SENTIMENT ANALYSIS PRIMER:

HOUSEHOLD CONSUMER PACKAGED GOODS (CPG)

ANALYSIS BY ROB BECOTTE 16 MARCH 2020

EXECUTIVE SUMMARY

Findings:

1. There is consistent high positive sentiment shared across examined brands
2. There is evidence validating consumer interest in environmental sustainability
3. @SeventhGen is the consistent leader in sentiment of the three brands on Twitter (Emulate their engagement style), however it has steadily dropped over the past two years
4. The Support Vector Machine (SVM) performed 1% better in training data accuracy than the Multinomial Naïve Bayes (MNB) classification algorithm.
5. The MNB algorithm appears to perform better on primary data from Twitter and suggests higher overall brand/consumer sentiment.

POSSIBLE NEXT STEPS

Looker deeper at…

1. **Sentiment:**
   - A. Research negative sentiment of competitors
   - B. Research positive sentiment of competitors
   - C. ~~Re-tune Classification Model for higher predictive confidence~~

2. **Engagement:**
   - A. Time series analysis more granularly
   - B. What are influencers saying
   - C. Cluster analysis
   - D. Industry leader direction signaling

So you can…

- Use findings to address their pitfalls
- Improve on their known successes

- Identify optimal engagement trends to align with your future marketing campaign
- Look for clusters to identify demographics or unseen driving forces with consumers (Unsupervised ML: Principal Component Analysis)

CONTENT

1. Orientation
2. Data Collection
3. Model Comparison and Performance
4. Findings
   A. Brand Sentiment
   B. Engagement Time Series Analysis
5. Recommendations and Next Steps

PURPOSE

1. **Catalyst:** Provide an independent data point for a NYC based startup
2. **Hypothesis:** There is high positive consumer sentiment towards using household goods that reduce waste (plastic) and promote environmental sustainability
3. **End State:** The startup will…
   A. Be armed with current consumer and market atmospherics
   B. Better target branding and marketing efforts
   C. Better align company vision with VCs or existing market leaders (M+A)

OBJECTIVES

1. Twitter Engagement Trends

A. **Magnitude** - How much

B. **Frequency –** How Often

C. **Timing -** When

D. **Clustering –** Why (Hard Part)

2. Sentiment Analysis

A. **Top Brands** – How do consumers feel about them? (% Positive Tweets)

B. **Top Features** – Why do consumers like these brands? (Convenience, social reasons, environment, ingredients, price)

C. **Find Meaningful Words** – Align marketing and branding

YARD STICKS

1. Machine Learning NLP Sentiment Analysis Benchmark for social media (Twitter):

- 60-80% Accuracy Rate

2. Mention Count: A mention is when someone uses the @ sign immediately followed by your Twitter Handle.

- @DrBronner
- @MrsMeyersClean
- @SeventhGen

(This analysis included the '@' in the web scrape to reduce ambiguity of handles)

3. Tag Count: An act of endorsement, which can be very powerful coming from an influencer with an engaged audience made up of people similar to your target market.

- #plasticfree

(This analysis omitted the '#' in the web scrape to capture all data points)

Hypothetical Examples

- **Model accurately predicts positive and negative sentiment in 3 to 4 out of 5 Tweets**
- **"Hey @DrBronner, I love your products!"**
- **"We should live greener #plasticfree**

https://sproutsocial.com/insights/twitter-mentions/

http://nlpprogress.com/english/sentiment_analysis.html

COMPANY ENGAGEMENT ACTIVITY SINCE INCEPTION

@SeventhGen	@DrBronner	@MrsMeyersClean
13K Tweets	**30K Tweets**	3K Tweets
83K Followers	54K Followers	11K followers

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DATA COLLECTION

Train/Test NLP Data Sets:

- Kaggle – Twitter and Reddit Tweets (Binary Pos/Neg Labels)
- AWS – 6M Amazon Product Reviews (1-5 Star Label)

Data Scrapes:

- Twitter –GOT3 Python API
  - ~400K Tweets scraped from January 1 2018 to March 1 2020
- Reddit – Pushshift Python API
  - ~100K Reddit 'r/SkincareAddiction' posts NOT analyzed

METRICS ENUMERATION

Retweets/Replies:

- No duplicative counts logged from scrape
- Considering adding retweets to the mention count as the twitter community would hypothetically see

	artifact	datetime	text	retweets	username	year	month	day	month_year	hour	neg	neu	pos	compound	vader_pred	svm_pred	svm_proba
0	@SeventhGen	2018-01-01 03:34:56-05:00	Hey Everyone Get samples, test products and make a difference: join me @SeventhGen's #GenerationGood http://h3.sml360.com/-/27f3a	0	Shantele_Marie	2018	1	Monday	2018-01	3	0.0	0.855	0.145	0.2960	1	1	0.625190
1	@SeventhGen	2018-01-01 04:38:23-05:00	They've got fun products. Get samples, test products and make a difference: join me @SeventhGen's #GenerationGood http://h3.sml360.com/-/27f44	0	Shantele_Marie	2018	1	Monday	2018-01	4	0.0	0.718	0.282	0.6705	1	1	0.676501
2	@DrBronner	2018-01-01 11:00:05-05:00	Grateful for every person who believes in the All-One Mission, devoted to love, respect & equality for all. Every employee who mobilizes daily with a palpable passion. Every customer who feels called to be of service to the world, empowering us to do more, do better.	8	DrBronner	2018	1	Monday	2018-01	11	0.0	0.665	0.335	0.9594	1	1	0.714697
3	@DrBronner	2018-01-01 11:00:06-05:00	This year, we donated approximately $7 million to philanthropic causes—from animal advocacy & fair trade supply chains to drug policy reform & LGBTQIA equality. We did that together.	3	DrBronner	2018	1	Monday	2018-01	11	0.0	0.916	0.084	0.3182	1	1	0.722890
4	@DrBronner	2018-01-01 11:00:06-05:00	We have more work to do in 2018 to stand up for people-planet-animals, and one day achieve our mission of unifying the human race. Onwards!	4	DrBronner	2018	1	Monday	2018-01	11	0.0	1.000	0.000	0.0000	0	1	0.685856
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
375544	plasticfree	2020-02-28 16:21:07-05:00	@refill @cocacola maybe this is future! #plasticfree	0	EnvironmentPlym	2020	2	Friday	2020-02	16	0.0	1.000	0.000	0.0000	0	1	0.710810
375545	plasticfree	2020-02-28 16:30:12-05:00	Chessel Bay March Clean Up - Sat 14 March 2020 http://www.greenhampshire.co.uk/events/564/Chessel-Bay-March-Cleanup #Southampton #LitterPick #BeachClean #PlasticFree #NurdleHunters	0	GreenHampshire	2020	2	Friday	2020-02	16	0.0	0.838	0.162	0.4019	1	1	0.702101
375546	plasticfree	2020-02-28 16:31:17-05:00	Sé parte de la iniciativa para generar un cambio en nuestro planeta. #RegresandoAlOrigen #KiriPlanet #ECO #MedioAmbiente #EcoFriendly #ReduceWaste #ZeroWaste #PlasticFree	4	KiriPlanet	2020	2	Friday	2020-02	16	0.0	1.000	0.000	0.0000	0	1	0.778596
375547	plasticfree	2020-02-28 16:34:32-05:00	¡Empaque totalmente amigable con el medio ambiente!. #RegresandoAlOrigen #KiriPlanet #ECO #MedioAmbiente #EcoFriendly #ReduceWaste #ZeroWaste #PlasticFree	4	KiriPlanet	2020	2	Friday	2020-02	16	0.0	1.000	0.000	0.0000	0	1	0.736188
375548	plasticfree	2020-02-28 16:51:27-05:00	Be a planet saver with Tavos! #ecofriendly #paperstraws #plasticfree #planet #plasticfreeoceans #saveenvironment #sustainability #Biodegradable #Compostable	0	TavosCanada	2020	2	Friday	2020-02	16	0.0	1.000	0.000	0.0000	0	1	0.739465

