2447148575360206"	(Positive: "0.00807113383227833," Negative: "0.00139680363485553," Neutral: "0.9	0.3	neutral	neutral	negative	0	0	-0.532677
16	From live public conference call this morning to Abilene City Council... I sure do wish @W	"24471422944534019"	(Positive: "0.5702162002311077," Negative: "0.075216034386634827," Neutral: "0.4743	0.2	positive	neutral	positive	0.570216	-0.1	0.516197
17	So are they going to arrest CEO of @Walmart for the hundreds of people in Walmart at or	"2447133348940431"	(Positive: "0.00510781304301779," Negative: "0.6355412602424622," Neutral: "0.35921	15	negative	neutral	negative	-0.635541	0	-0.973015
18	Nearly half a million job openings right now at @Lowes @HomeDepot @Walmart, applica	"2447132578578841"	(Positive: "0.21548438178778886," Negative: "0.0023837823308024075," Neutral: "0.7	0	neutral	neutral	neutral	0.2	0	0
19	It @Walmart I target @you @Walmere Really wanted to help in this pandemic they'd i	"2447126188369395"	(Positive: "0.02168518300373453," Negative: "0.276823955231748," Neutral: "0.7014	1.5	neutral	negative	negative	-0.2	-0.1	-0.865452
20	Never seen a roach at Wal-Mart. What kind of spray do yall use? @Walmart	"2447115015308820"	(Positive: "0.02778483707010748," Negative: "0.31083376387381433," Neutral: "0.6805	0.5	neutral	neutral	negative	-0.2	-0.1	-0.767322
21	Fuck @Walmart	"2447111812336083"	(Positive: "0.000179487853777425," Negative: "0.9882328607003988," Neutral: "0.00	0	negative	neutral	negative	-0.988233	0	-0.367543
22	What solves missing kid cases? @Walmart @HamilHerad @TeenVogue @TheHS @H	"2447108236126140"	(Positive: "0.002128853895038885," Negative: "0.014783088407773372," Neutral: "0.	0.2	neutral	neutral	negative	0	0.1	-0.898602
23	Just got my groceries from @Walmart pickup and I told the employee loading my groce	"24471043025783917"	(Positive: "0.537623878520956," Negative: "0.001043356185544885," Neutral: "0.06	1.3	positive	positive	positive	0.3376239	0.3	0.853756
24	CRIMINAL: Grocery Stores MUST let their EMPLOYEES WEAR MASKS!!!! @Walmart Ne	"2447100194568063"	(Positive: "0.00422286614756575," Negative: "0.8533607544889887," Neutral: "0.13	0.8	negative	positive	negative	-0.853361	0.4	0.903553
25	Virginia is officially now on a stay at home order, unfortunately I work at @Walmart and pu	"2447103327652470"	(Positive: "0.0096584185357190863," Negative: "0.3185393919891357," Neutral: "0.0738	1.8	negative	neutral	negative	-0.318539	-0.2	-0.31893
26	This was all a lie from @realDonaldTrump @VP and the @coughpharmacy @Walmart peop	"2447103272325663"	(Positive: "0.00580572843135712," Negative: "0.31853518405154," Neutral: "0.0786	0.6	negative	negative	negative	-0.318538	-0.3	-0.444886
27	Walmart catches trapping its employees @Walmart needs to allow the one's that fear v	"2447087517545717"	(Positive: "0.00172465550132411," Negative: "0.954351568222046," Neutral: "0.0428	1.3	negative	neutral	negative	-0.954351	-0.1	-0.933229
28	I've got the best assistant in the world. I mean he can't help too much with my interview s	"244708722278054"	(Positive: "0.3681678413447788," Negative: "0.000498434348613024," Neutral: "0.03	1.4	positive	positive	positive	0.3681678	0.3	0.554793
29	Are you brewing up a #asteCtoAmerica2020 emmy? You have until TOMORROW, March	"2447087222020472"	(Positive: "0.7946100830103759," Negative: "0.0014363582185464753," Neutral: "0.203	0.3	positive	neutral	positive	0.7946101	0	0.741191
30	I'm at @Walmart Supercenter in Washington, DC	"2447081171345328"	(Positive: "0.018010367894768176," Negative: "0.001384867187185316," Neutral: "0.96	0	neutral	neutral	neutral	0	0	0
31	That's why @Walmart down here in the valley should of taken precaution like all other s	"244707803750585"	(Positive: "0.018810404136776324," Negative: "0.563723643821783," Neutral: "0.4194	0	negative	neutral	negative	-0.56373	0	-0.838835
32	@Walmart has not taken measures to ensure ALL workers have safe working conditions	"244707665568391"	(Positive: "0.00440836559184626," Negative: "0.0674829303841019," Neutral: "0.921	1.5	neutral	negative	negative	0	-0.1	-0.863785
