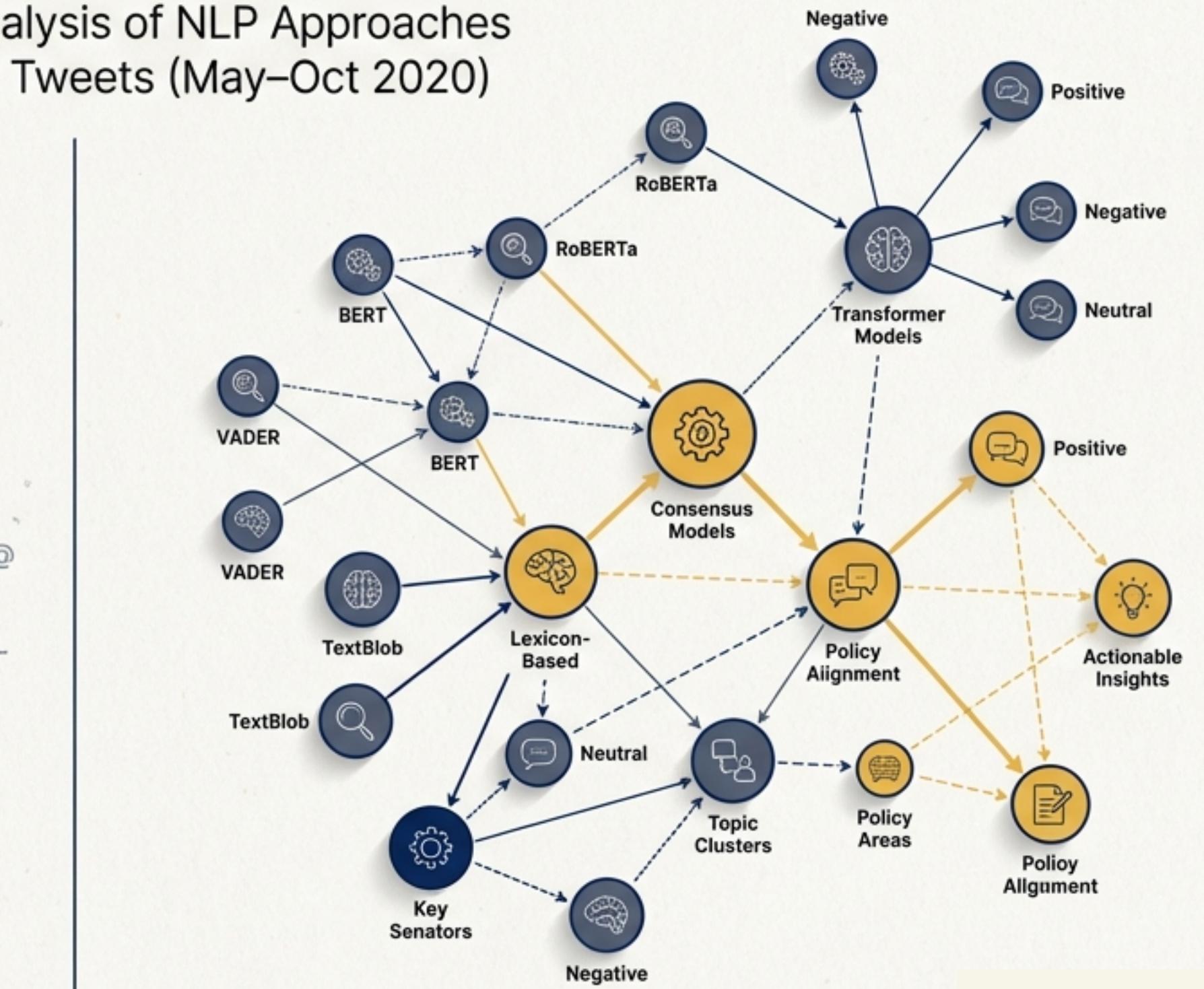
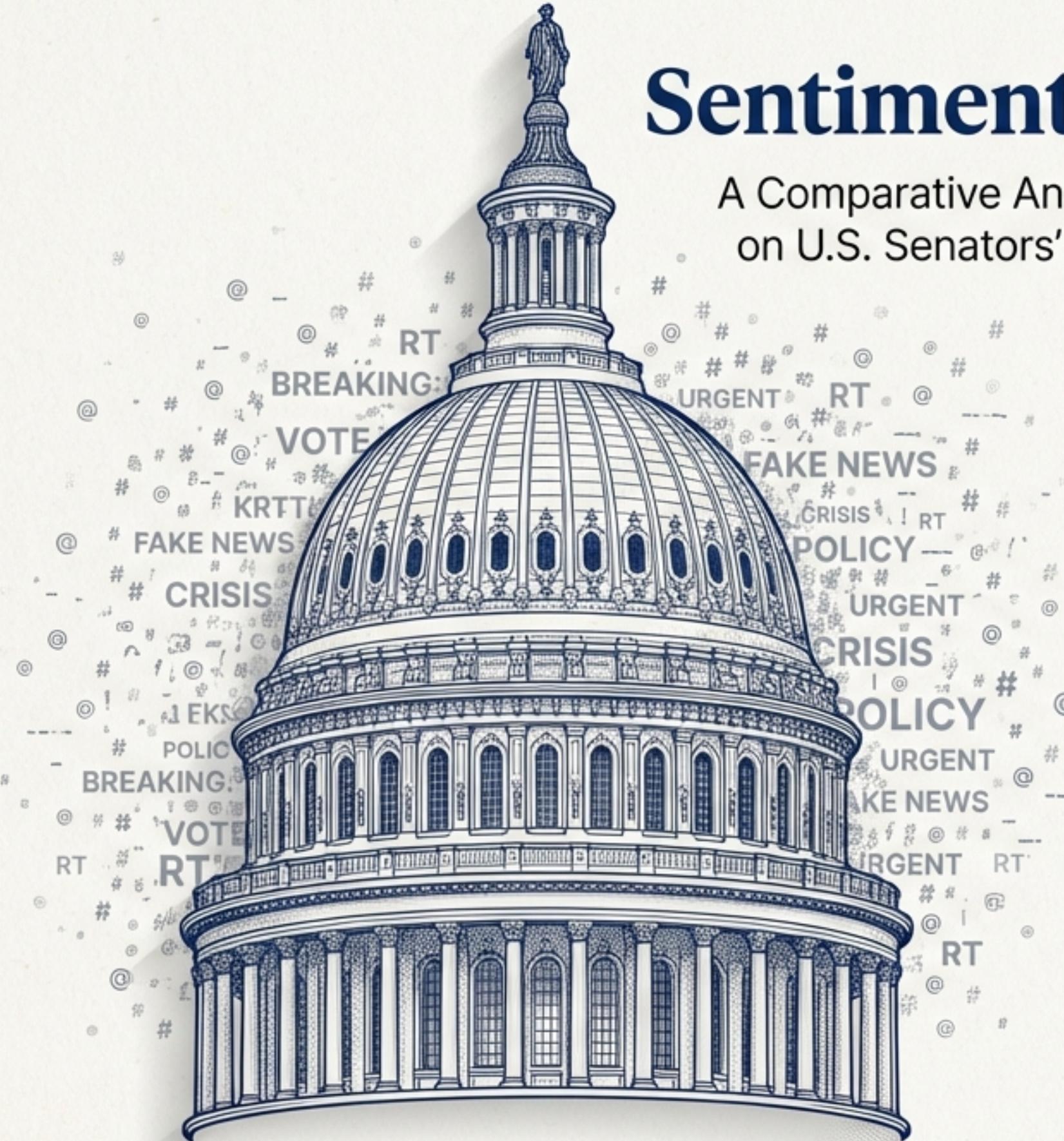