375549 rows × 17 columns

DATA COLLECTION

Scrape Output

	artifact	datetime	text	retweets	username
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2	@DrBronner	2018-01-01 11:00:05-05:00	Grateful for every person who believes in the All-One Mission, devoted to love, respect & equality for all. Every employee who mobilizes daily with a palpable passion. Every customer who feels called to be of service to the world, empowering us to do more, do better.	8	DrBronner
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375544	plasticfree	2020-02-28 16:21:07-05:00	@refill @cocacola maybe this is future! #plasticfree	0	EnvironmentPlym
375545	plasticfree	2020-02-28 16:30:12-05:00	Chessel Bay March Clean Up - Sat 14 March 2020 http://www.greenhampshire.co.uk/events/564/Chessel-Bay-March-Cleanup #Southampton #LitterPick #BeachClean #PlasticFree #NurdleHunters	0	GreenHampshire
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375549 rows × 17 columns

Feature Engineering (My Additions)

year	month	day	month_year	hour	mnb_pred	mnb_proba	svm_pred	svm_proba	vader_pred	compound	neg	neu	pos
2018	1	Monday	2018-01	3	1	0.858685	1	0.625190	1	0.2960	0.0	0.855	0.145
2018	1	Monday	2018-01	4	1	0.746199	1	0.676501	1	0.6705	0.0	0.718	0.282
2018	1	Monday	2018-01	11	1	0.786069	1	0.714697	1	0.9594	0.0	0.665	0.335
2018	1	Monday	2018-01	11	0	0.494399	1	0.722890	1	0.3182	0.0	0.916	0.084
2018	1	Monday	2018-01	11	1	0.739867	1	0.685856	0	0.0000	0.0	1.000	0.000
...	...	...	...	...	...	...	...	...	...	...	...	...	...
2020	2	Friday	2020-02	16	1	0.546094	1	0.710810	0	0.0000	0.0	1.000	0.000
2020	2	Friday	2020-02	16	1	0.561695	1	0.702101	1	0.4019	0.0	0.838	0.162
2020	2	Friday	2020-02	16	1	0.615212	1	0.778596	0	0.0000	0.0	1.000	0.000
2020	2	Friday	2020-02	16	0	0.270390	1	0.736188	0	0.0000	0.0	1.000	0.000
2020	2	Friday	2020-02	16	1	0.765798	1	0.739465	0	0.0000	0.0	1.000	0.000

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BASELINE MODEL ACCURACY (OFF THE SHELF ALGORITHM)

VADER Sentiment Analyzer Performance

Data Set	Data Set	Data Set	Data Set
Amazon Reviews	Kaggle Twitter #1 (Indian English Tweets)	Reddit	Kaggle Twitter #2
Long Varied Reviews	Tweet	Posts	Tweet
54% Accuracy	57% Accuracy	63% Accuracy	**64% Accuracy**

CUSTOM MODEL EVALUATION

Model	Tokenize and Fit Computation Time	Best Parameters	Train Accuracy	Test Accuracy
VADER	5 Minutes	OTS	64%	64%
Random Forest	344 Minutes	TFIDF, 20K Tokens Grams: (1,3)	**99%**	76%
Recursive Neural Network	27 Minutes	1 Hidden Layer, 600K Params	78%	76%
Multinomial Naïve Bayes	**2 Minutes**	TFIDF, 40K Tokens, n_grams= (1,3), use_idf=False α= 0.35,	83%	77%
Support Vector Classifier	360 Minutes	20K Tokens C=1.0 Kernel='rbf'	95%	**78%**

MULTINOMIAL NAÏVE BAYES (CLASSIFIER) TRAINING RESULTS

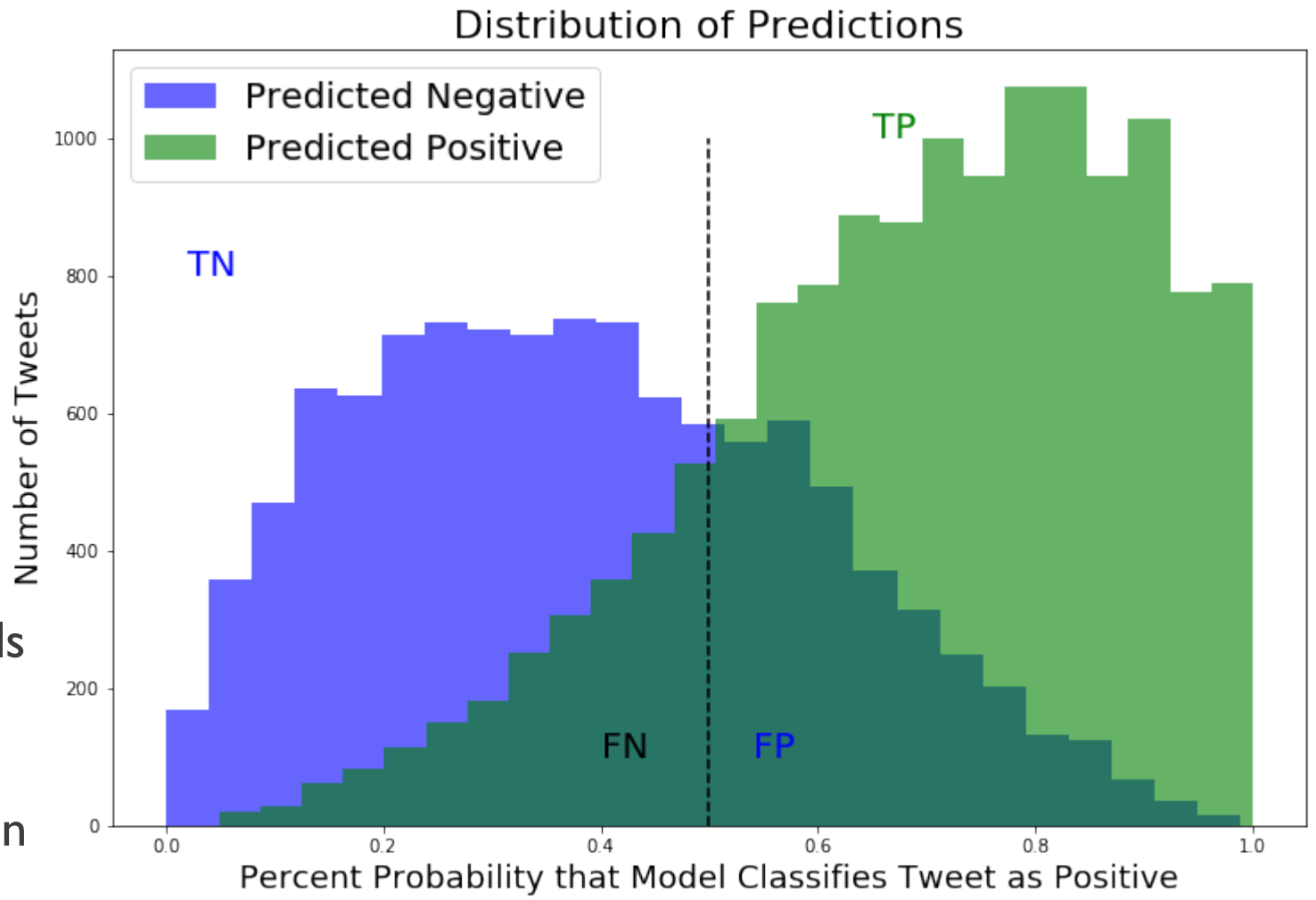
Insight

- Predictions have appropriate skews

  (Most predictions are accurate)

