

Using Sentiment Scores For Stance Detection

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Stance Detection Task

Classification task: determine the relationship between two statements
{agree, disagree, unrelated}

Can be useful for determining the opinion of a piece of text

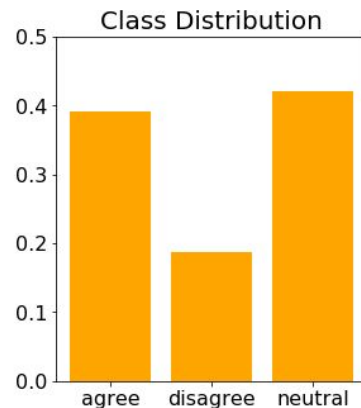
Target Statement: "Climate change/global warming is a serious concern."	
Example Sentence	Label
If carbon dioxide emissions continue to rise beyond 2020, or even remain level, the temperature goals set in Paris become almost unattainable.	neutral
The study is one more example that you can get any answer you want when the thermometer data errors are larger than the global warming signal you are looking for.	disagree
Millions more people around the world are threatened by river floods in coming decades due to climate change.	agree
45% of the general public view perceived global warming as caused by humans	neutral
Two billion people may be displaced by rising sea levels by the turn of the next century.	agree

Data set

2,050 sentences related to climate change scraped from news articles
(data set from paper: Luo, Y., Card, D., & Jurafsky, D. 2020)

Left-leaning outlets		Right-leaning outlets	
NYT	6K	Breitbart	2.7K
Moth. Jones	3.2K	Fox	2.6K
WaPo	2K	Forbes	2K
CS Monitor	1.9K	Wash. Times	1.4K
The Nation	1.4K	Daily Caller	1.2K
Vox	1.4K	Newsmax	1.2K
Dem. Now	1K	Wash. Exam.	1K
<i>Total</i>	20K	<i>Total</i>	36K

Luo et al., 2020



Class Imbalance

Luo et al. 2020 used BERT-base to achieve
0.75 accuracy, 0.73 macro-F1

Engineering Sentiment Scores

Hypothesis: Authors who are more opinionated on climate change also write with stronger sentiment.

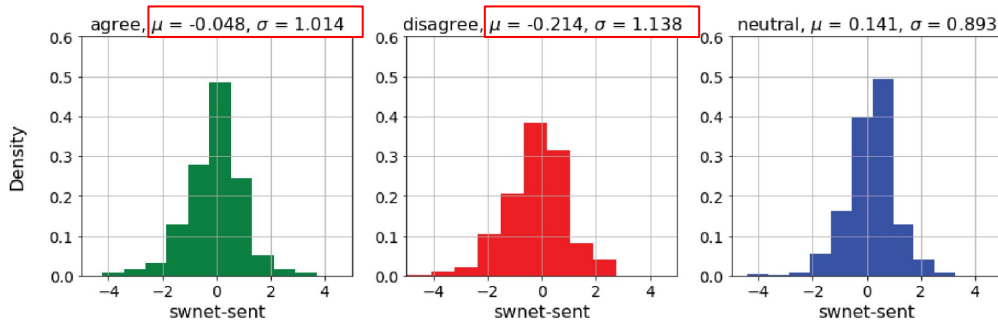
Tried 2 methods:

1. SentiWordNet
(sentiment lexicon)
2. distilBERT

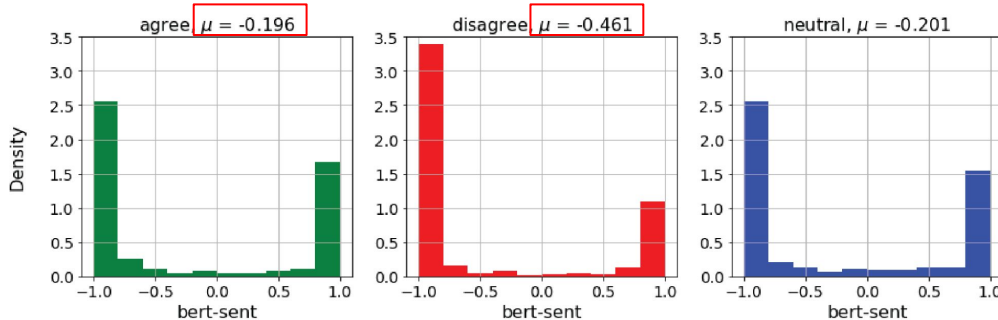
For both methods:
sentiment for *disagree*
lower than for *agree*