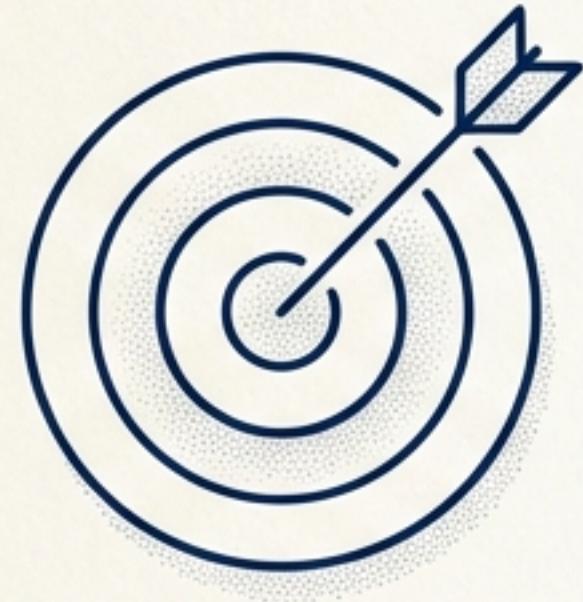
# Sentiment in the Senate

A Comparative Analysis of NLP Approaches  
on U.S. Senators' Tweets (May–Oct 2020)



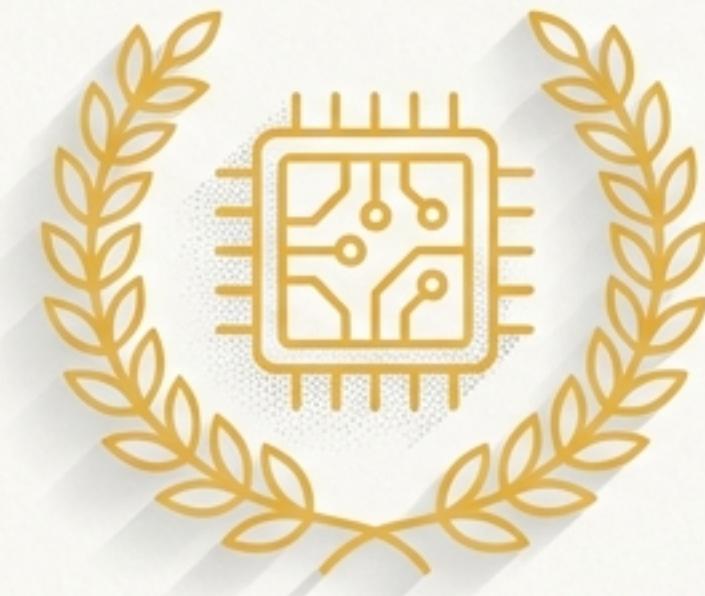
# Executive Summary

## The Objective



Classify sentiment (Positive, Neutral, Negative) in tweets from U.S. Senators during a highly volatile period (May 1 – Oct 31, 2020) to understand political communication styles.

## The Verdict



Transformer models (RoBERTa) outperformed Dictionary methods (VADER) by correctly identifying 'Neutral' policy speech. Traditional dictionary methods drastically overestimated positivity due to an inability to detect context.

## The Insight

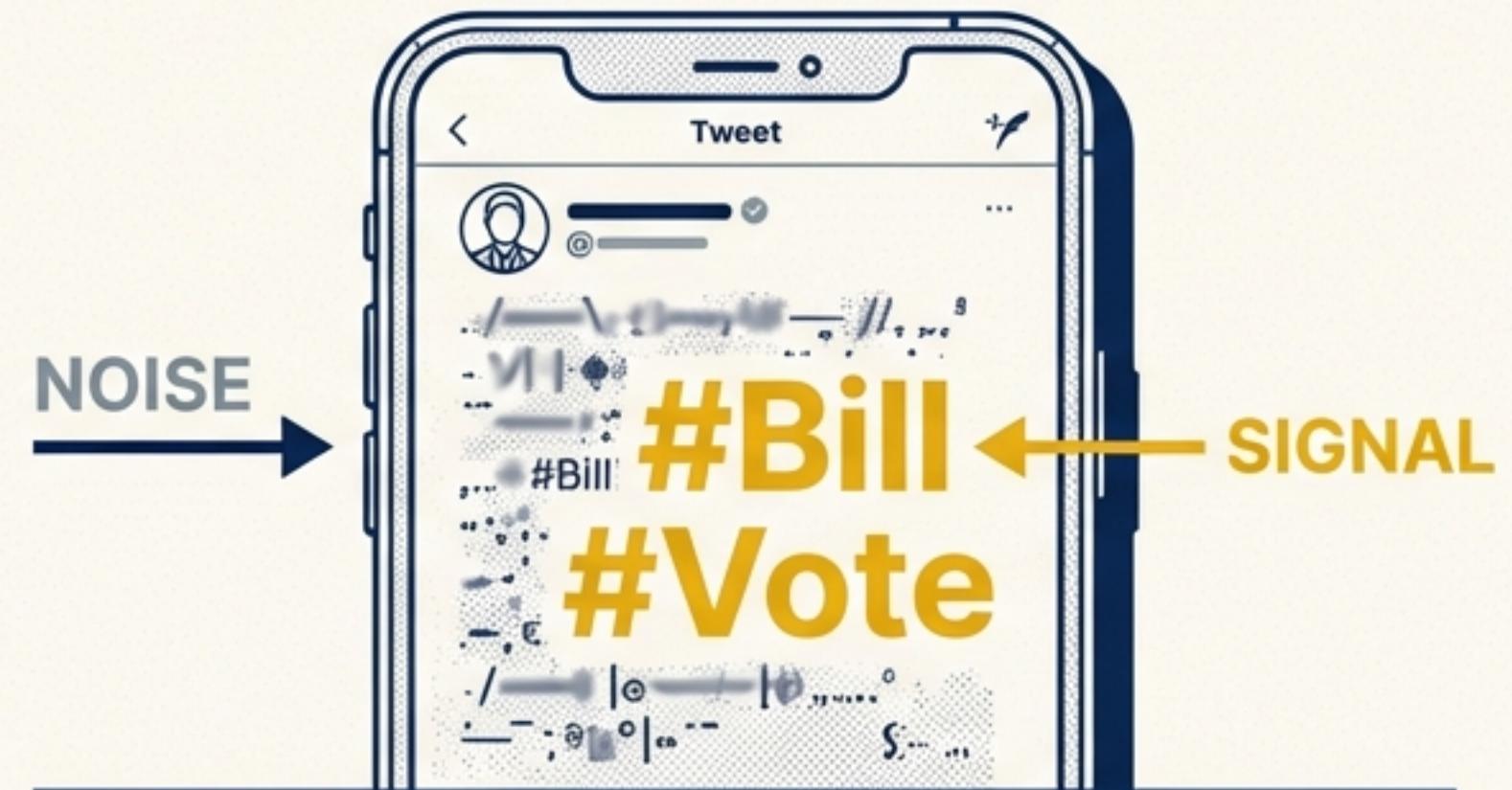


Despite the polarized climate, engagement metrics (Likes/Retweets) showed near-zero correlation with sentiment score. Additionally, Republicans consistently displayed higher positive sentiment metrics than Democrats.