- The high confidence predictions were generally accurate

- This model hedged confidence intervals more than the SVM model, suggests there are many tweets that require more context (Accurate representation of Twitter's often sarcastic tone)



MULTINOMIAL NAÏVE BAYES (CLASSIFIER) TRAINING RESULTS

Insight

- Performs **best** at predicting positive sentiment **(Sensitivity)**

  Business Advice: *Use this model for identifying positive influencers and PR wins*

- **Underperforms** when predicting negative sentiment **(Specificity)**

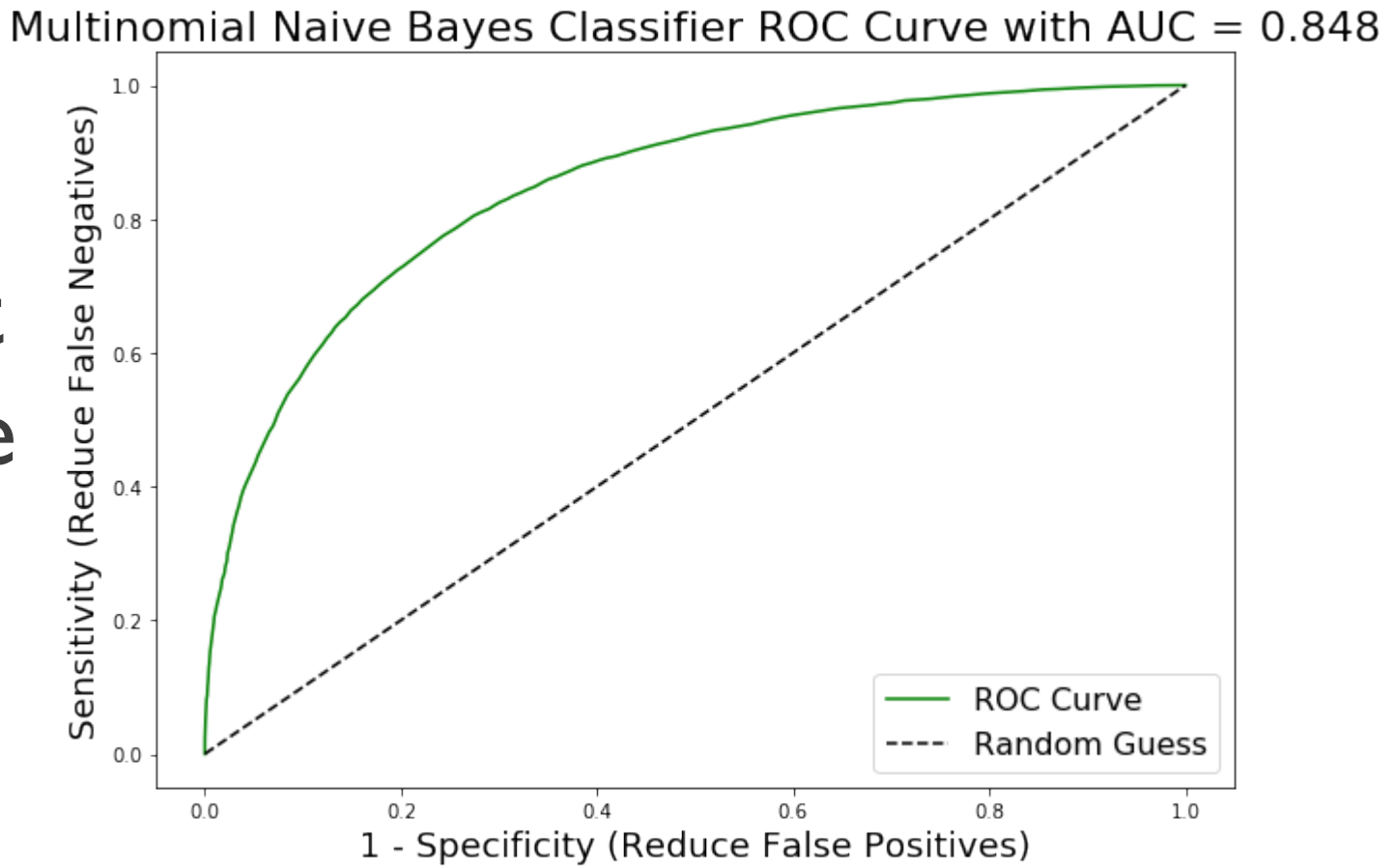
  Business Advice: *Avoid if looking for negative feedback*

	Predicted Negative Tweet	**Predicted Positive Tweet**	
Actual Negative Tweet	7616	Type I Error 3346	Specificity 70%
Actual Positive Tweet	Type II Error 2424	11612	**Sensitivity 83%**
		Precision 78%	Accuracy 77%

MULTINOMIAL NAÏVE BAYES (CLASSIFIER) TRAINING RESULTS

Insight

- 85% probability of rating a Positive tweet higher than a Negative Tweet



WHERE DID THE MODEL GUESS WRONG?

Twitter Training Data

- Model (and people) need context to make an accurate prediction of sentiment, Ceteris Paribus

- I randomly sampled 10 incorrect guesses… I agreed with the model on 5 of 10

	predicted	actual	title
0	0	1	@Allieandra wheeee!
6	1	0	..I've already listened to all the S4 commentary except the finale
7	0	1	"Everybody make mistakes." I'm gonna go get some sleep because I have an other show tomorrow night and I want it to be peeeeerfect!
14	0	1	@changroy no he's the actor
17	1	0	#WeAreStupid what worries me most, these are gov't employees from an office building across the street, and they're REGULARS in the store
...	...	...	...
24978	0	1	@bpfox Not at 5:30 am, it wasn't.
24981	1	0	@bperz And what about you, lady? I hear you're loving your job. But you never call Don't you miss me??? lol
24985	1	0	@baileyschneider: awwwwwwwww that sounds so amazing - my sister can't even make a real yummy egg xxxx
24992	0	1	@batpower lol movie FAILLL. but i still had fun
24993	1	0	@bethie138 I'm using the stuff that came with the couch when we bought it...but I'm kinda giving up hope

