Aspect Based Sentiment Analysis for Fashion Products

Springboard Data Science Career Track

Context

Fashion industry is characterized by rapidly changing trends and consumer preferences.

Problem

Develop a novel aspect based sentiment analysis (ABSA) pipeline for extracting aspects from fashion product reviews and predicting the sentiment toward each aspect.

Constraint

- No annotated data for supervised learning
- Neural network model requires GPU for training, but there are runtime and RAM constraints on Google Colab

ABSA Pipeline

Natural Language Processing	Aspect Extraction	Sentiment Prediction
Preprocess and tokenize textual data, extract nouns and adjectives for aspect extraction through POS tagging	Provide a list of six aspects for fashion products: *color, design, material, price, quality, sizing*. Use the unsupervised approach to extract aspects from the nouns and adjectives.	Train a classification model on the preprocessed textual data to predict the sentiment of each aspect for fashion product reviews.

The Dataset

- Product reviews from Amazon Fashion.
- Time period: 2002 - 2018
- Number of records: 883,636
- Number of fields: 12

	overall	verified	reviewTime	reviewerID	asin	reviewerName	reviewText	summary	unixReviewTime	vote	style	image
0	5	True	10 20, 2014	A1D4G1SNUZWQOT	7106116521	Tracy	Exactly what I needed.	perfect replacements!!	1413763200	NaN	NaN	NaN
1	2	True	09 28, 2014	A3DDWDH9PX2YX2	7106116521	Sonja Lau	I agree with the other review, the opening is ...	I agree with the other review, the opening is ...	1411862400	3.0	NaN	NaN
2	4	False	08 25, 2014	A2MWC41EW7XL15	7106116521	Kathleen	Love these... I am going to order another pack...	My New 'Friends' !!	1408924800	NaN	NaN	NaN
3	2	True	08 24, 2014	A2UH2QQ275NV45	7106116521	Jodi Stoner	too tiny an opening	Two Stars	1408838400	NaN	NaN	NaN
4	3	False	07 27, 2014	A89F3LQADZBS5	7106116521	Alexander D.	Okay	Three Stars	1406419200	NaN	NaN	NaN

Source: Amazon Review Data (2018)

Data Wrangling

Remove duplicates and missing values

Natural language processing:
- Remove urls
- Remove html tags
- Remove extra white spaces
- Remove accented characters
- Expand contractions
- Convert all characters to lowercase
- Remove special characters
- Lemmatize tokens
- Extract nouns and adjectives

Keep stop words, punctuations and numbers

Original Review

"*Love it but it tore up shortly after I got it. I ordered two and they both tore at the part that connects to the metal. Great seller though. Very prompt.*"
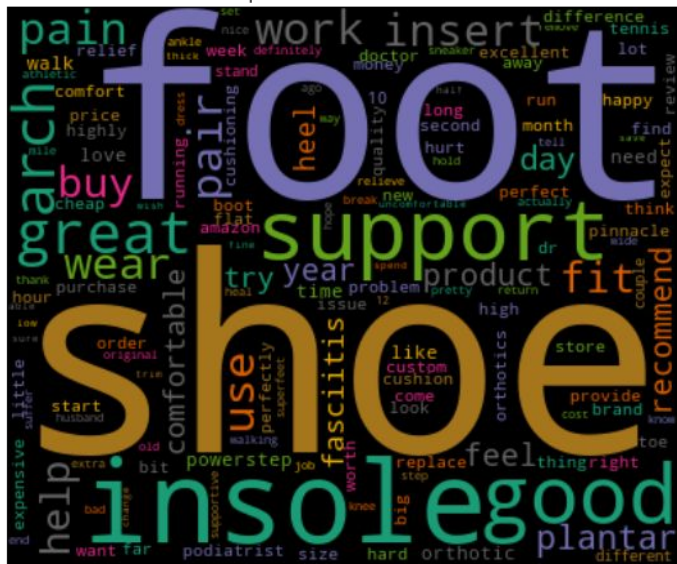
Processed Review

love, it, but, it, tear, up, shortly, after, i, get, it, ., i, order, two, and, they, both, tear, at, the, part, that, connect, to, the, metal, ., great, seller, though, ., very, prompt, .