# The Signal in the Noise: The Data Challenge

**The Source:** Comprehensive dataset of U.S. Senators' tweets sourced from the Harvard Dataverse.

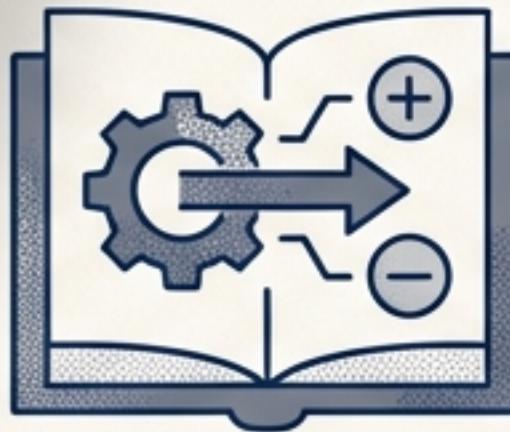
**The Problem:** Political tweets present a unique challenge for NLP. They are short, context-heavy, and filled with slang, hashtags, and mentions. Standard tools often fail to distinguish between genuine emotion and political sloganeering.



Analysis Window: May 1 – Oct 31, 2020 (Legislative & Pre-Election Activity).

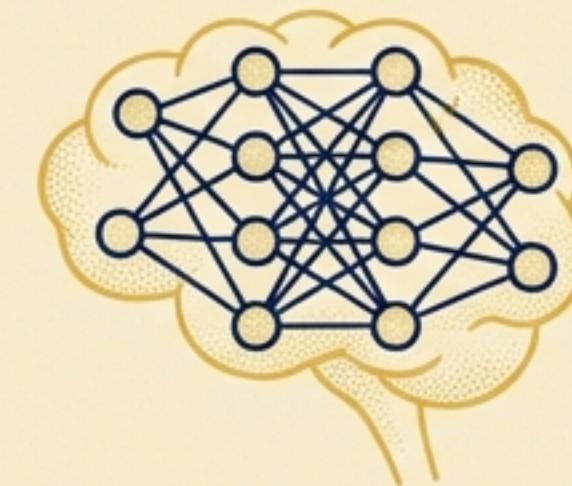
# Three Approaches to Decoding Political Speech

## The Baseline



**Model:** VADER (Valence Aware Dictionary and sEntiment Reasoner).  
**Method:** Rule-based lexicon. Counts positive/negative words and analyzes punctuation.  
**Pros/Cons:** Fast, but rigid.

## The Powerhouse



**Model:** RoBERTa (Twitter-Base).  
**Method:** Deep Learning Transformer. Pre-trained on 58M tweets. Context-aware.  
**Pros/Cons:** Detects nuance, but computationally heavy.

## The Student



**Model:** TF-IDF + Logistic Regression.  
**Method:** Supervised Classical ML. Trained to mimic the Powerhouse using "Silver Labels."  
**Pros/Cons:** Efficient, mimics complex models.

# The Optimism Bias: Why Lexicons Fail

## The VADER / Dictionary Approach

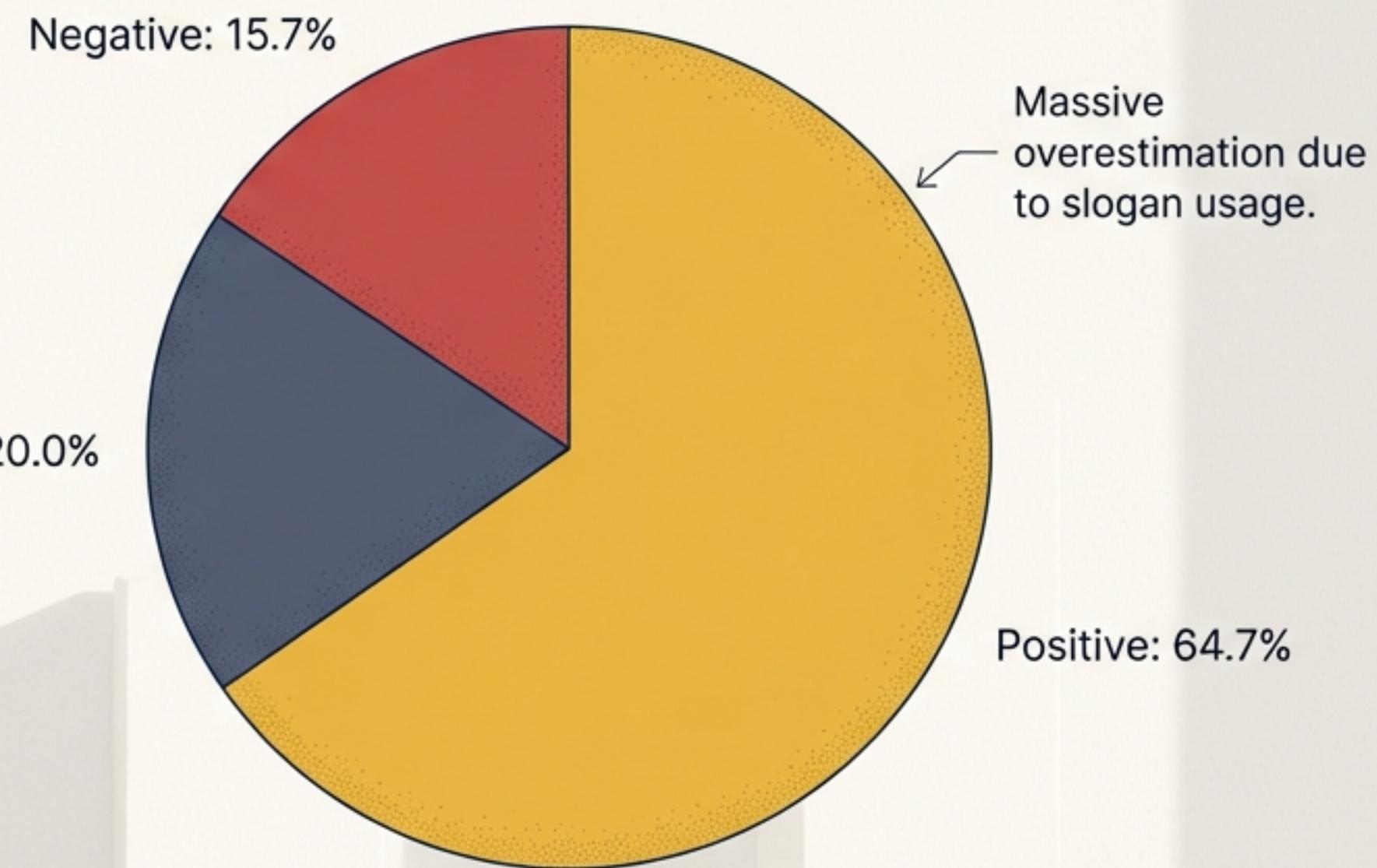
### The Mechanism:

Scores tweets by summing values of positive/negative words (e.g., 'great', 'bad').

### The Failure Mode:

In politics, words like 'Great', 'Win', or 'Proud' are often slogans, not emotions. VADER lacks context and misreads these as genuine joy.