5770 rows × 3 columns

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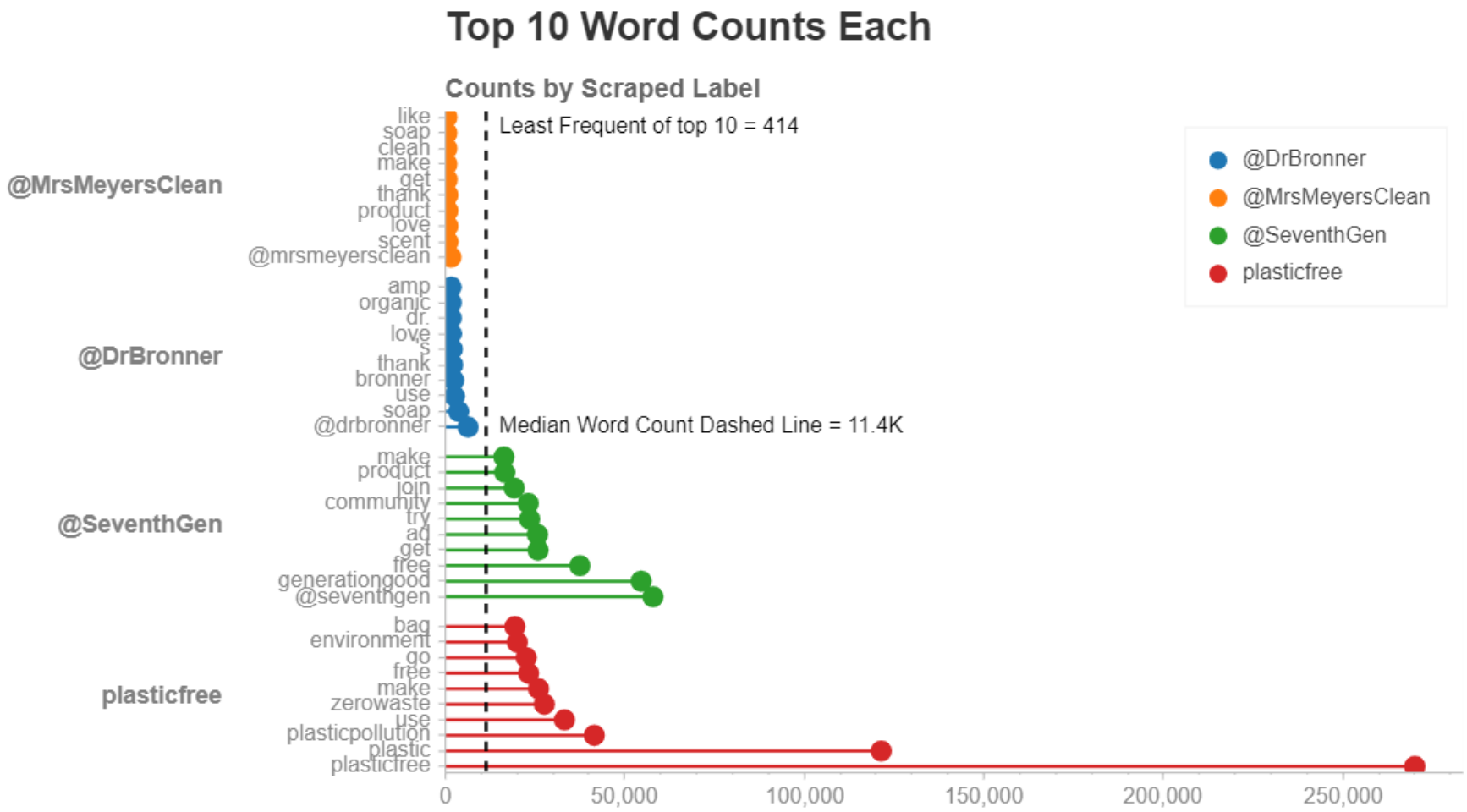
TOP 10 MOST OCCURRING WORDS BY LABEL



5.9M tokens in Corpus

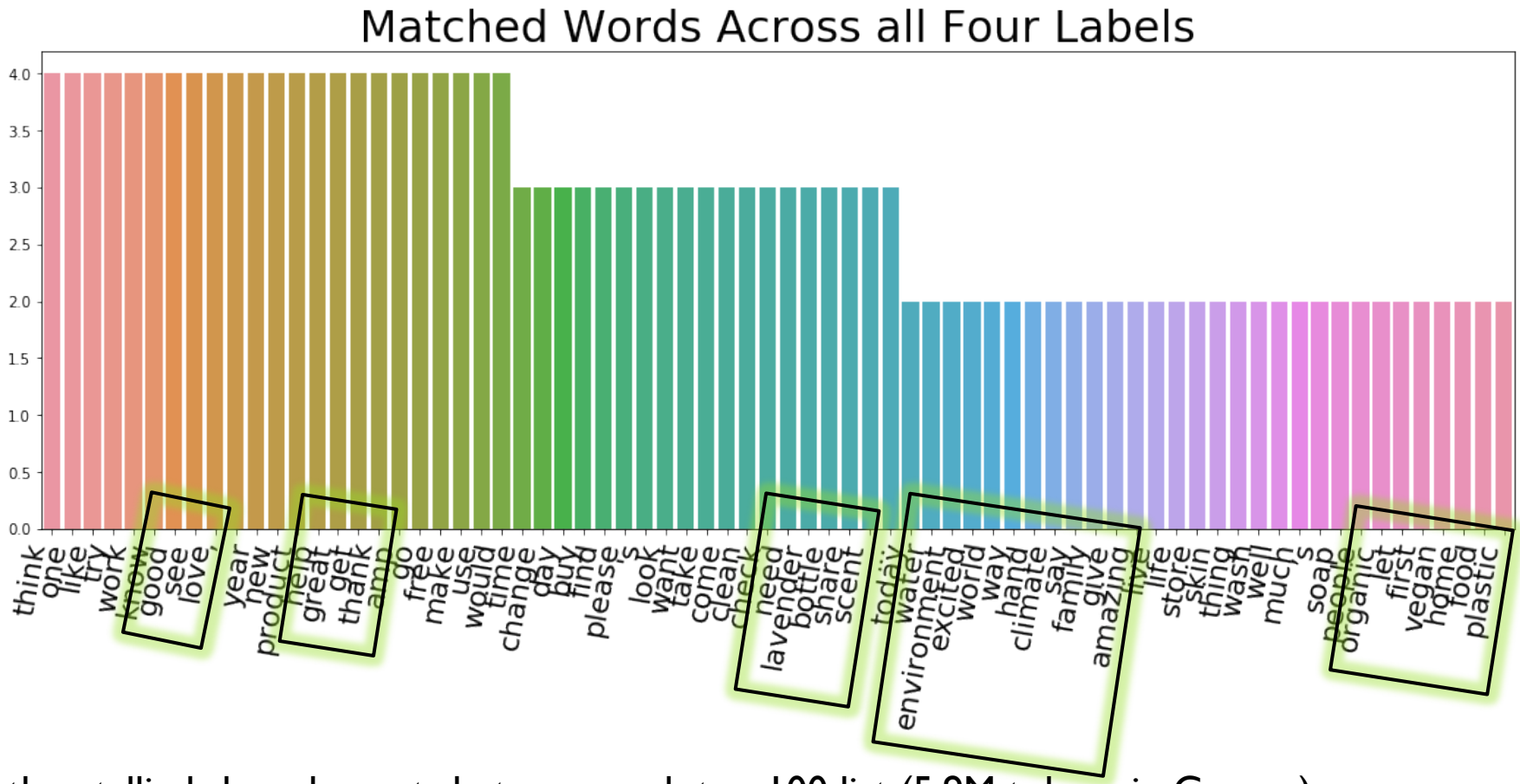
SHARED THEMES BETWEEN ACCOUNTS

Insights

- Highest shared interest in:

1. Positive words
2. Features: 'Lavender', 'scent', organic', 'vegan', 'plastic'
3. Environment

Business Advice: *Ensure business philosophy, branding, and actions align with these concepts*