Nouns & Adjectives

part, metal, great, seller, prompt
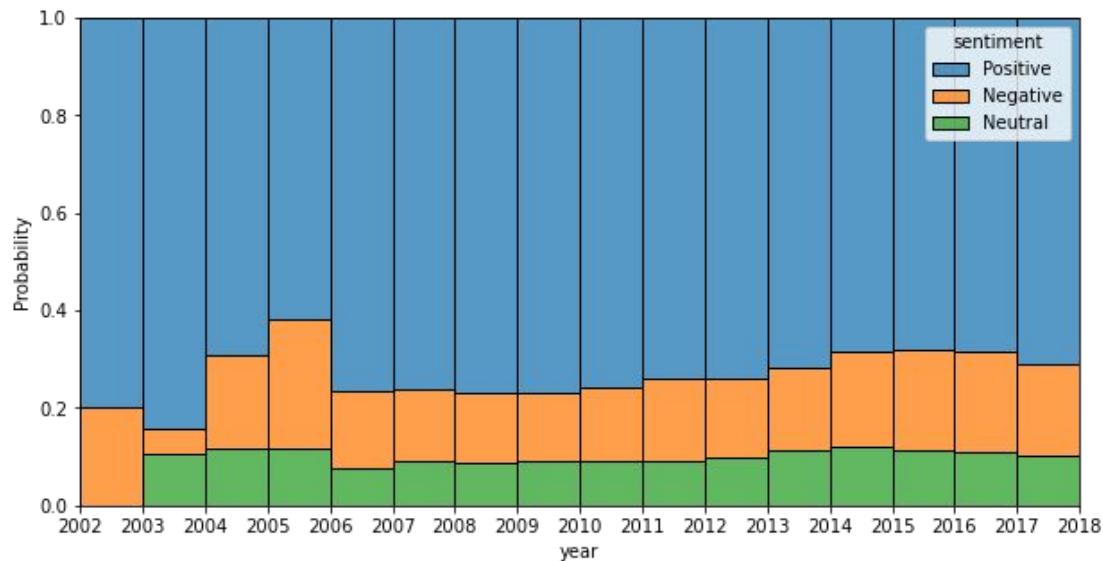
Exploratory Data Analysis

Word clouds for products with the longest reviews

Exploratory Data Analysis
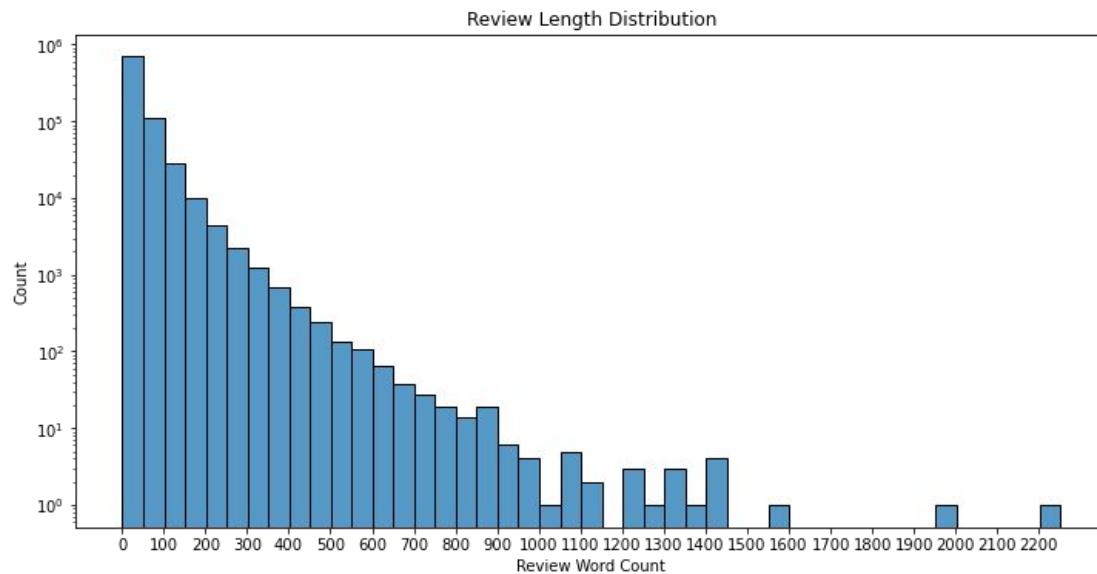
Histogram for word counts of the processed reviews