VADER Sentiment Distribution



# The Context Expert: The Transformer Advantage

RoBERTa (Twitter-Base Model)

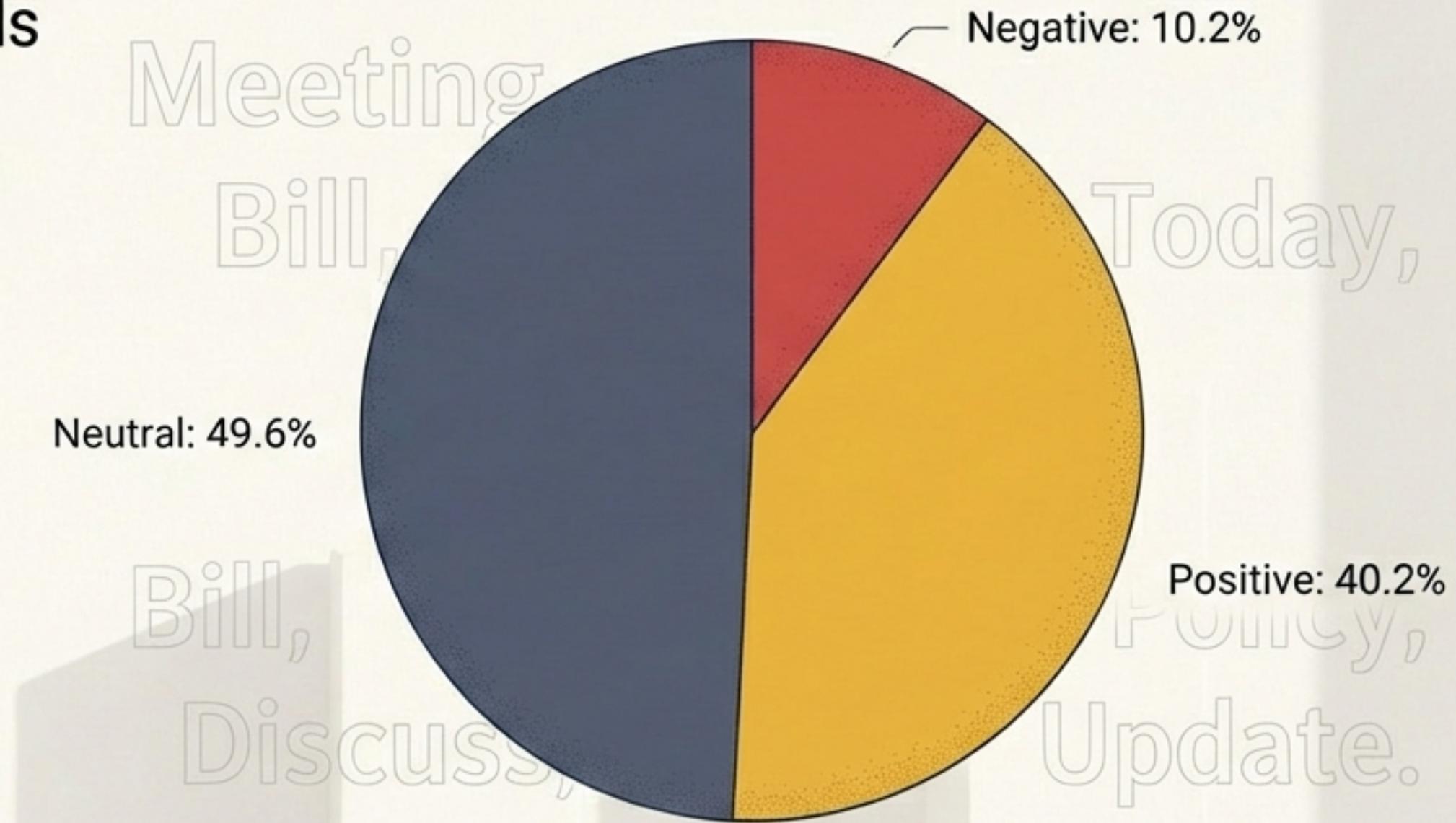
## The Mechanism:

A deep learning model that reads entire sentence structures, not just isolated words.

## The Breakthrough:

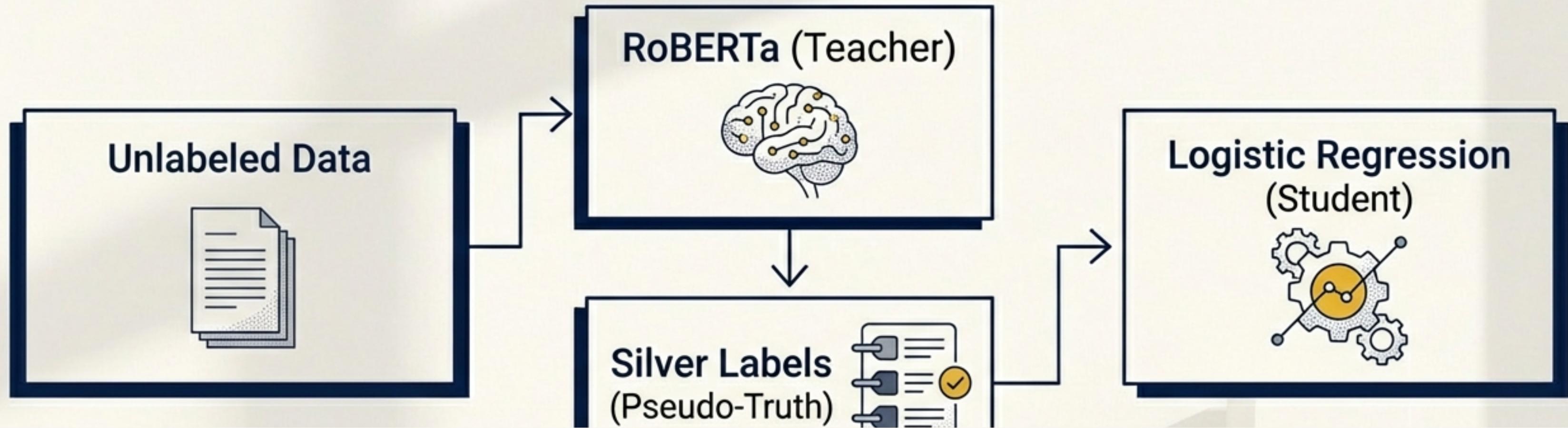
RoBERTa recognizes that most Senatorial tweets are informational—announcing bills, sharing links, or stating positions—and correctly classifies them as Neutral.