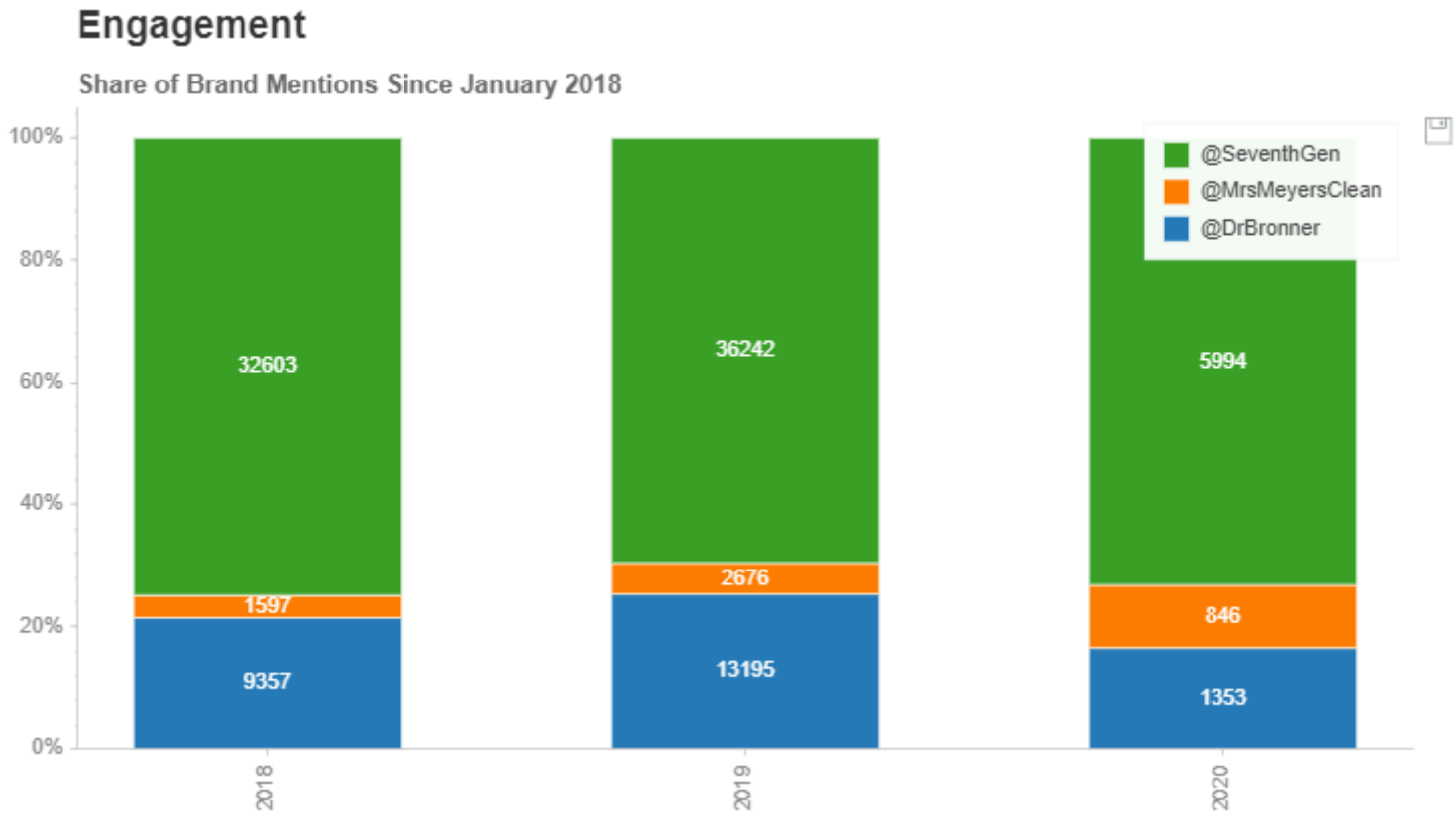


Collated top 100 words from each label, then tallied shared counts between each top 100 list (5.9M tokens in Corpus)

ENGAGEMENT BY BRAND BY YEAR

Insights

- @SeventhGen has the largest Twitter footprint
- @MrsMeyersClean is proportionately increasing their engagement year over year