33	Update @hm @PVMHCorp @hmals and pence have agreed to pay for clothing orders	"2447075307137026"	(Positive: "0.00542318605148125," Negative: "0.10317817436403," Neutral: "0.885175	0.8	neutral	neutral	negative	-0.103139	-0.2	-0.394009
34	Here's to the PR people who knew we needed this news in our life. Thanks @Walmart for	"2447071930361591"	(Positive: "0.9305425862339476," Negative: "0.00093430603087136," Neutral: "0.06	1.6	positive	positive	positive	0.9305426	0.5	0.94421
35	Join the United States Hispanic Chamber of Commerce (@USHCC) and @Walmart on a	"2447063625689701"	(Positive: "0.04287376254739682," Negative: "0.001051736608147621," Neutral: "0.9	0.4	neutral	neutral	positive	0	0.2	0.404387
36	Businesses giving wage increases during pandemic \$2hr - @Target, @Walmart, @amg	"2447061851713303"	(Positive: "0.0002383782032370339," Negative: "0.0008985228487290442," Neutral: "0.	1.9	neutral	neutral	negative	0	0	-0.367178
37	If @Governor are letting @SamClub @Walmart @Target @HomeDepot @Lowes @Cost	"2447050840431185"	(Positive: "0.001957352369478771," Negative: "0.8805531827108785," Neutral: "0.18	1.3	negative	negative	negative	-0.880553	-0.6	-0.325336
38	Enter for a chance to win a \$100 @Walmart Gift Card, only with @giftloop! Download and	"2447050282174382"	(Positive: "0.025348075636856117," Negative: "0.0001854608939552437," Neutral: "0.	0.7	neutral	positive	positive	0	0.7	0.580392
39	In these times, it's important to be clean and stay positive! 🧼 Introducing the SHAMPC	"2447047265003901"	(Positive: "0.7615932471970581," Negative: "0.00018812602502233885," Neutral: "0.238	1.7	positive	positive	positive	0.7615932	0.4	0.32831
40	📺 VIRTUAL JOB FAIR! 📺 Pre-register now by visiting @CareerSourceSD to hosting its.	"2447044563333186"	(Positive: "0.23450186941158515," Negative: "0.00044255203858973086," Neutral: "0.7	0.2	neutral	neutral	positive	0.2	0.2	0.368715
41	Just a heads up that if anyone ever wonders @Walmart doesn't price match anyone	"2447043763737075"	(Positive: "0.034357471737484532," Negative: "0.8317043827304077," Neutral: "0.2783	0.5	negative	negative	negative	-0.831705	-0.5	-0.813867
42	Just found out my @Walmart assessments were altered. I'm on those to make the emplo	"2447029733121258"	(Positive: "0.013573398585343361," Negative: "0.5582029229463299," Neutral: "0.428	0.3	negative	neutral	negative	-0.558221	0	-0.412519
43	When your local @Walmart employee says "I see you in here alot" um yeah, this the only	"2447029046966105"	(Positive: "0.3724872118788147," Negative: "0.0071110329153538," Neutral: "0.6203	1	neutral	neutral	negative	0.2	0	-0.347746
44	Around The Clock Childcare That Voiks For Essential employees https://t.co/3d3p3m1f	"2447018508560666"	(Positive: "0.000212161825053035," Negative: "0.0000576055814438115," Neutral: "0.	1.1	neutral	neutral	positive	0	0.2	0.875724
45	It turns out she told him she thought she might stop by @Walmart "if it wasn't too crowde	"2447011483175731"	(Positive: "0.008401873521506786," Negative: "0.326187346725464," Neutral: "0.0651	2.4000001	negative	negative	negative	-0.326016	-0.3	-0.755683
46	Sam's Club in Murreletsboro is firing/laying off their employees over the virus and then fig	"2446939833381836"	(Positive: "0.0013211127370595332," Negative: "0.857032022895813," Neutral: "0.14158	1.3	negative	neutral	negative	-0.857032	-0.1	-0.856334
47	Ordered an in stock item from Amazon that is needed. Can only get them in @Walmart	"2446935160374391"	(Positive: "0.06584030582141876," Negative: "0.7084853603603882," Neutral: "0.2256	1	negative	neutral	negative	-0.708486	-0.2	-0.66751
48	I wonder if @Walmart will accept as returns the @EstatePlannecare outfits purchased by it	"2446935850283771"	(Positive: "0.433181263915237427," Negative: "0.0705284894848622," Neutral: "0.257	1.3	positive	neutral	positive	0.4331813	0.1	0.254781
49	Today's @OriginalUnko hunt at @Walmart was a success	"2446932335612255"	(Positive: "0.82853321867114," Negative: "0.0012606123943209648," Neutral: "0.1702	0.1	positive	neutral	positive	0.8285331	-0.1	0.853513
50	Thank you Judy Miller for using Hickey Bottom Sweet Ebb Sauce! @HickeyBottomBBQ	"2446388785924698"	(Positive: "0.359186851978302," Negative: "0.00012549132225103676," Neutral: "0.040	1	positive	positive	positive	0.3591868	0.4	0.963135