Transformer Sentiment Distribution



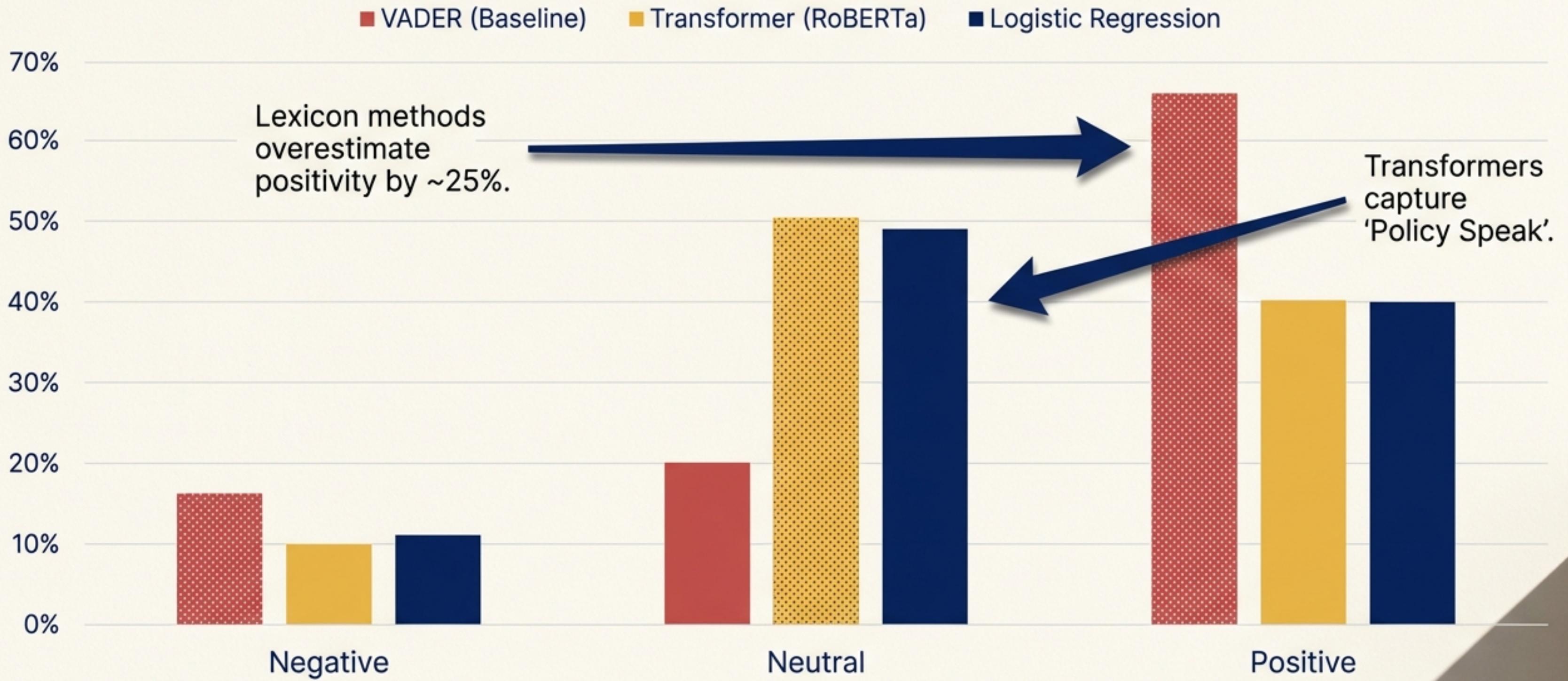
# The ‘Silver Label’ Strategy

Training Classical ML without Human Annotation



**The Result:** The Logistic Regression model achieved **81.22%** accuracy on the holdout test set.

# The Verdict: Comparing Sentiment Distributions



Conclusion: Simple dictionaries fail to detect the neutral tone of governance.

# RQ1: The Partisan Divide

Do Republicans and Democrats sound different?

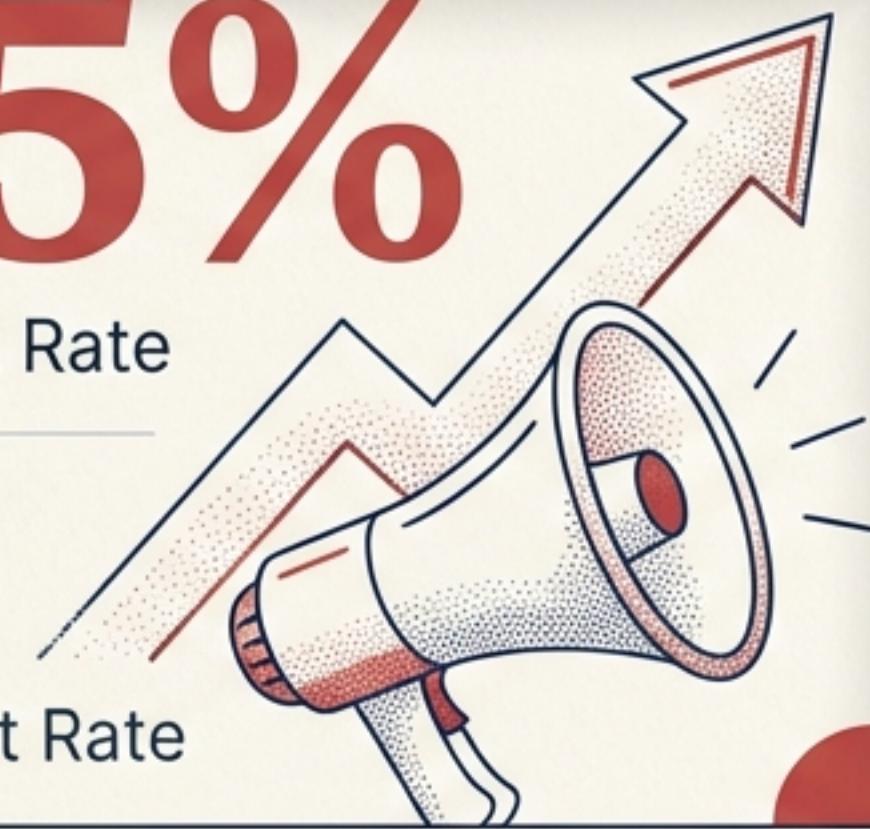
## REPUBLICANS

**46.5%**

Positive Sentiment Rate

**6.5%**

Negative Sentiment Rate



Consistently higher sentiment scores.  
Communication strategy focuses on  
rallying support.