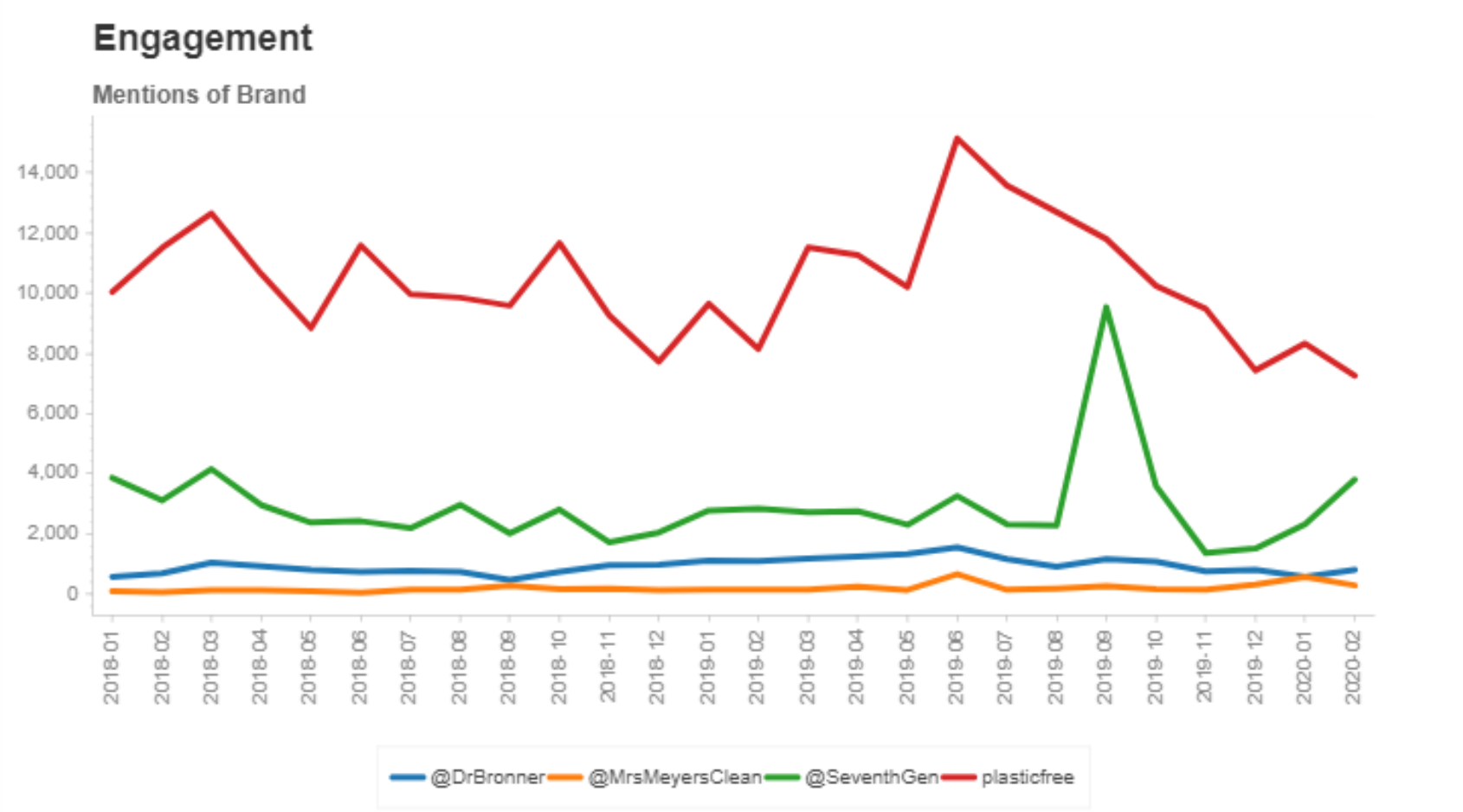
ENGAGEMENT BY MONTH

Insights

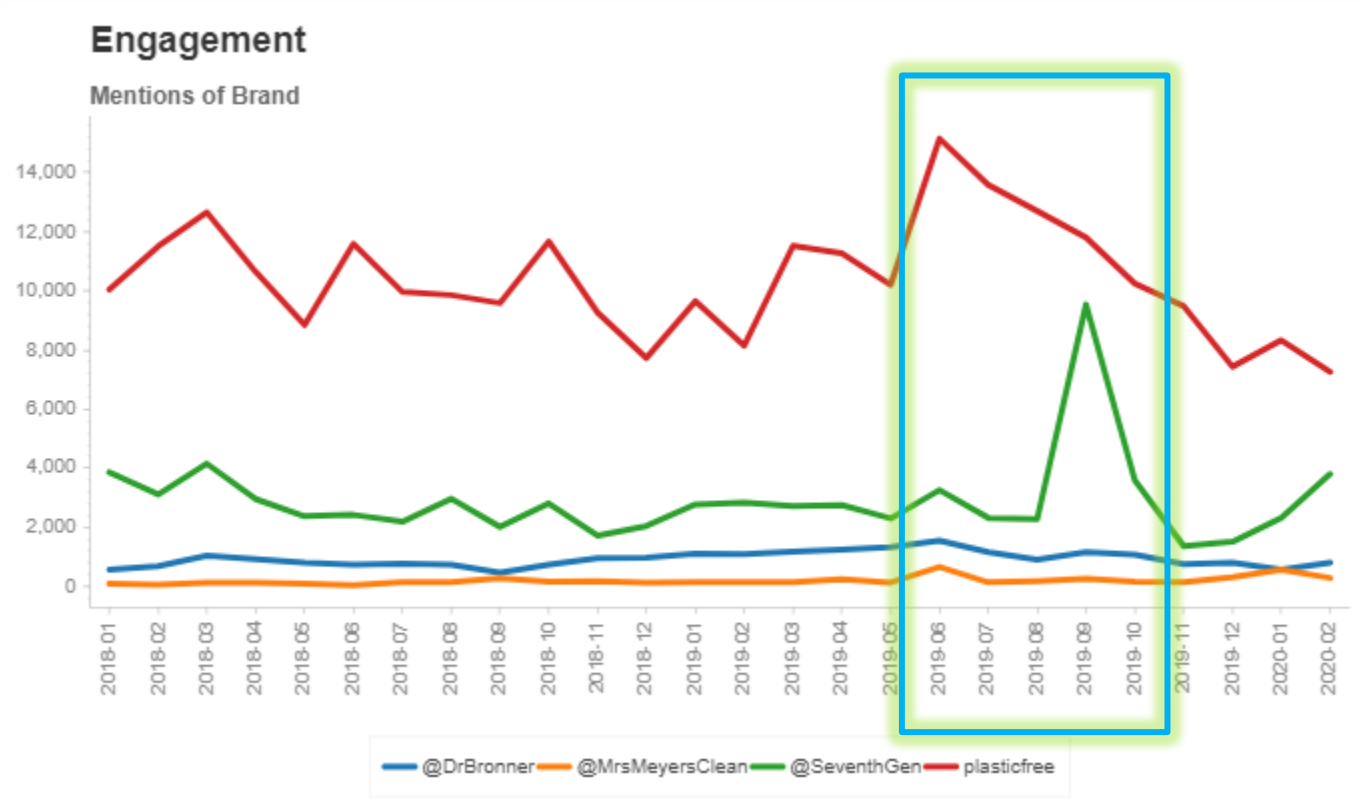
- #plasticfree averages 2.5X the engagement of @SeventhGen

- Generally plateaued mention counts across the board

  Business Advice: *Seek an opportunity to springboard product launch with a high-vis PR event*