(for swnet-sent: t-test, $p = 0.011$
for bert-sent: Wilcoxon, $p < 1e-9$)

SentiWordNet-based sentiment scores (swnet-sent)



BERT-based sentiment scores (bert-sent)

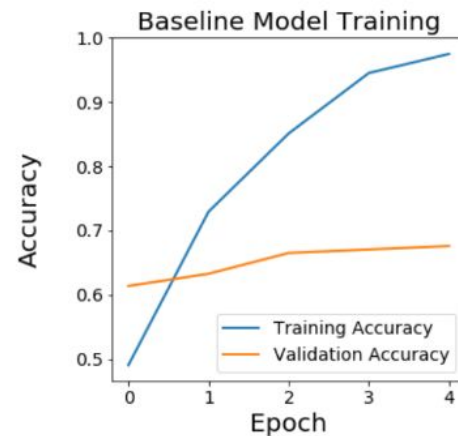


Model Performance

Trained 5 variants of a BERT-base-uncased model (1,850 examples with 5-fold CV)

Table 2: Summary of model performance: (mean \pm std) across 5-fold cross-validation for each model

Model	Validation Accuracy	Validation Macro-F1
Majority Class	0.43	0.17
BERT (baseline)	0.67 ± 0.02	0.64 ± 0.03
BERT With Only "numTokens"	0.64 ± 0.03	0.65 ± 0.03
BERT With Only swnet-sent	0.66 ± 0.02	0.65 ± 0.03
BERT With Only bert-sent	0.69 ± 0.02	0.66 ± 0.03
BERT With 3 Engineered Features	0.67 ± 0.03	0.65 ± 0.04

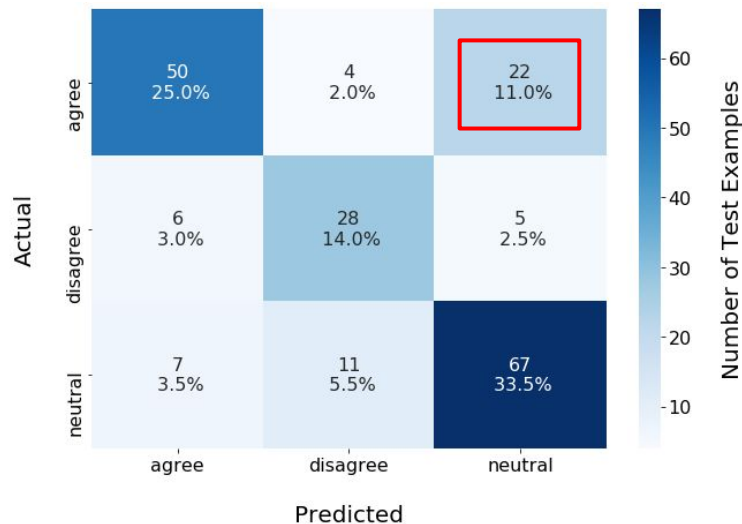


The model with only bert-based sentiment scores performed best by a small margin (qualitatively, all models performed within the same range)

Overfitting was a major issue

Error Analysis

Most common misclassification: actual *agree* predict *neutral*



Example misclassifications:

1. 'The globally averaged **sea surface temperature** for 2013 is among the 10 warmest on record.'
2. 'By the year 2100, **floods** like the ones caused by Sandy could become **1-in-20-year events**.'
3. 'A **domino effect** will kick in if global temperatures rise.'
4. '**Coal** would have to be phased out even before the **Paris Agreement** to combat climate change.'
5. 'We can expect the **Arctic** to be **ice-free** in summer within 20 years.'

Model doesn't seem to effectively learn abstract relationships that require previous knowledge.