Figure 1: Data Table of @Walmart Tweets.

Line Plot Data

The line plot shown below is one way data was translated per company. The closer the lines are to each other the less variance there is in the scores given by the AIs. It can be seen in this example that occasionally sentiment ratings differed significantly (ex: tweet 44)

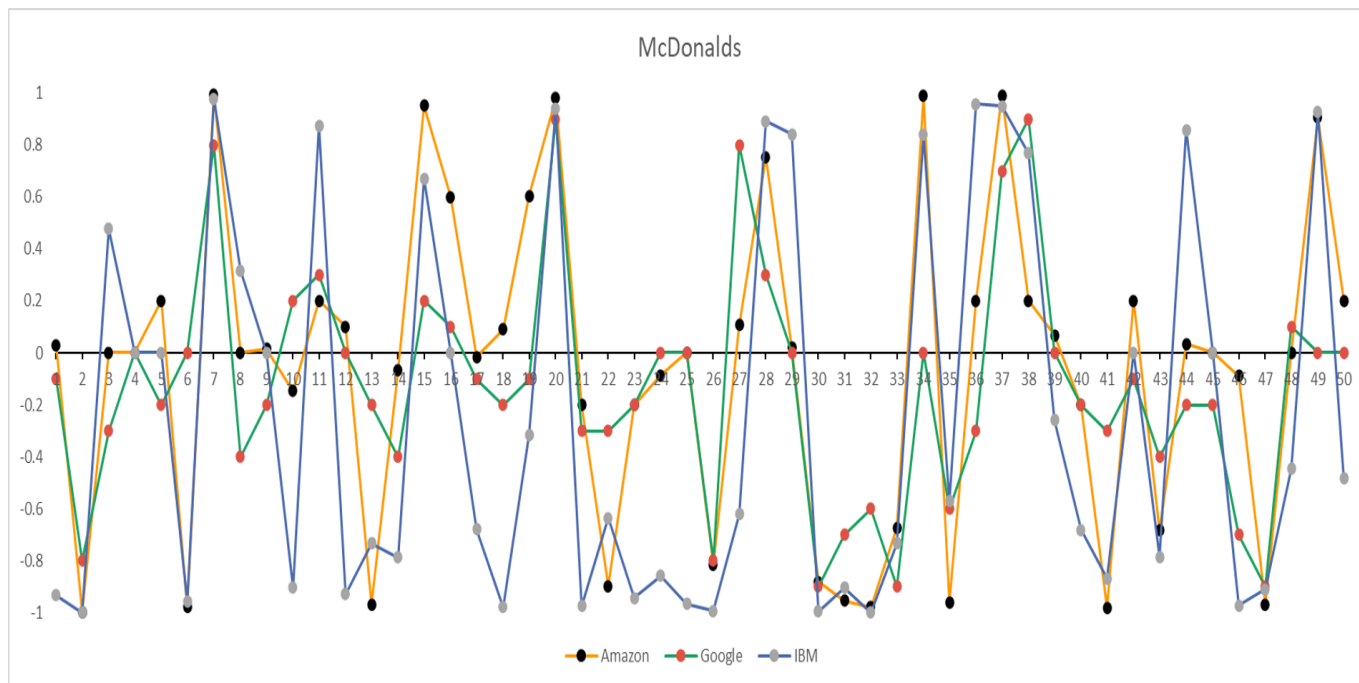


Figure 2: Line Plot of @McDonalds Tweets.

Bar Chart Data

Below is a bar chart with the sentiment score averages of every company analyzed. By just eyeballing, it can be seen that the difference in scores is slight. Even in the most