#CLIMATESTRIKE

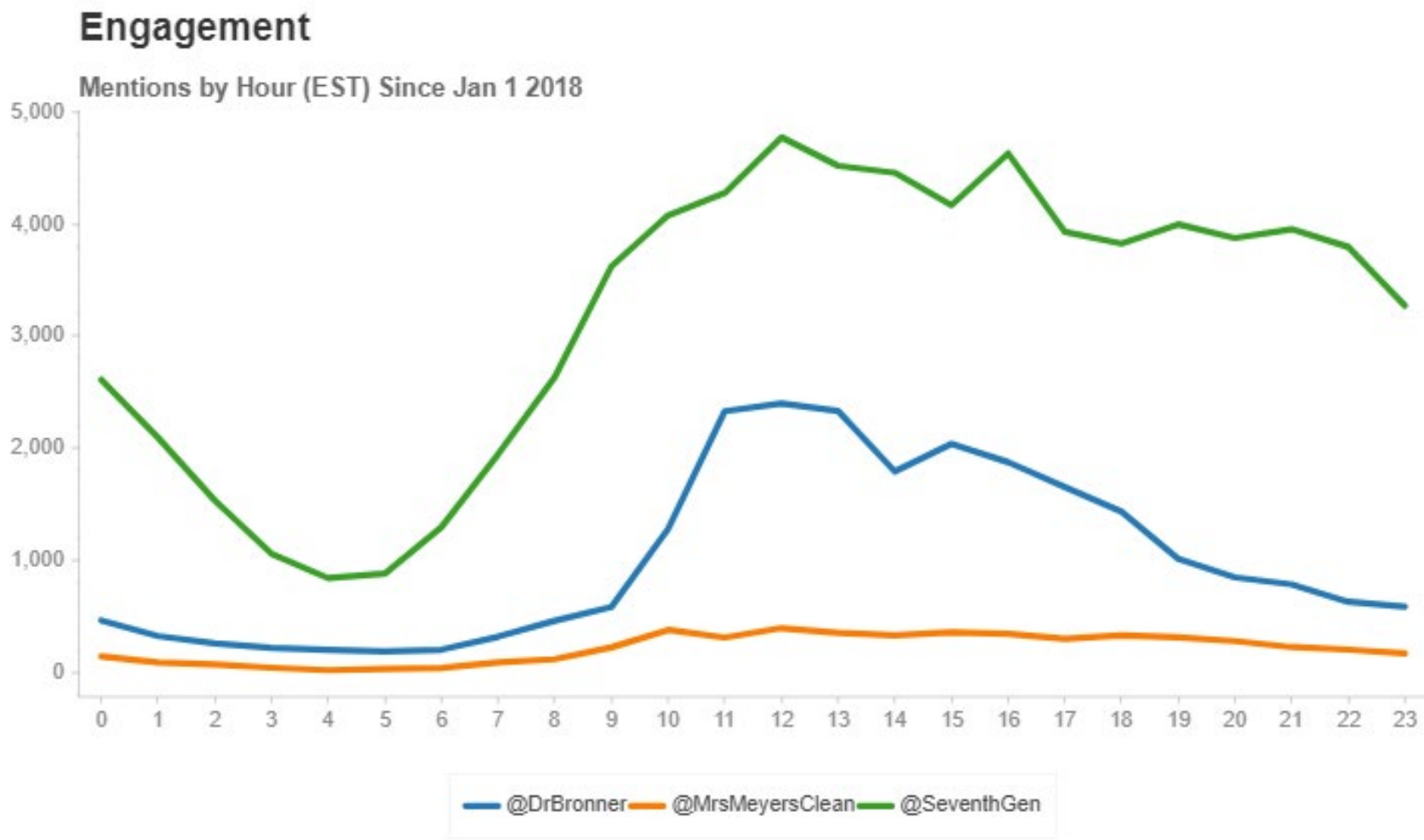


AGGREGATED 2 YEAR ENGAGEMENT BY HOUR

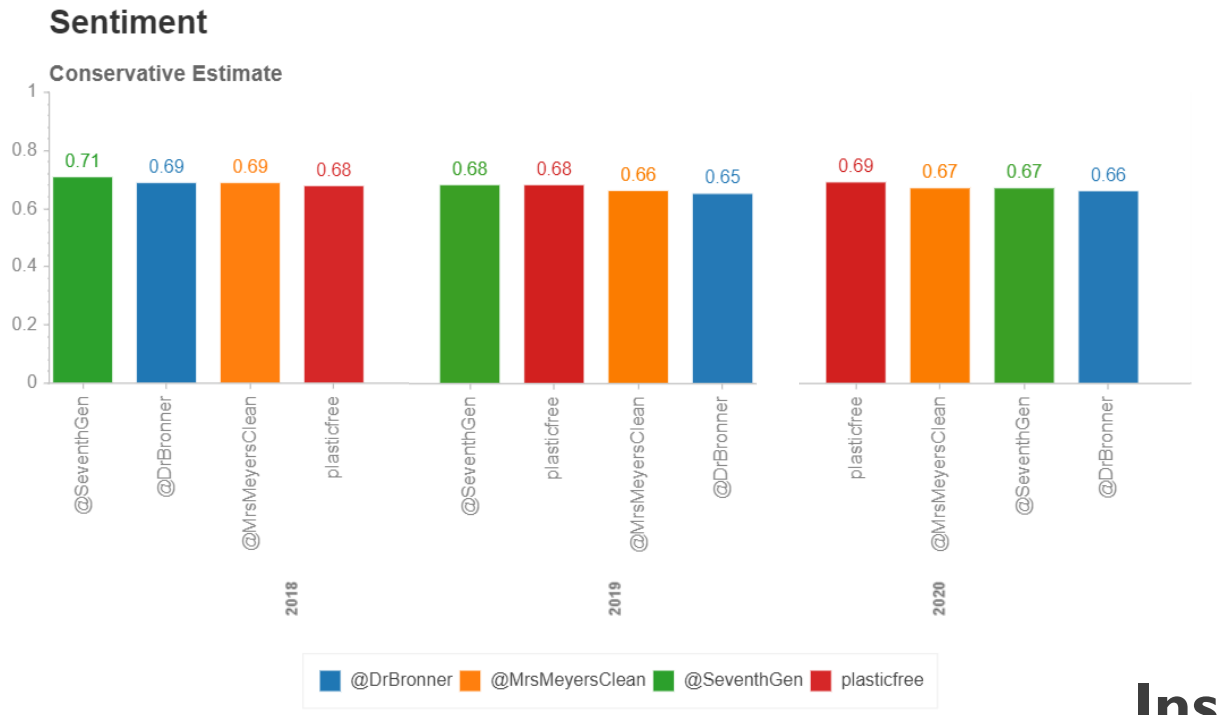
Insights

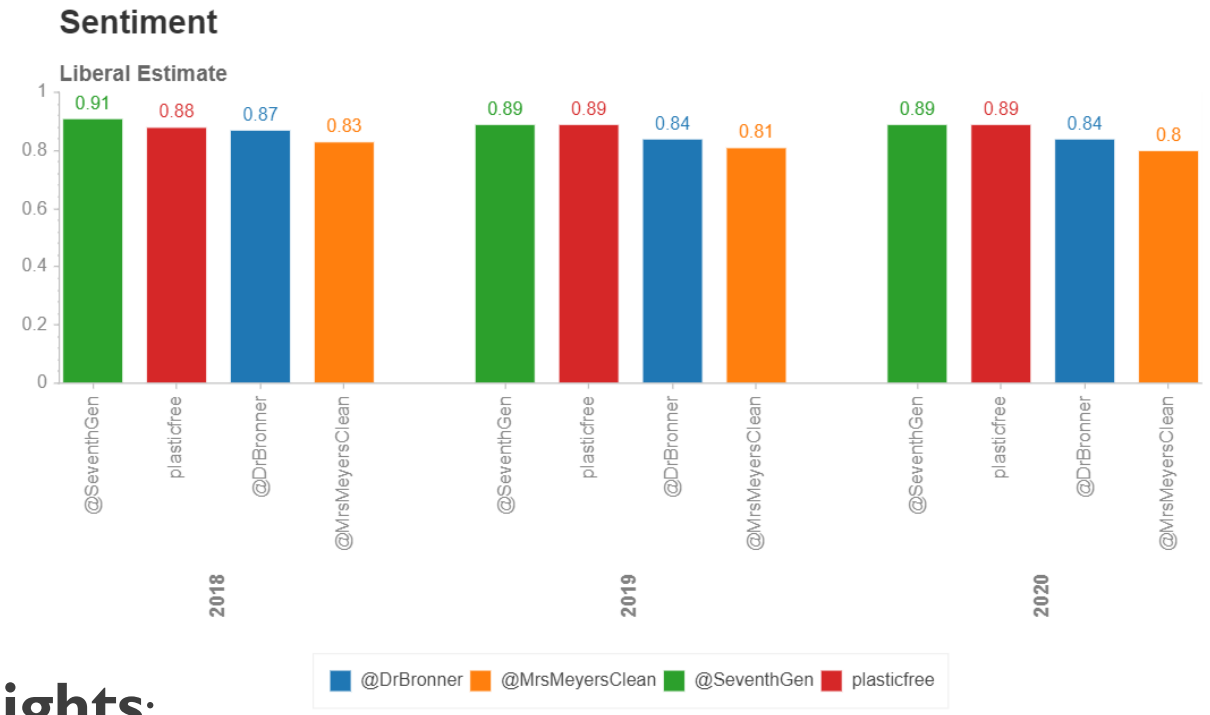
- Noticeable seasonality:
  - 6AM-12PM Ascent
  - 12AM-5AM Descent