Exploratory Data Analysis

Bar plot for review sentiment distribution from 2002 to 2018

Hypothesis Testing

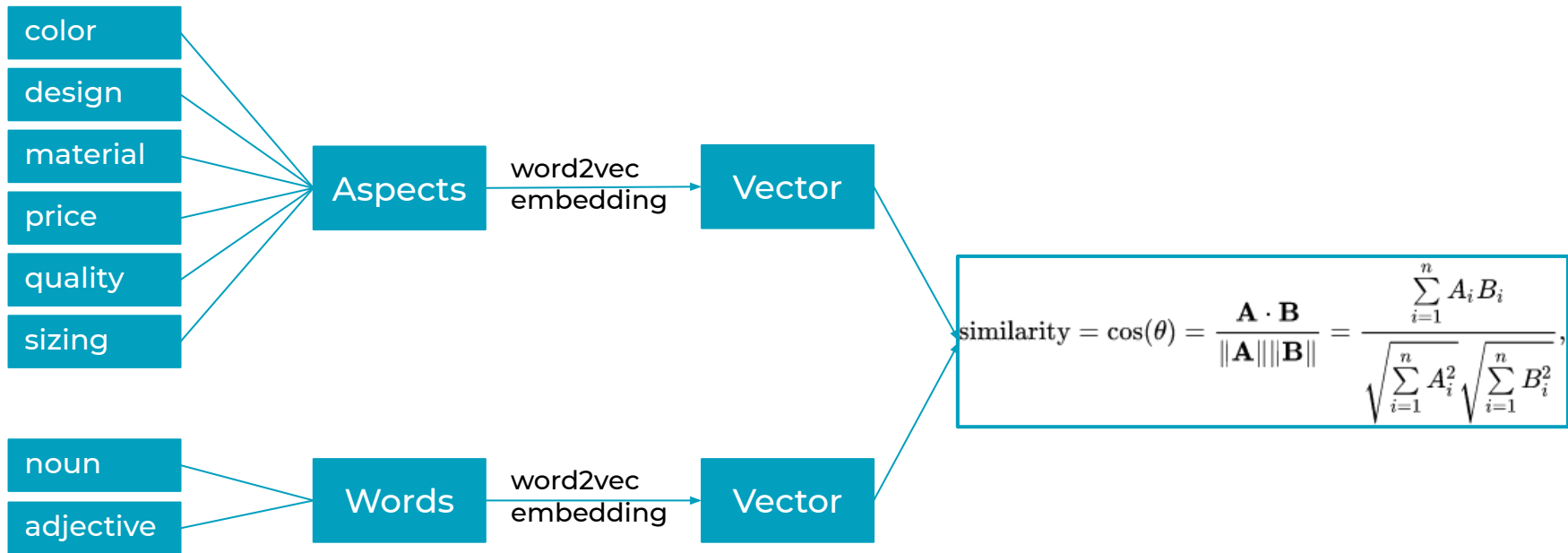H_0: The positive review % of the current year is lower than or equal to the previous year

$$p_{year} \leq p_{year-1}$$

H_1: The positive review % of the current year is higher than the previous year

$$p_{year} > p_{year-1}$$

year	review_count	positive_count	positive_pct	p_value
2002	5	4	0.800000	nan
2003	19	16	0.842000	0.411100
2004	52	36	0.692000	0.896600
2005	154	95	0.617000	0.835800
2006	326	249	0.764000	0.000400
2007	1473	1123	0.762000	0.521700
2008	1716	1319	0.769000	0.338700
2009	1956	1506	0.770000	0.463100
2010	2083	1581	0.759000	0.793400
2011	3019	2230	0.739000	0.949800
2012	7547	5578	0.739000	0.481200
2013	25118	18051	0.719000	0.999800
2014	86723	59439	0.685000	1.000000
2015	195397	132669	0.679000	0.999600
2016	306711	210145	0.685000	0.000000
2017	165984	117416	0.707000	0.000000
2018	54306	39212	0.722000	0.000000

Aspect Extraction

color

design

material

price

quality

sizing

Aspects

word2vec embedding

Vector

noun

adjective

Words

word2vec embedding

Vector

$$\text{similarity} = \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum\limits_{i=1}^{n} A_i B_i}{\sqrt{\sum\limits_{i=1}^{n} A_i^2} \sqrt{\sum\limits_{i=1}^{n} B_i^2}},$$

Sentiment Prediction

Labels:

- Positive - 4 & 5 star rating
- Neutral - 3 star rating
- Negative - 1 & 2 star rating

Features:

- BOW with unigram and bigram features
- TF-IDF with unigram and bigram features
- Word2Vec

Machine Learning Algorithms:

- Logistic Regression
- Multinomial Naive Bayes
- Random Forest

Neural Network Algorithms:

