

Understanding COVID-19 Vaccine Campaign on Facebook using Minimal Supervision

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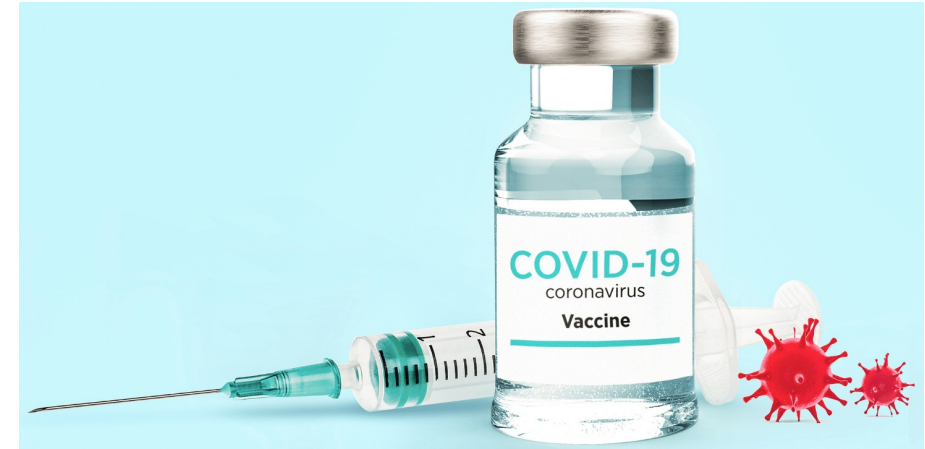
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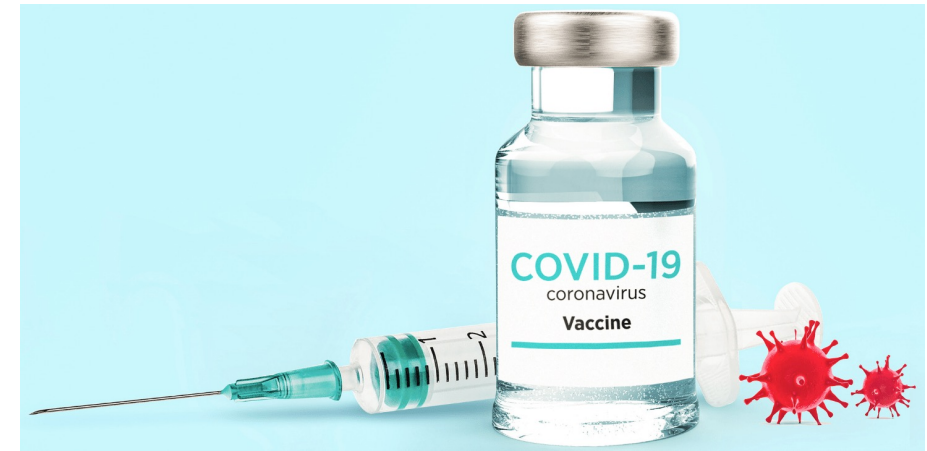
COVID-19 Global *Infodemic*

- **Polarizing** information in **Social Media**.