Business Advice:
Engage your future consumers when they are active 7AM-7PM



PERCENTAGE OF MENTIONS THAT ARE POSITIVE

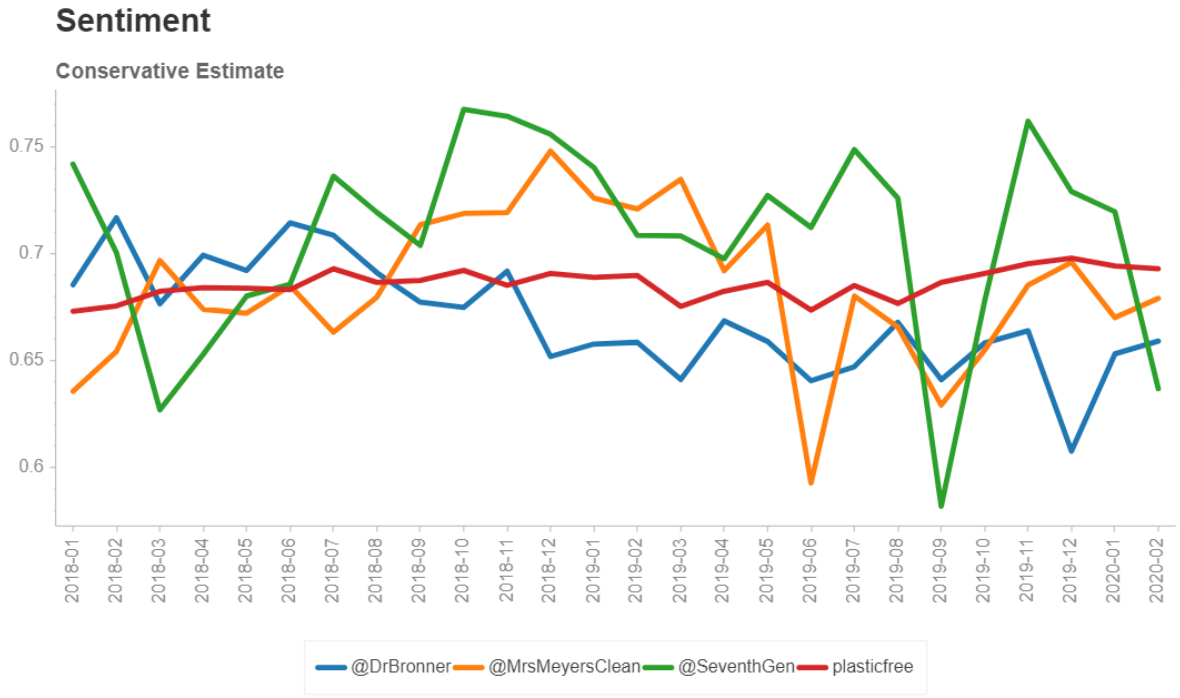


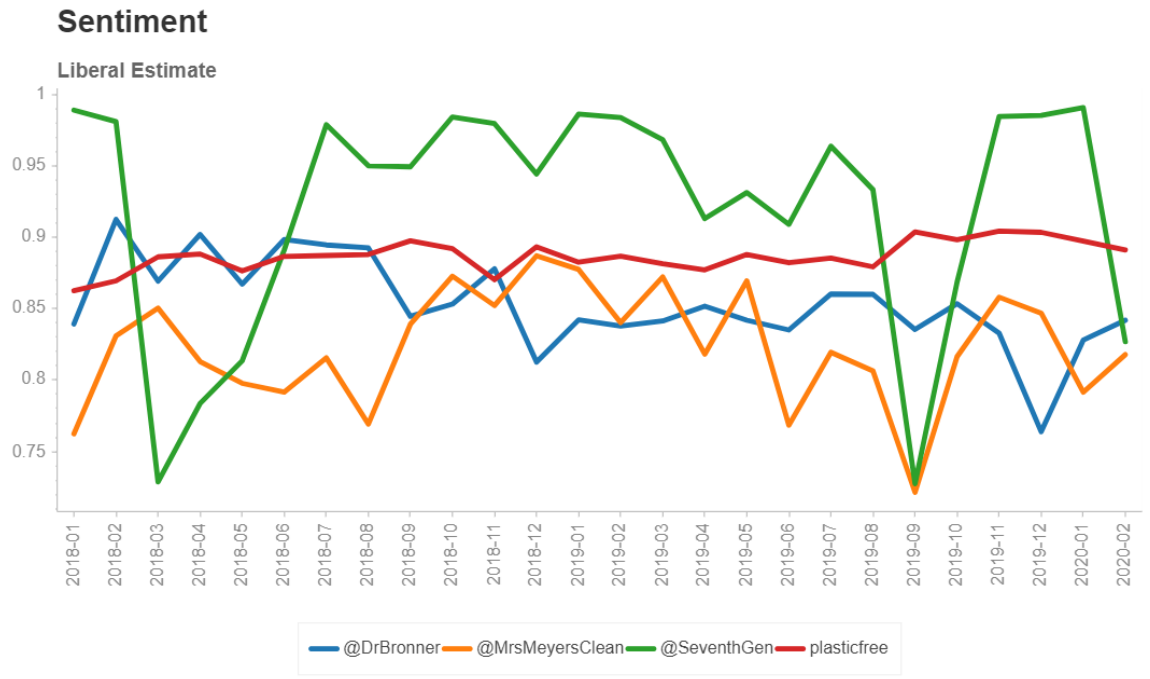


Insights:

- @SeventhGen and plasticfree are generally leading in positive sentiment across both confidence intervals
  - All brands are decreasing their positive sentiment levels over time
  - plasticfree appears to be slightly increasing its positive sentiment

PERCENTAGE OF MENTIONS THAT ARE POSITIVE





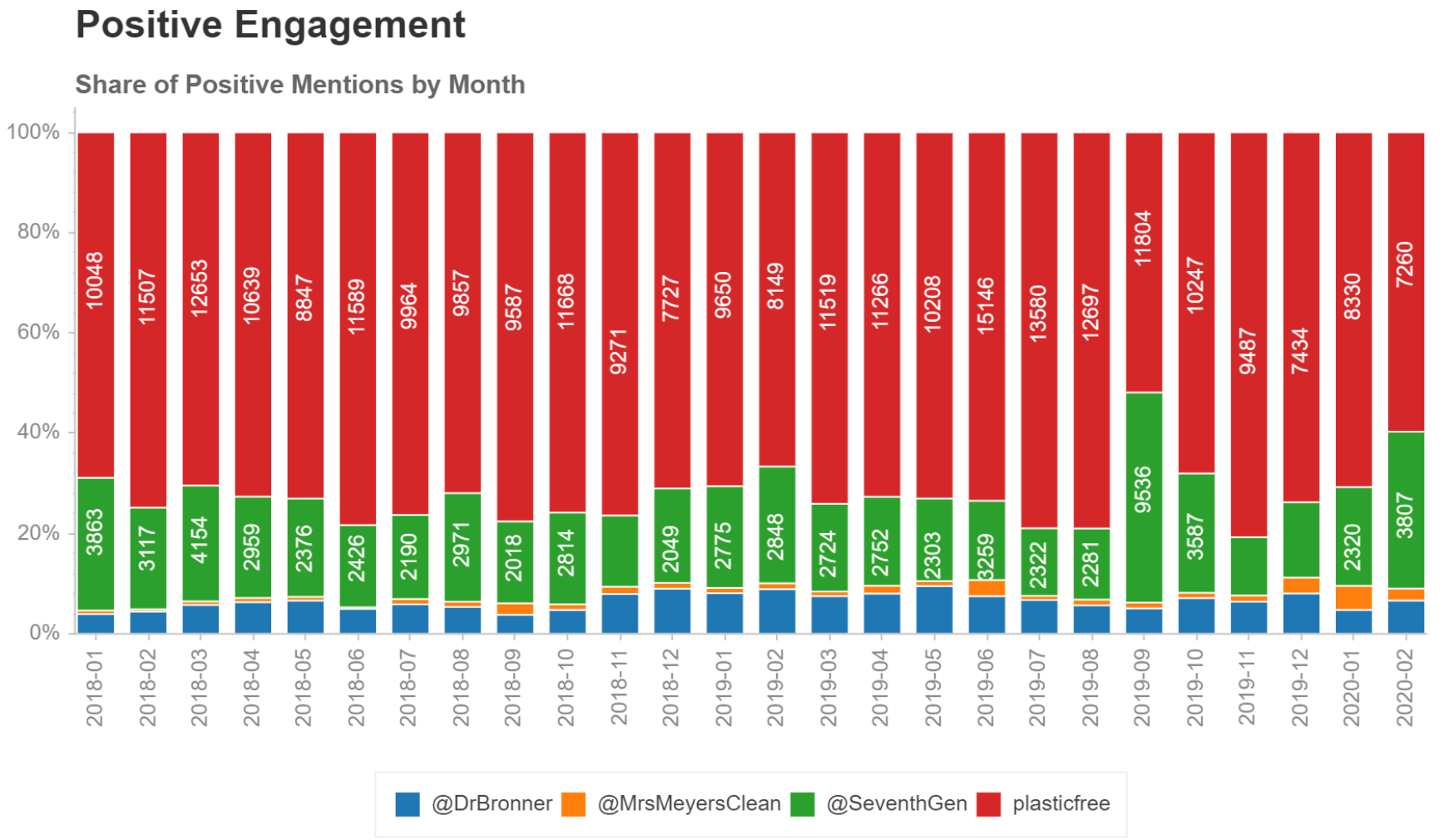
Insights:

- @SeventhGen has the highest volatility in sentiment
- All three brands sentiment dropped in September 2019, coincides with the increased engagement from #ClimateStrike
  - I noticed an uptick in trolling efforts during that time, which would partially contribute to the lowered sentiment

SHARE OF POSITIVE ENGAGEMENT

Insights

- #plasticfree leads positive engagement by both share and count



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SUMMARY AND NEXT STEPS

Hypothesis:

There is high positive consumer sentiment towards using household goods that reduce waste and promote environmental sustainability

Findings:

1. There is consistent high positive sentiment shared across examined brands
2. There is evidence validating consumer interest in environmental sustainability
3. @SeventhGen is the consistent leader in sentiment of the three brands on Twitter (Emulate their engagement style)
4. The Multinomial Naïve Bayes NLP* Classification model performed best on the Sensitivity score

Recommendations without additional analysis:

1. Align business philosophy, model, branding, and actions consistent with these companies (sustainability)
2. Seek out large scale events and influencers to promote brand and launch
3. Engage consumers while they are active: 7AM to 7PM