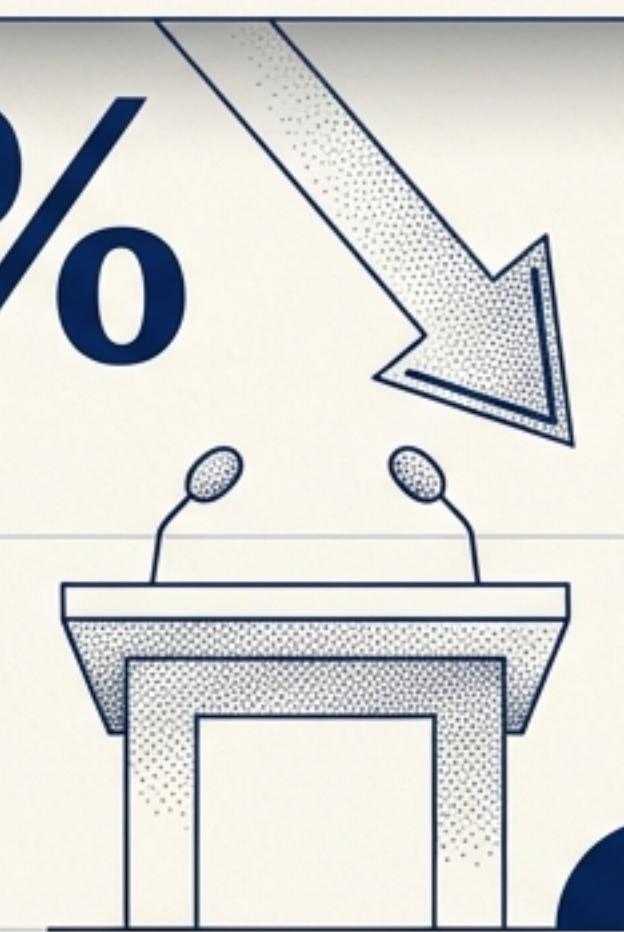
## DEMOCRATS

**35.9%**

Positive Sentiment Rate

**13.8%**

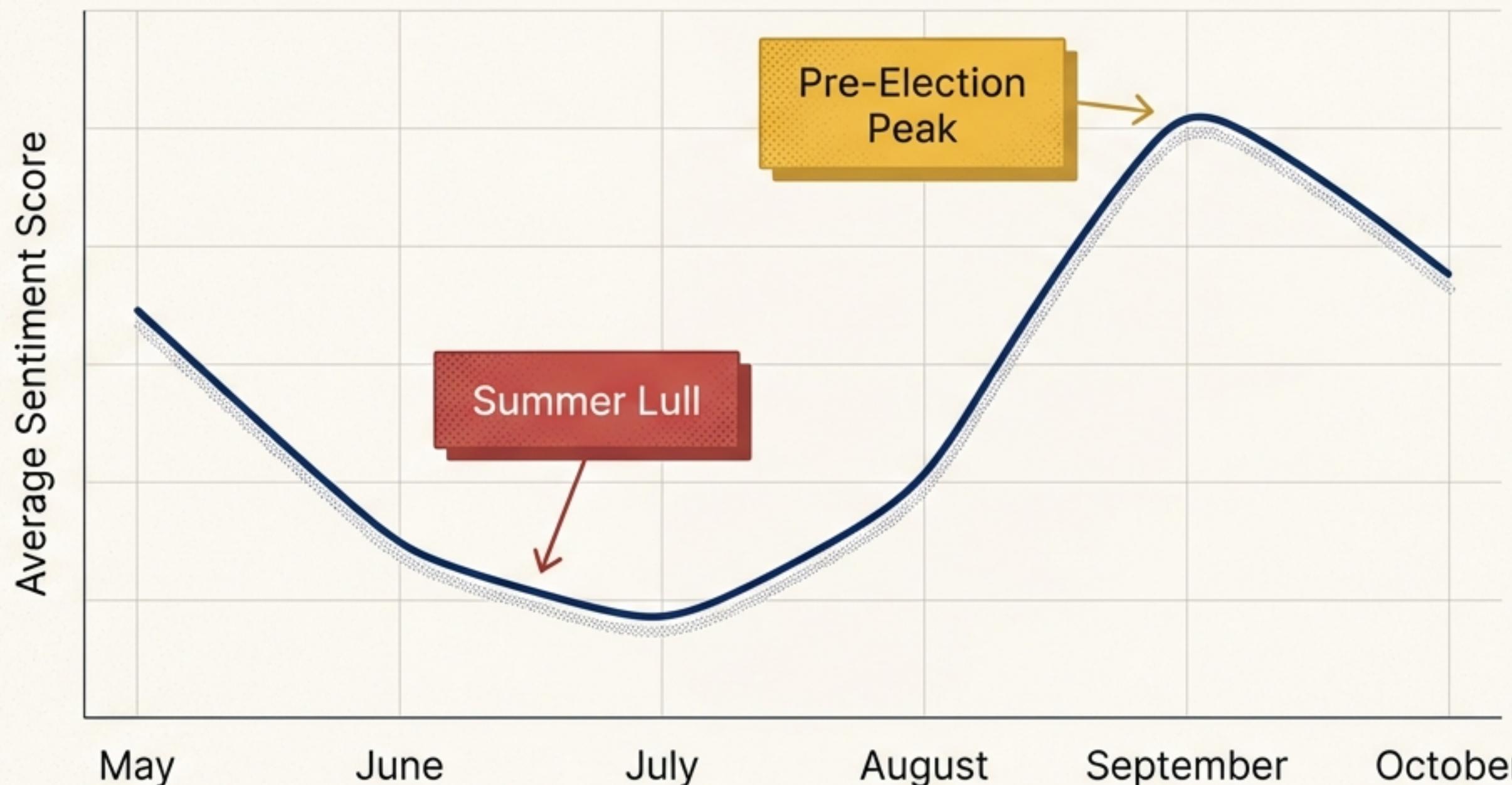
Negative Sentiment Rate



Lower average sentiment. Content often  
focuses on critique of administration or  
current events.

# RQ2: The Pulse of the Senate

Analyzing Sentiment Trends (May–Oct 2020)

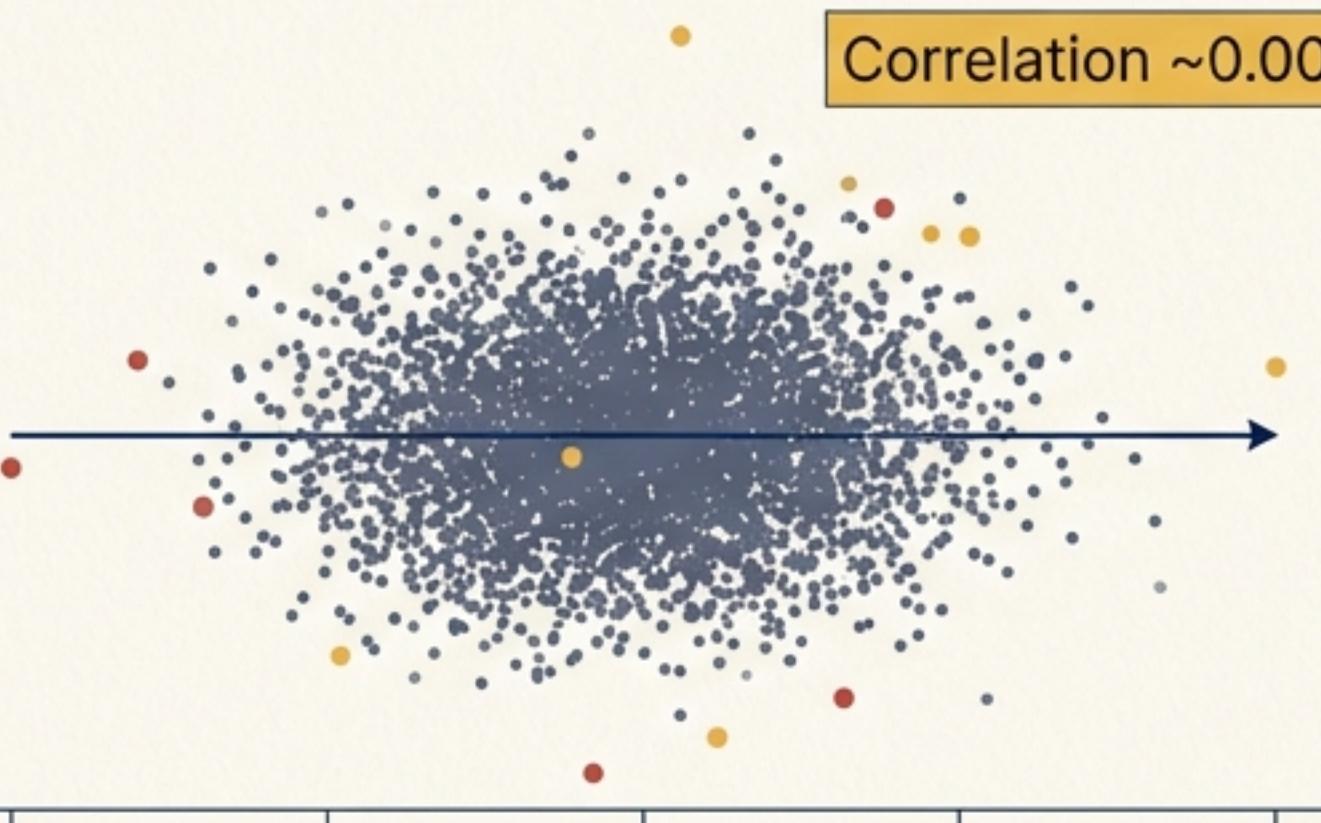


Sentiment is not static.  
It moves with the  
legislative calendar and  
campaigning intensity.