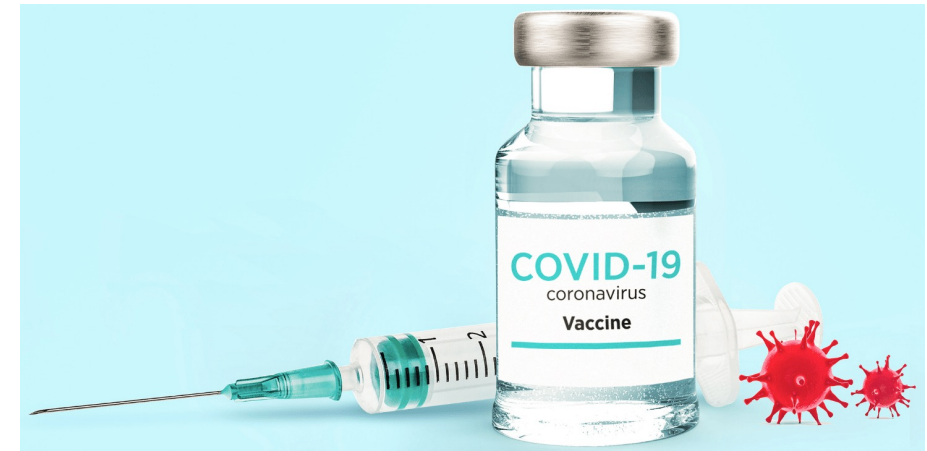
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- **Polarizing** information in **Social Media**.
- **Jeopardize** measures to **control** the pandemic.
 - creating panic, vaccine hesitancy, and fragmented social response.



COVID-19 Global *Infodemic*

- **Polarizing** information in **Social Media**.
- **Jeopardize** measures to **control** the pandemic.
 - creating panic, vaccine hesitancy, and fragmented social response.
- **Increase polarization** around topics related to **vaccine mandate, vaccine efficacy, religious sentiment, vaccine equity** etc.



Moral Foundation

- **Moral Foundation Theory (MFT)** suggests a theoretical framework for analyzing **morality** (Haidt 2004).
 - **6** moral foundations (MFs).

CARE/HARM: Saying that someone other than the speaker deserves care or gets harmed. Reflects the base of Maslow's Hierarchy of Needs [3]. Security, Shelter, Food, Water, Warmth.

FAIRNESS/CHEATING: Justice, rights, and autonomy, comparison to other groups. Equality of Opportunities. Social Intolerance to "Free-Rider".

LOYALTY/BETRAYAL: Patriotism and self-sacrifice for the group (Or failure to provide it, in the case of betrayal). It is active anytime people feel that it's "one for all, and all for one."

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SANCTITY/DEGRADATION: Not simply a religious value. Respect for the human spirit. Social aversion of personal degradation. Degradation causes disgust. Physical and spiritual contagion, including virtues of chastity, wholesomeness, and control of desires. It underlies the widespread idea that the body is a temple which can be desecrated by immoral activities and contaminants (an idea not unique to religious traditions).

LIBERTY/OPPRESSION: Feelings of people towards those who dominate them and restrict their liberty. The hatred of bullies and dominators motivates people to come together, in solidarity, to oppose or take down the oppressor.

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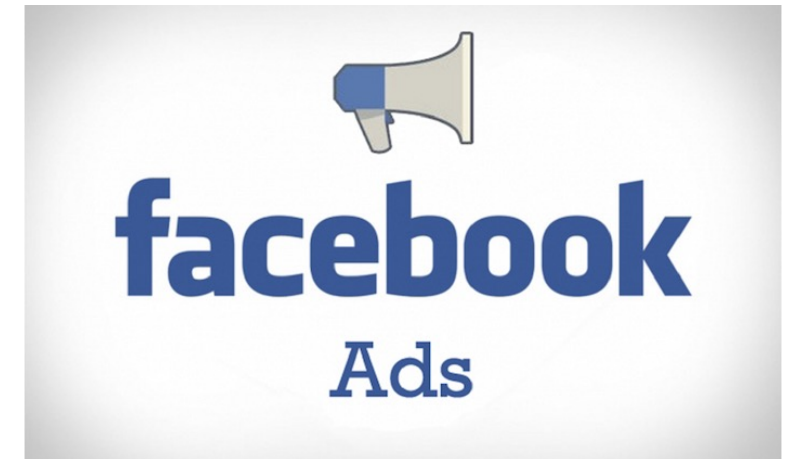
Microtargeting

- Facebook allows advertisers to **adapt** their messaging to **target** audiences.