Conclusions

- Null result: sentiment scores did not reliably improve performance of BERT
- Overfitting was a major problem
- Architecture engineering may be more useful than feature engineering
 - Concatenating scalar values onto BERT embeddings may make the information too sparse for the model to effectively use

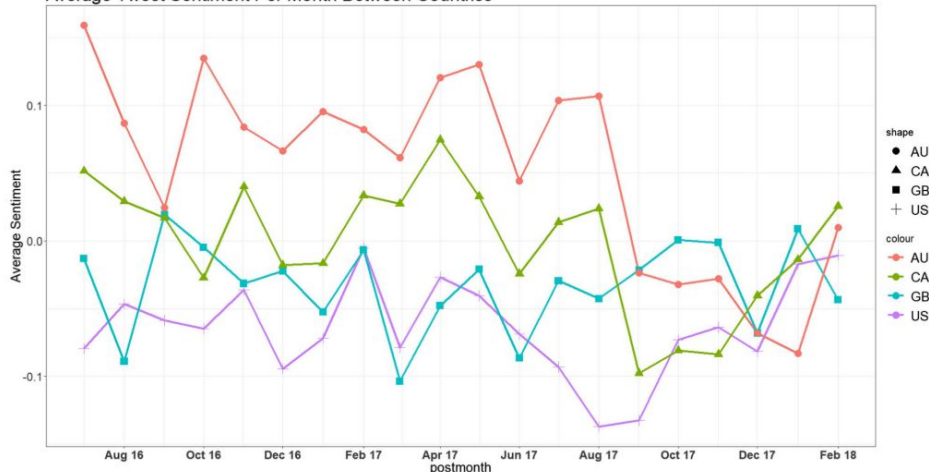
Stance Detection and Sentiment Analysis

Stance does not always align with sentiment

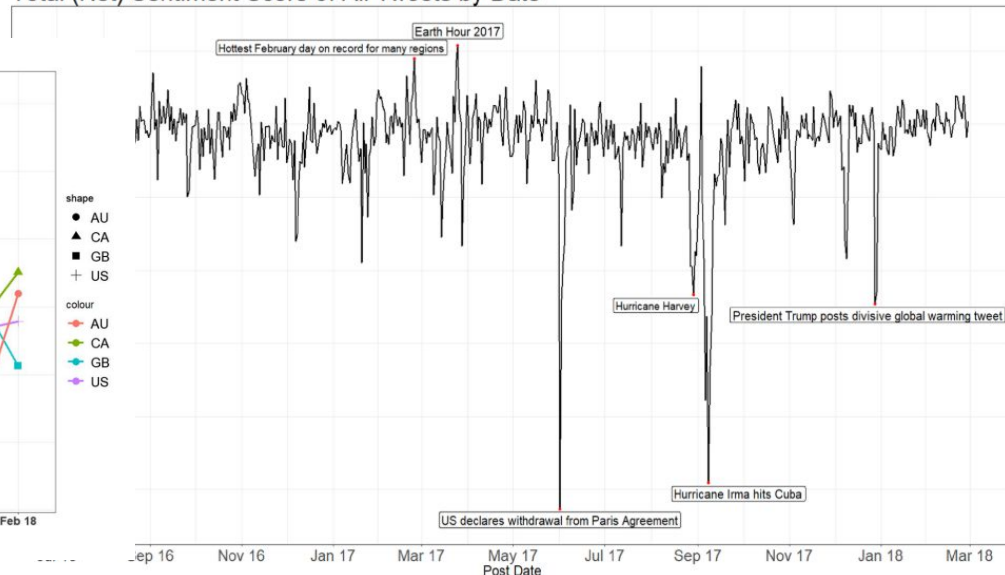
Example: “Extreme storms will be much more frequent as a result of global warming”
strongly **negative sentiment**; **agrees** with “climate change is a serious concern”

Dahal et al., 2019

Average Tweet Sentiment Per Month Between Countries



Total (Net) Sentiment Score of All Tweets by Date



Stance detection can complement sentiment analysis for tracking opinions

Thank You

Extra Slides

Engineering Sentiment Scores: bert-sent

Using distilBERT sentiment-analysis probabilities:

Example sentence (neutral sentiment): “Climate change models predict a 15 year period of global cooling.”