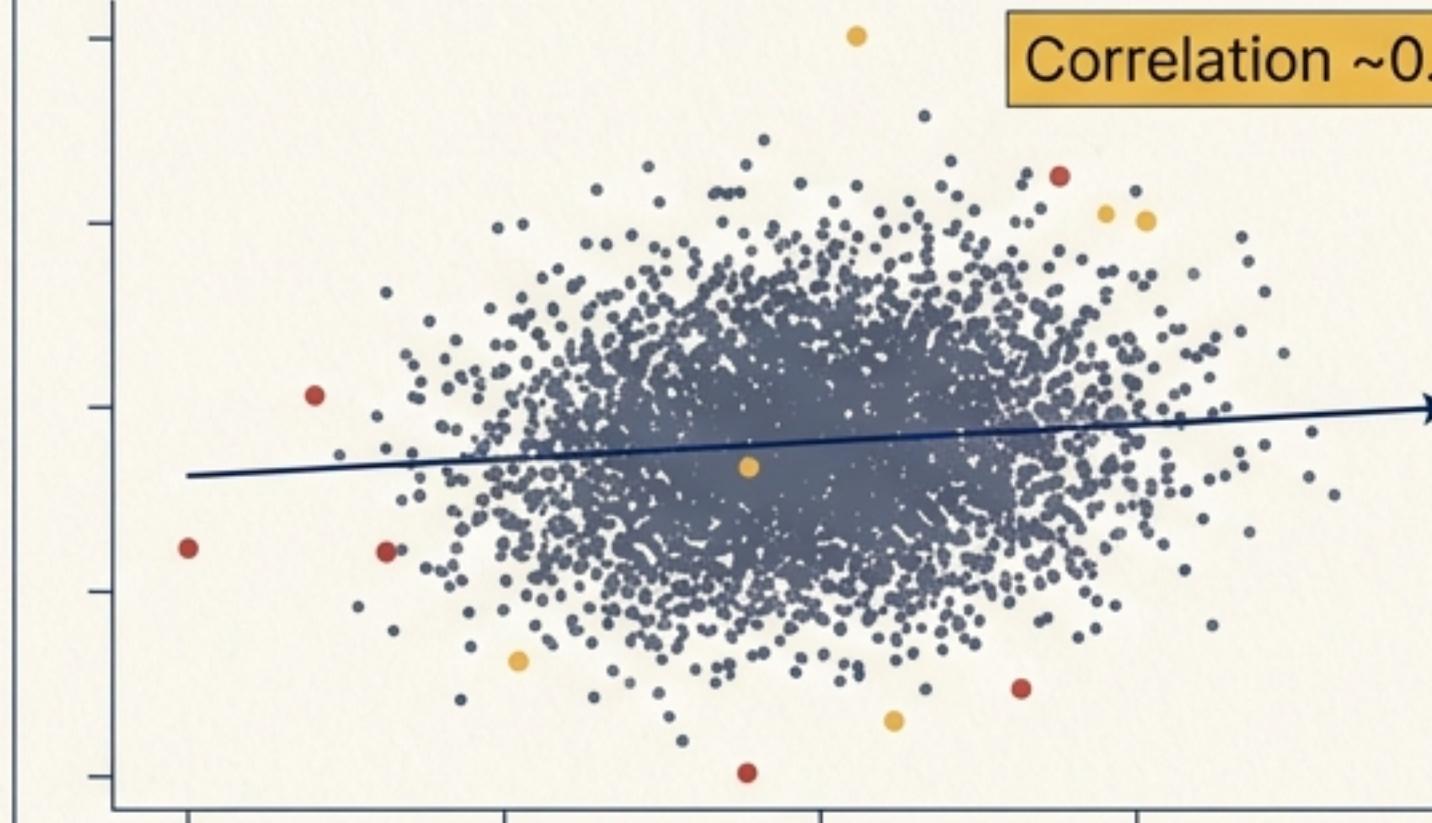
# RQ3: The Engagement Myth

Does sentiment drive Likes and Retweets?

Sentiment vs. Retweets



Sentiment vs. Likes



**Findings:** Being happier or angrier does not guarantee virality. Engagement is driven by **ACCOUNT SIZE** (Who you are) and **TOPIC RELEVANCE** (What you say), not emotional phrasin

# Critical Review & Limitations

👁️? **The 'Truth' Problem:** The study relies on Silver Labels (Transformer predictions) rather than Human Ground Truth. We measured agreement, not absolute human accuracy.

😏 ↪ **Sarcasm & Context:** Even advanced models struggle with deep sarcasm or tweets that rely entirely on linked articles for context.

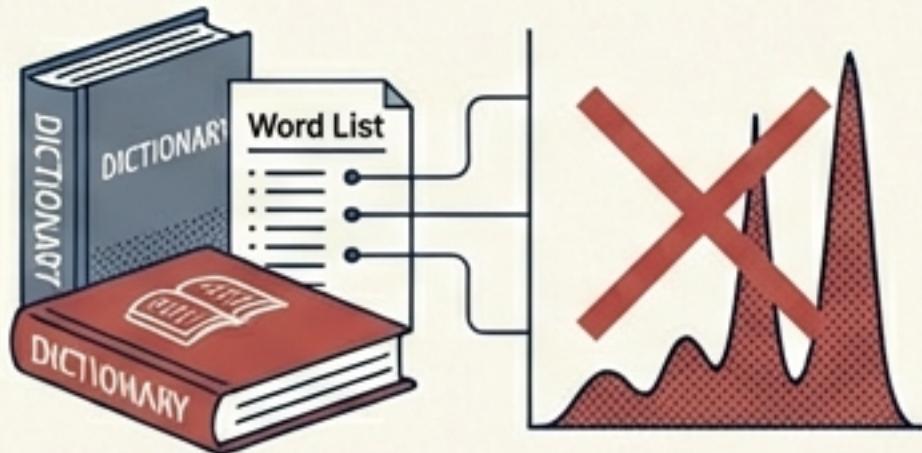
🎙 **Topic Bias:** Sentiment scores may be conflated with specific topics (e.g., a national crisis vs. a holiday greeting) rather than reflecting pure communication style.



# Technical Lessons Learned

01.

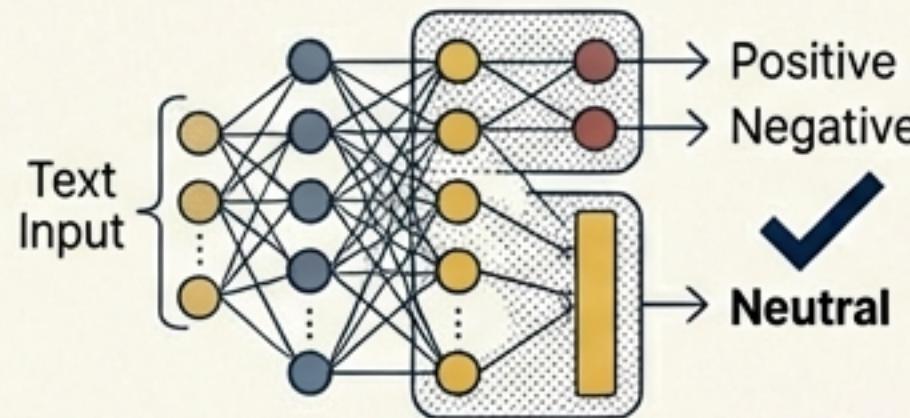
## Abandon Simple Lexicons



VADER and Dictionary methods are too risky for political text. They treat strategic slogans as genuine emotion, skewing results.