dramatic case, Amazon, one can see that the scores still fall within the predefined "neutral" score range of -0.2 to 0.2

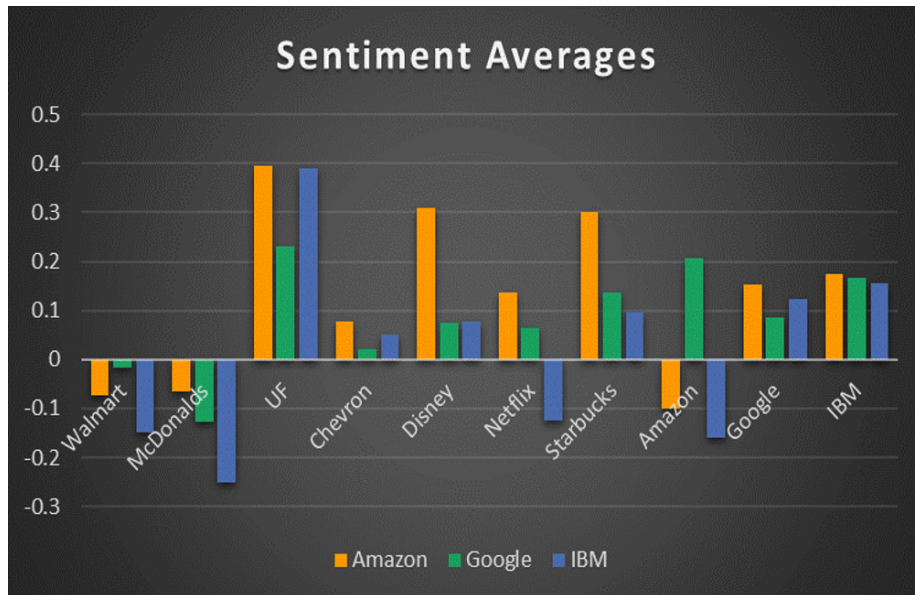


Figure 3: Average Score of all Companies

Below is a bar chart with the total count of all sentiment labels by each AI service. Each service analyzed 500 tweets with Google and Amazon having near identical charts. IBM's chart is clearly more polarizing and this is likely due to the AI being stricter on its classification of neutral sentiment. Unlike the other services, if a tweet is found to be neutral IBM will return a score of zero.