- LSTM
  - LSTM
  - Bidirectional LSTM
  - LSTM with attention layer
- Transformer (BERT model)

Model Evaluation

Model	Feature	Accuracy	F1	F1 Positive	F1 Neutral	F1 Negative	Predict Time (seconds)
Logistic Regression	BOW	0.85	0.84	0.93	0.36	0.79	
	TF-IDF	0.86	0.84	0.93	0.34	0.80	0.125
Multinomial Naive Bayes	BOW	0.84	0.83	0.92	0.31	0.78	
	TF-IDF	0.77	0.70	0.86	0.00	0.53	
Random Forest	BOW	0.82	0.78	0.90	0.11	0.74	
	TF-IDF	0.82	0.78	0.90	0.09	0.74	
LSTM	Word2Vec	0.82	0.80	0.91	0.23	0.73	
Bi-LSTM	Word2Vec	0.83	0.81	0.91	0.27	0.73	
Bi-LSTM + Attention	Word2Vec	0.83	0.81	0.91	0.30	0.74	
Transformer	Built-in	0.87	0.87	0.95	0.42	0.82	512.725

Model performance comparison table

Positive Review Example

★★★★☆ **Colors are not correctly represented in the photos**
Reviewed in the United States on September 24, 2020
Color: Matte Havana/Blue | Lens Width: 55 Millimeters | **Verified Purchase**

Just got the pair described as Matte Havana / Blue. The colors are not even close to the photos. In the photos on Amazon they look royal blue and orange. They are in fact slate blue, almost gray, on the outside of the ear pieces, and basically coffee or caramel colored on the inside. While the look is still very cool, it is not accurate on this site at all. I own another pair of these that I have enjoyed for many years, and I am going to keep these, but be aware that the colors are pretty hard to pick out on this site and they are WAY off, like, not even close.

Review: just got the pair described as matte havana / blue. the colors are not even close to the photos. in the photos on amazon they look royal blue and orange. they are in fact slate blue, almost gray, on the outside of the ear pieces, and basically coffee or caramel colored on the inside.
Aspects: color
Sentiment: Negative

Review: while the look is still very cool, it is not accurate on this site at all.
Aspects: general
Sentiment: Negative

Review: i own another pair of these that i have enjoyed for many years, and i am going to keep these, but be aware that the colors are pretty hard to pick out on this site and they are way off, like, not even close.
Aspects: color
Sentiment: Negative

Neutral Review Example

★★★☆☆ **Off center logo....**
Reviewed in the United States on June 20, 2020
Size: One Size | Color: Black/White

Kind of pissed. First one i got. Ended up being bleached from sweat which seems stupid as its an athletic hat and i only had it for two months in the winter.

Ordered another and the logo was off center.

Dont know if ill buy again if i cant even be guarenteed quality and cant speek to anyone about making sure the hats logo is centered. As it should be.

Review: kind of pissed. first one i got. ended up being bleached from sweat which seems stupid as its an athletic hat and i only had it for two months in the winter. ordered another and the logo was off center.
Aspects: general
Sentiment: Negative

Review: do not know if ill buy again if i can not even be guarenteed quality and can not speek to anyone about making sure the hats logo is centered.
Aspects: quality
Sentiment: Negative

Review: as it should be.
Aspects: general
Sentiment: Positive

ABSA Pipline

Negative Review Example

⭐☆☆☆☆ **Bas quality. Fake Product**
Reviewed in the United States on January 13, 2021
Color: 02blue | Size: Medium | **Verified Purchase**

Garbage quality product and nothing like the picture. Fabric looks thick and nice color on the picture. The real thing is dull and very cheap fabric that it looks secondhand. False advertisement

Review: garbage quality product and nothing like the picture.
Aspects: quality
Sentiment: Negative

Review: fabric looks thick and nice color on the picture.
Aspects: material, color
Sentiment: Positive

Review: the real thing is dull and very cheap fabric that it looks secondhand.
Aspects: price, material
Sentiment: Negative

Review: false advertisement
Aspects: general
Sentiment: Negative

Future Improvements

- Extract quantities, measurements and their units from numbers in the preprocessing step, and utilize them to improve aspect extraction and sentiment prediction results.
- Train a model on annotated data for better aspect extraction.
- Include emoticons as features for the sentiment prediction.
- Tune hyperparameters for the transformer model.
- Train the LSTM model on the entire Amazon Fashion review dataset.

Thank You