02.

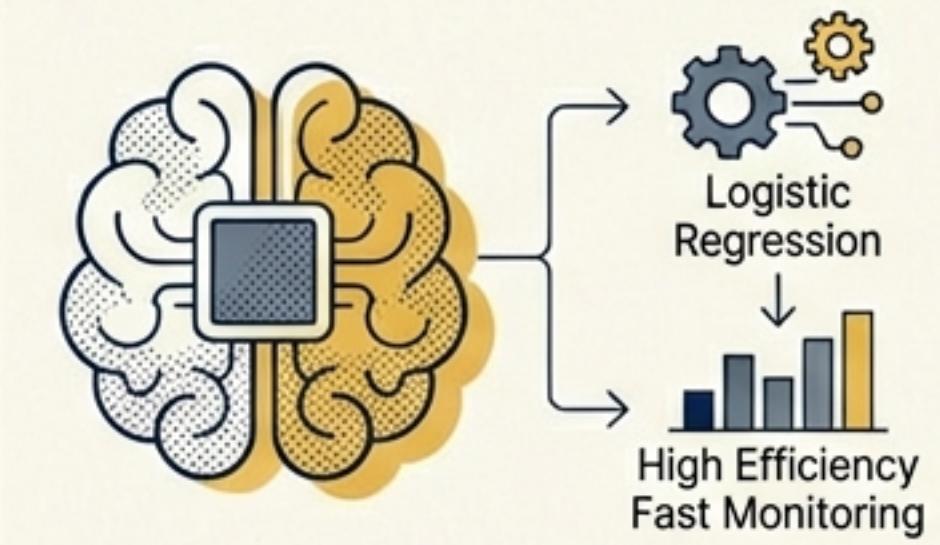
## The Necessity of Transformers



For professional or 'official' datasets, detecting Neutrality is just as important as detecting Polarity. Only Transformers handled this correctly.

03.

## Distillation Works



We proved that a complex Transformer can successfully teach a simple Logistic Regression model, offering a path to build fast, efficient tools for large-scale monitoring.

# Applications & Future Outlook

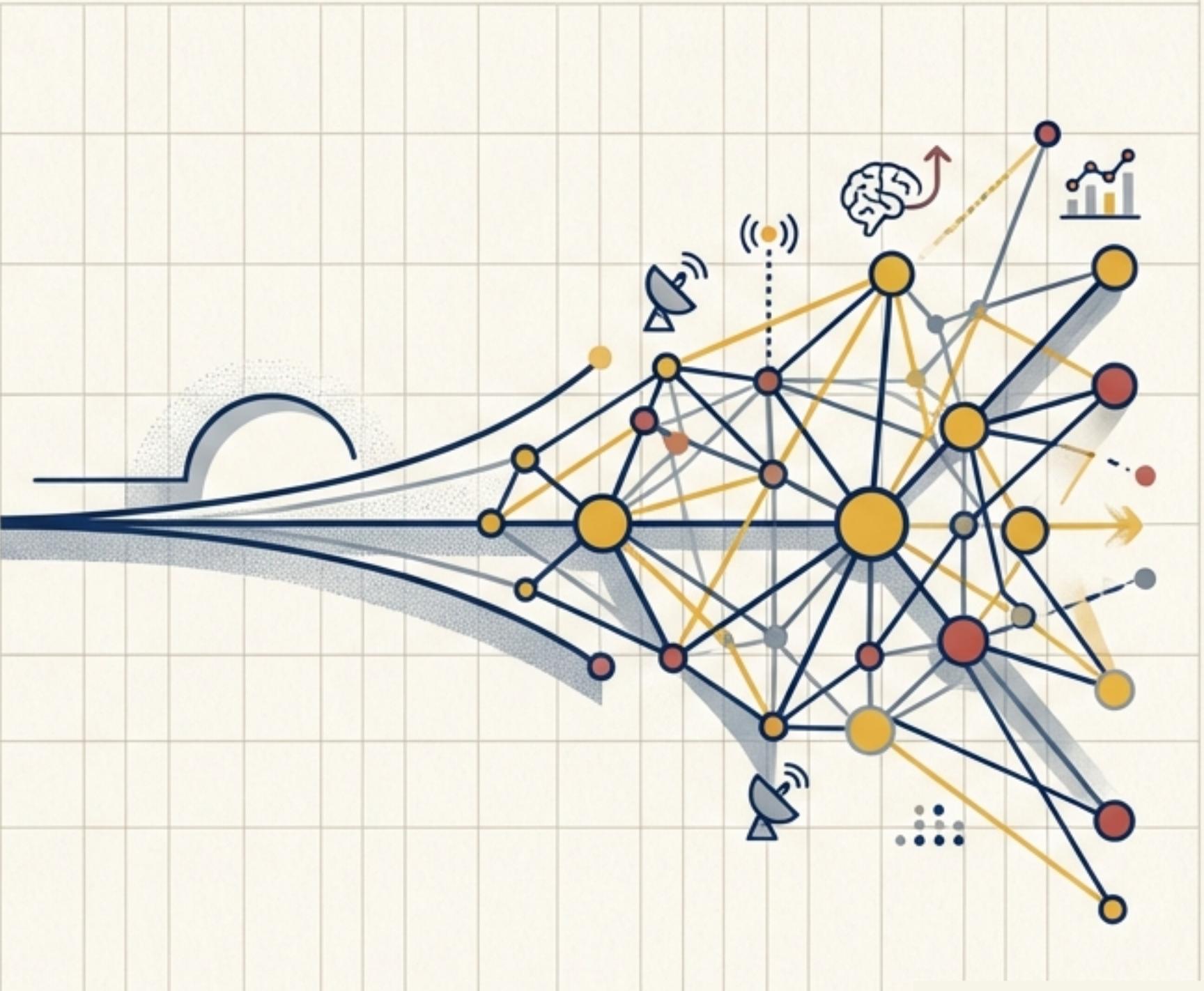
## Summary:

We successfully benchmarked NLP methods to reveal a distinct 'Republican Positivity' gap and a lack of sentiment-driven engagement.

## Applications:

- **Media Monitoring:** Tracking subtle shifts in official tones.
- **Reputation Management:** Distinguishing between "Policy Neutral" and "Negative" coverage.

**Future Work:** Human annotation to validate Silver Labels and correlating sentiment spikes with specific legislative events.



# References & Toolkit

Project Author: E-Zahra (ID: 476679)

**Data Source:** Harvard Dataverse (Senators' Tweets May–Oct 2020).

**Tech Stack:** Python, Pandas, Scikit-Learn, Hugging Face Transformers.

**Models:** cardiffnlp/twitter-roberta-base-sentiment-latest. VADER.

Repository: <https://github.com/E-Zahra/SENTIMENT-ANALYSIS-OF-U.S.-SENATORS-TWEETS>