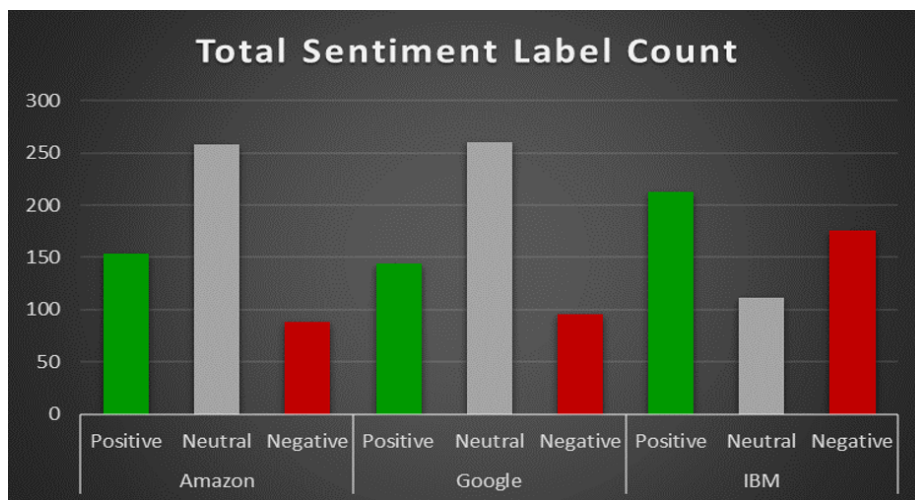


Figure 4: Total Label Count of all Companies

Below is the most important chart of this project. It shows the average sentiment of each AI provider and the variance found. While the size difference in each bar appears large, the difference between a score of 0.13 and 0.02 when humanly interpreted is essentially the same as scoring a 0 or "neutral".

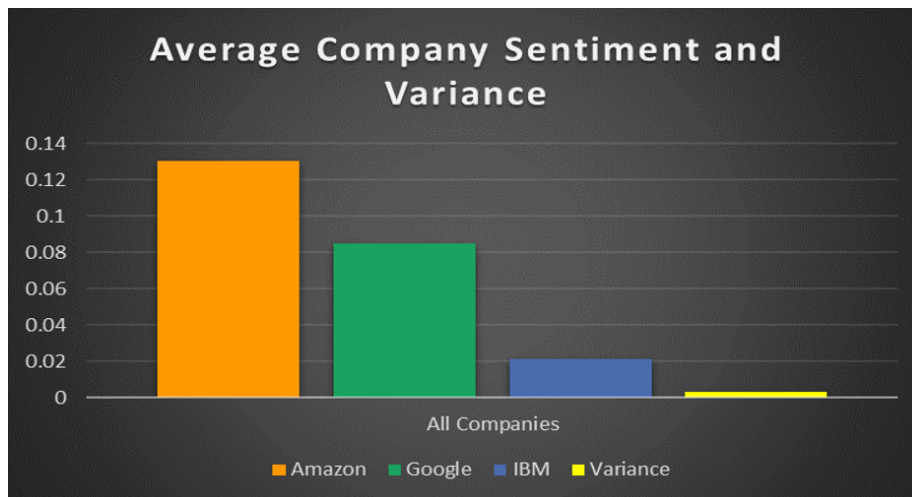


Figure 5: Collective Average Score and Variance

Front End Interface

The front end application portion of this project has a simple interface. The first input box accepts any twitter handle as input and the second one allows up to 100 tweets to be searched. The 100 limit is due to Twitter Search API constraints. Google's Chart API is used to visualize the sentiment labels gathered from the search along with an average sentiment score from each service and a data table containing all the raw text and scores analyzed. The raw scores are color coded to help the user see which tweets the AI services disagreed on.