1. $P(\text{negative}) = 0.508$ $P(\text{positive}) = 0.492$
2. “Net Sentiment” = $0.508 - 0.492 = 0.016$
3. $P(\text{negative}) > P(\text{positive})$ so bert-sent = **-0.016**

Sentiment Analysis

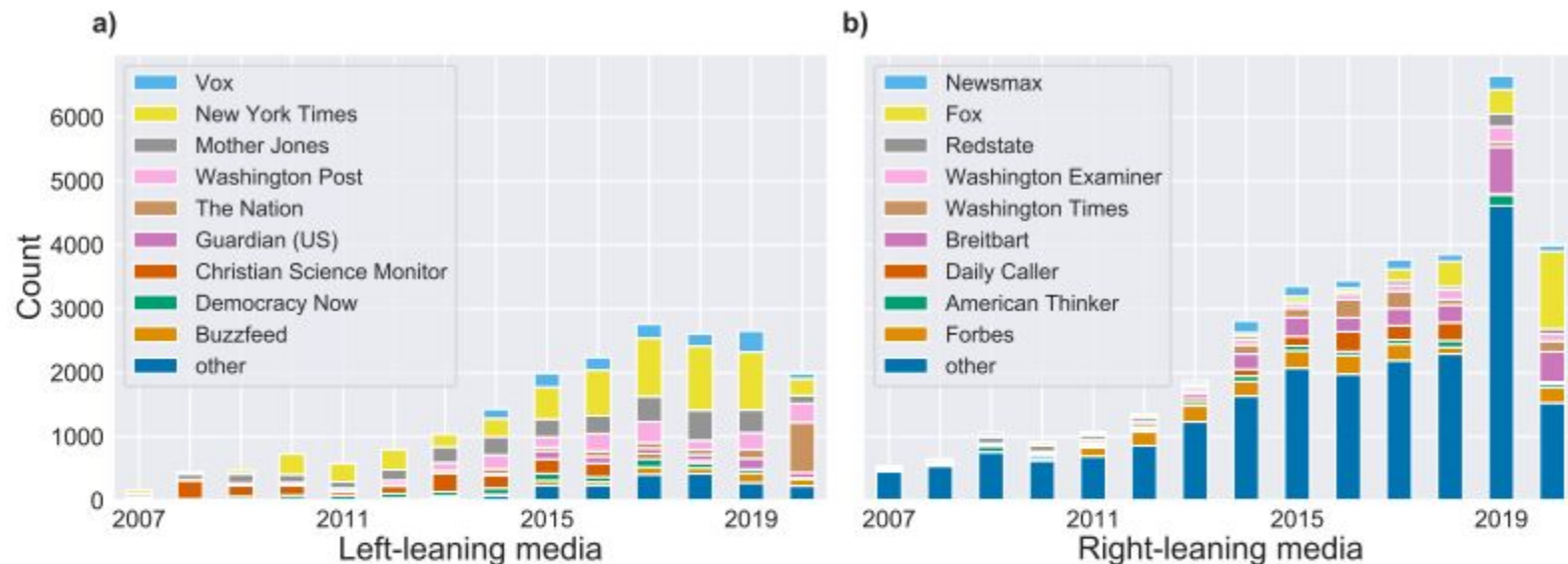
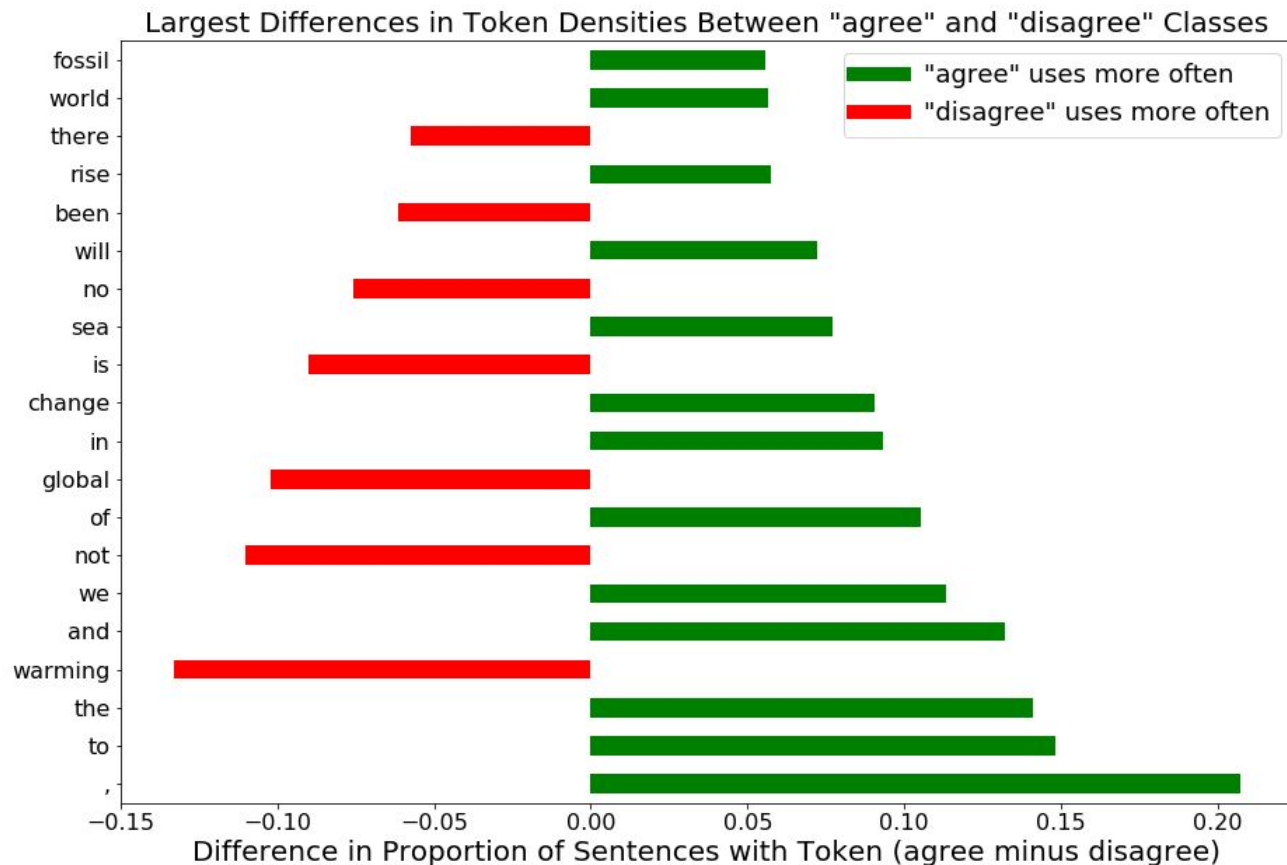