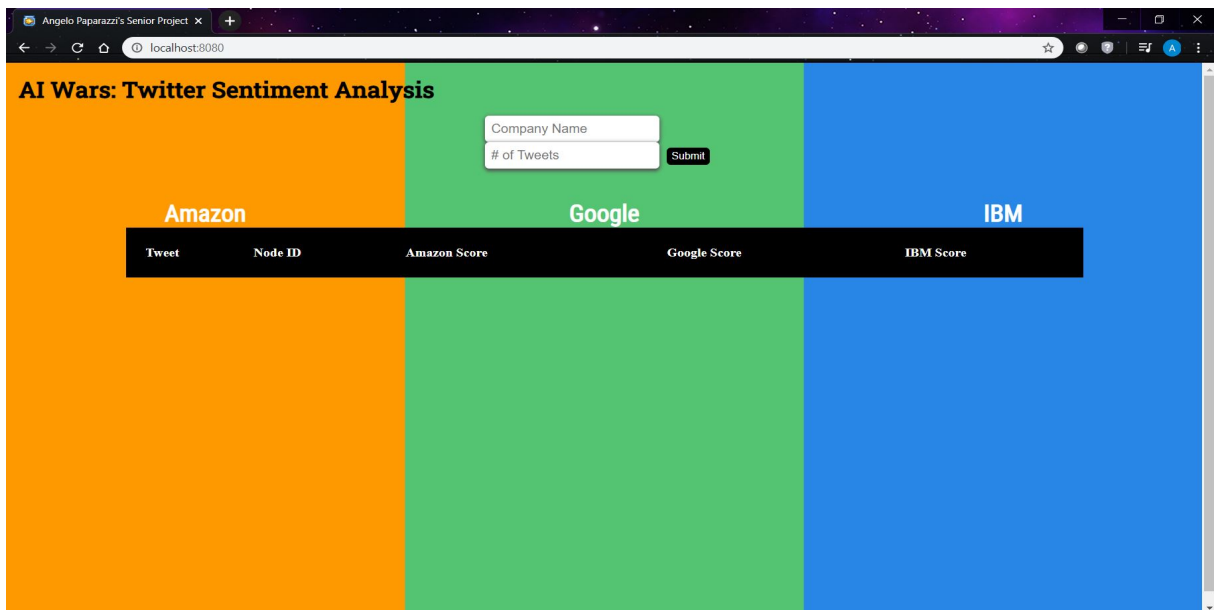


Figure 6: Website Home Page

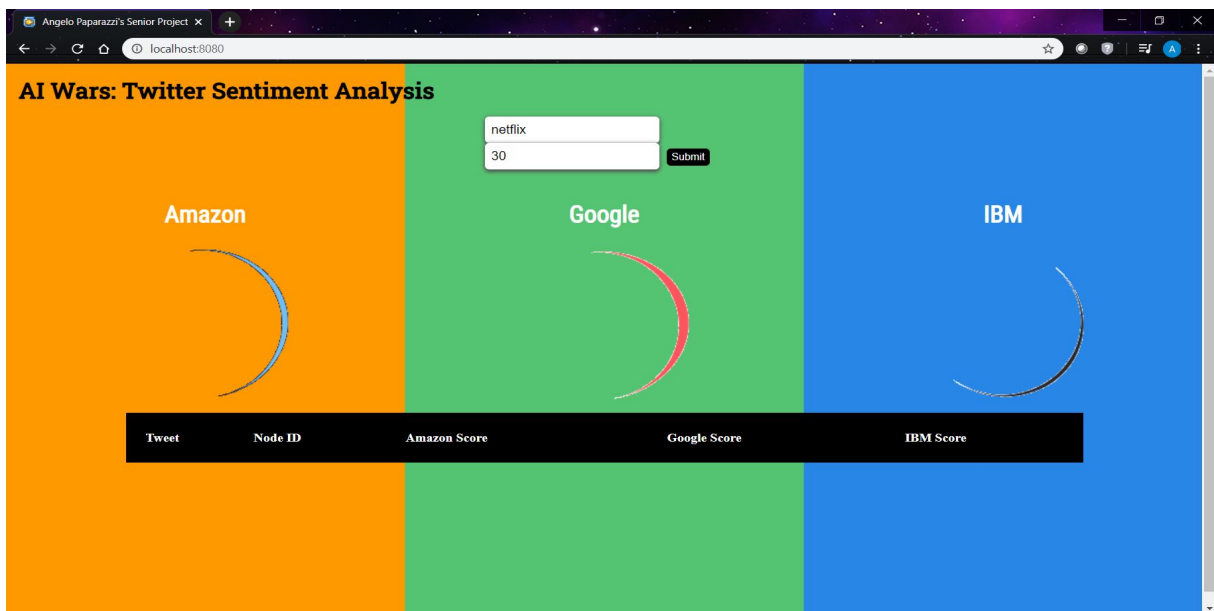


Figure 7: Website Loading Animation

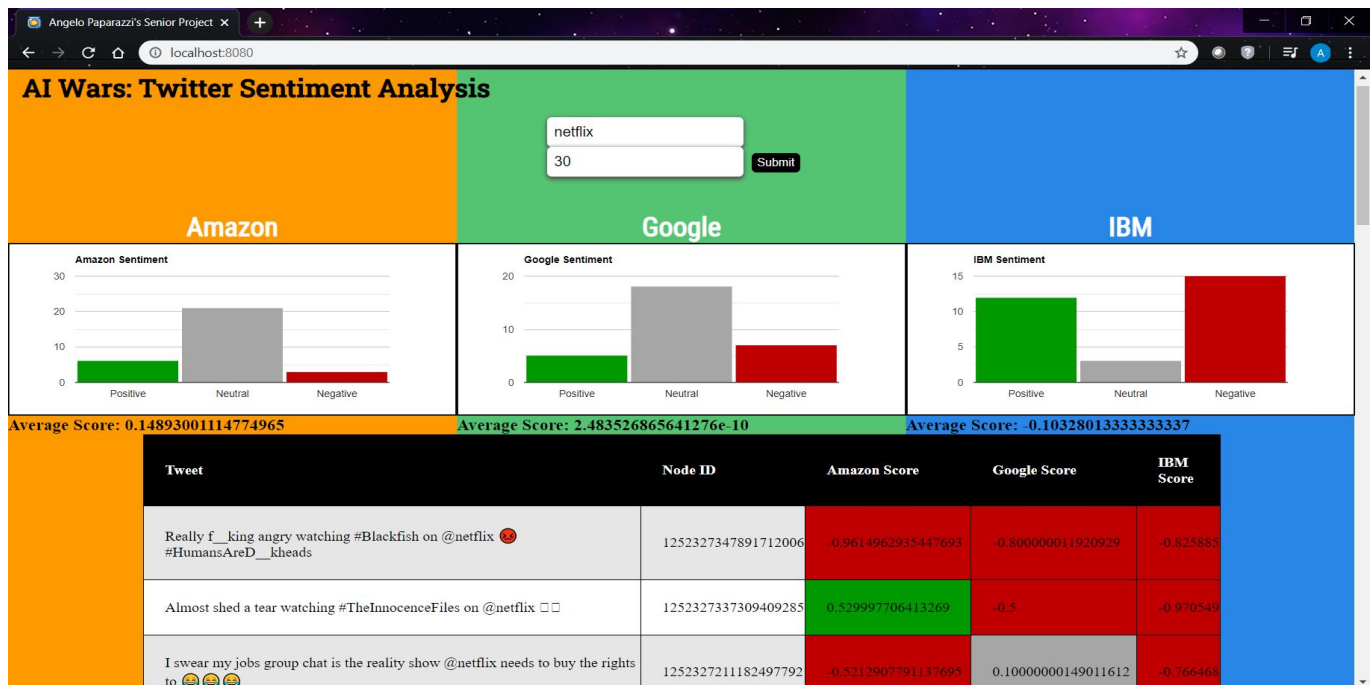


Figure 8: Website Results Page

Conclusion

This project collected 50 tweets from 10 different companies using three different AI sentiment analysis services to come to the conclusion that the variance between each service on large data sets is negligible. In terms of research and data collection, the possible data that could be extracted was very limiting due to free tier constraints on Twitter's Search API. In the future, I would hope to collect even more data from time periods outside of the last 7 days. Also, I would like to later extend this project by also measuring the accuracy of the various AI services using pre-labeled test data. On the other end, the front end of the user experience is severely lacking in professional appearance and features due to both time constraints and my lack of experience in front end design. To fix this issue I would simply find a partner to focus on front end design.

Bibliography and Acknowledgments

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Acknowledgments

I would like to thank Dr.Dobbins for being my project adviser despite my late request and also for helping me along the development process. I would also like to thank UF graduate Aliyah Chance for providing me with a base html and css skeleton to get me off the ground despite my lack of front end development skills. Thank you both!

Short Biography

My name is Angelo Paparazzi and I have worked internships at both UPS and IBM and I am currently employed part time with IBM. After graduation, I have plans to work full time with IBM on Watson AI SDK development. Quite fitting to my project I would say. I am excited to begin my life as a developer and couldn't ask for more. I became interested in coding through a lucky summer program I got into at Carnegie Mellon University and have been hooked since. I would say my interests within the field are wide because as long as I am solving problems in some way through code I find myself enjoying it. The great possibilities AI presents for the future is why I decided to focus my project on it.