Figure 2. Number of GW articles in our dataset from 2007 to 2020 in **a)** Left-, **b)** Right-leaning media.

EDA: Tokens for agree vs. disagree classes



Stance Detection Task

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FNC-I TIMELINE FAQ FNC-I RESU



Exploring how artificial intelligence technology
leveraged to combat fake news.

EXAMPLE HEADLINE

"Robert Plant Ripped up \$800M Led Zeppelin Reunion Contract"

EXAMPLE SNIPPETS FROM BODY TEXTS AND CORRECT CLASSIFICATIONS

"... Led Zeppelin's Robert Plant turned down £500 MILLION to reform supergroup. ..."

CORRECT CLASSIFICATION: AGREE

"... No, Robert Plant did not rip up an \$800 million deal to get Led Zeppelin back together. ..."

CORRECT CLASSIFICATION: DISAGREE

"... Robert Plant reportedly tore up an \$800 million Led Zeppelin reunion deal. ..."

CORRECT CLASSIFICATION: DISCUSSES

"... Richard Branson's Virgin Galactic is set to launch SpaceShipTwo today. ..."

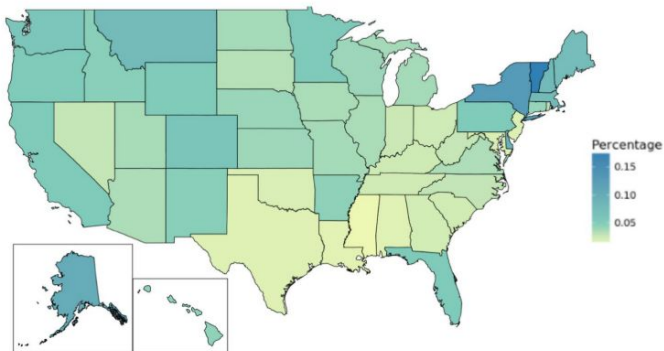
CORRECT CLASSIFICATION: UNRELATED

Conclusions

- Sentiment scores did not reliably improve performance of BERT
- Overfitting was a major problem
- Architecture engineering may be more useful than feature engineering

Stance detection can complement sentiment analysis
(for applications like automatic polling and tracking public opinion)

Percentage of Climate Change Related Tweets by State
United States, 07/16 - 02/18



Total (Net) Sentiment Score of All Tweets by Date