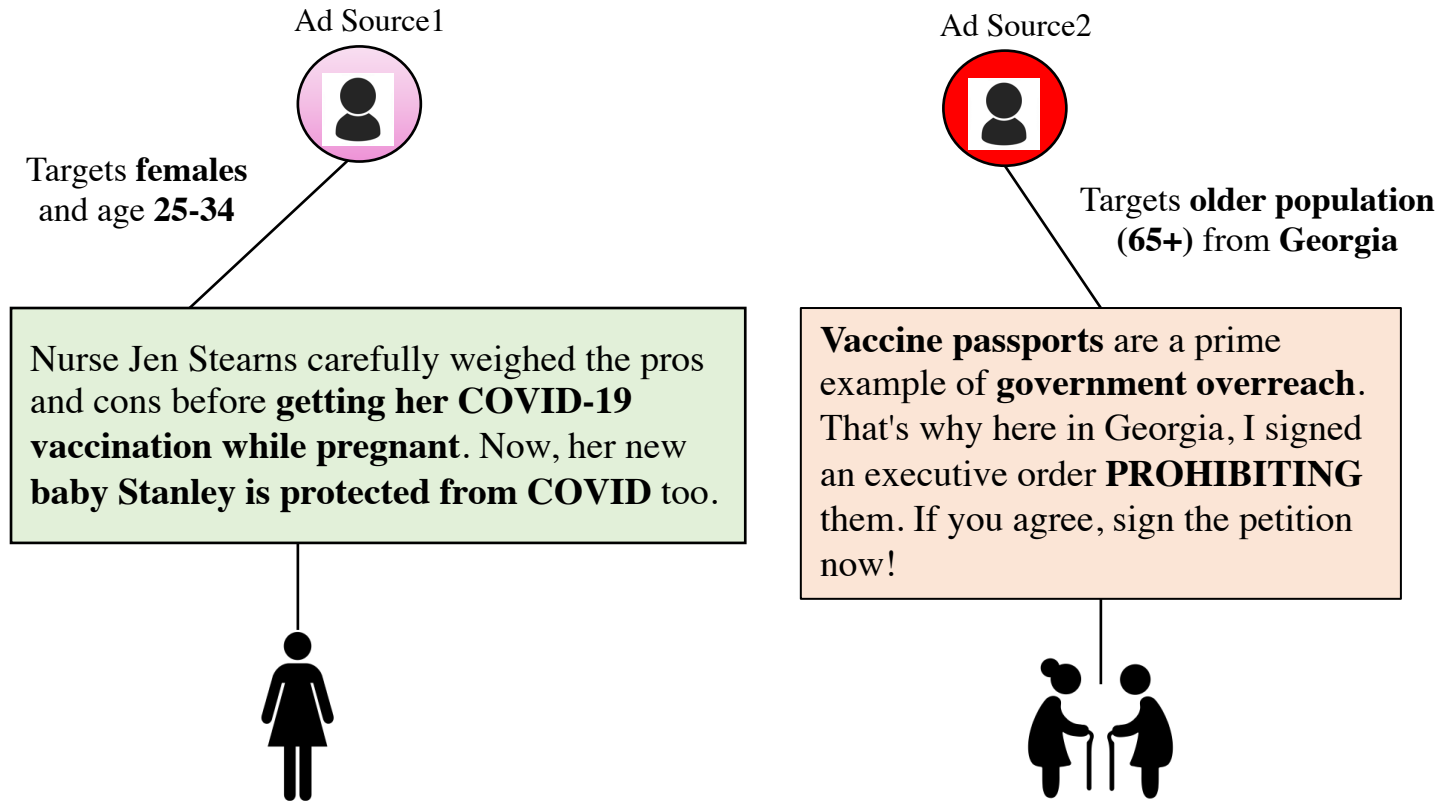


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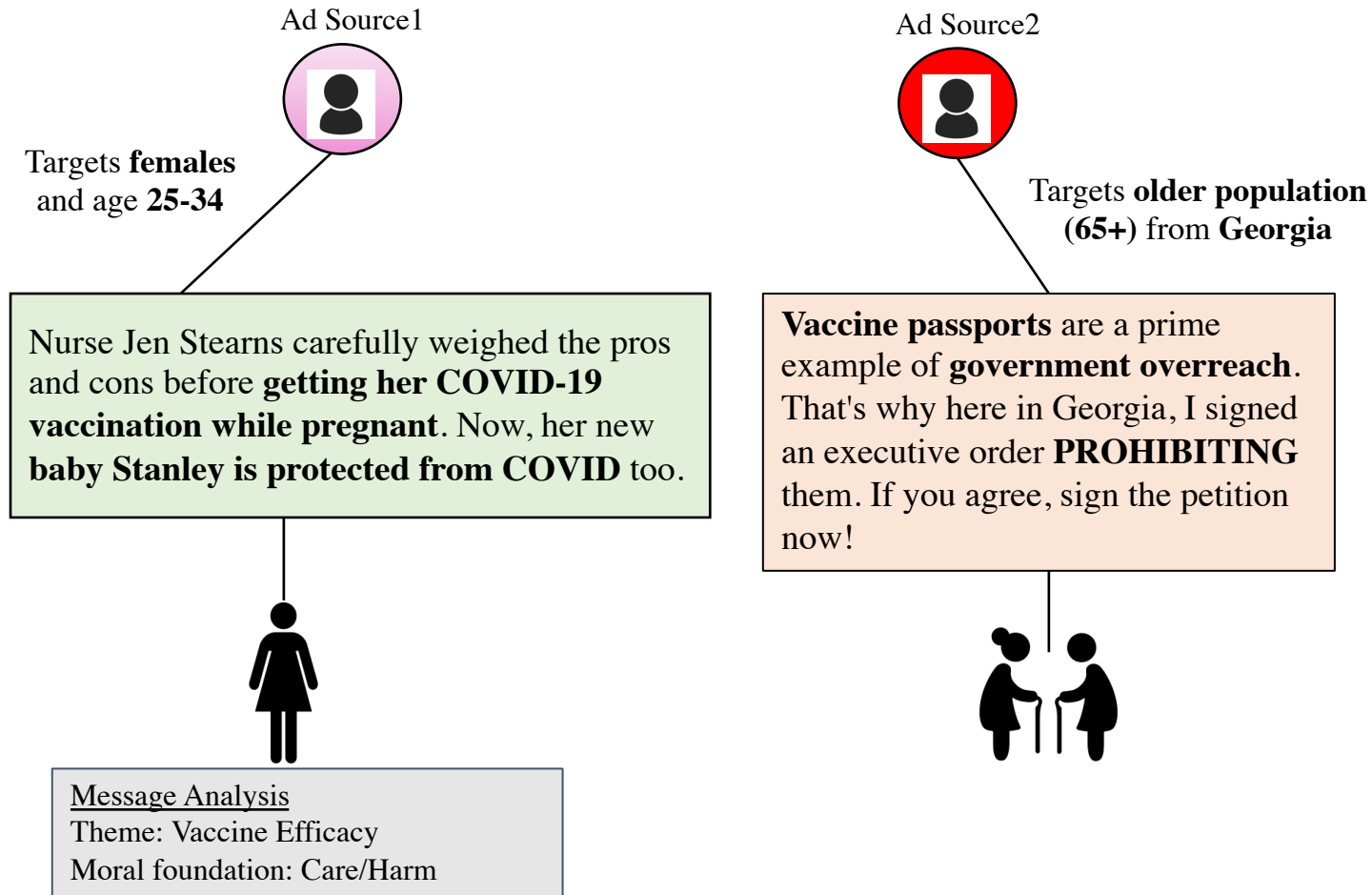
- Facebook allows advertisers to **adapt** their messaging to **target** audiences.
- **Alleviate** or **exacerbate** the infodemic.



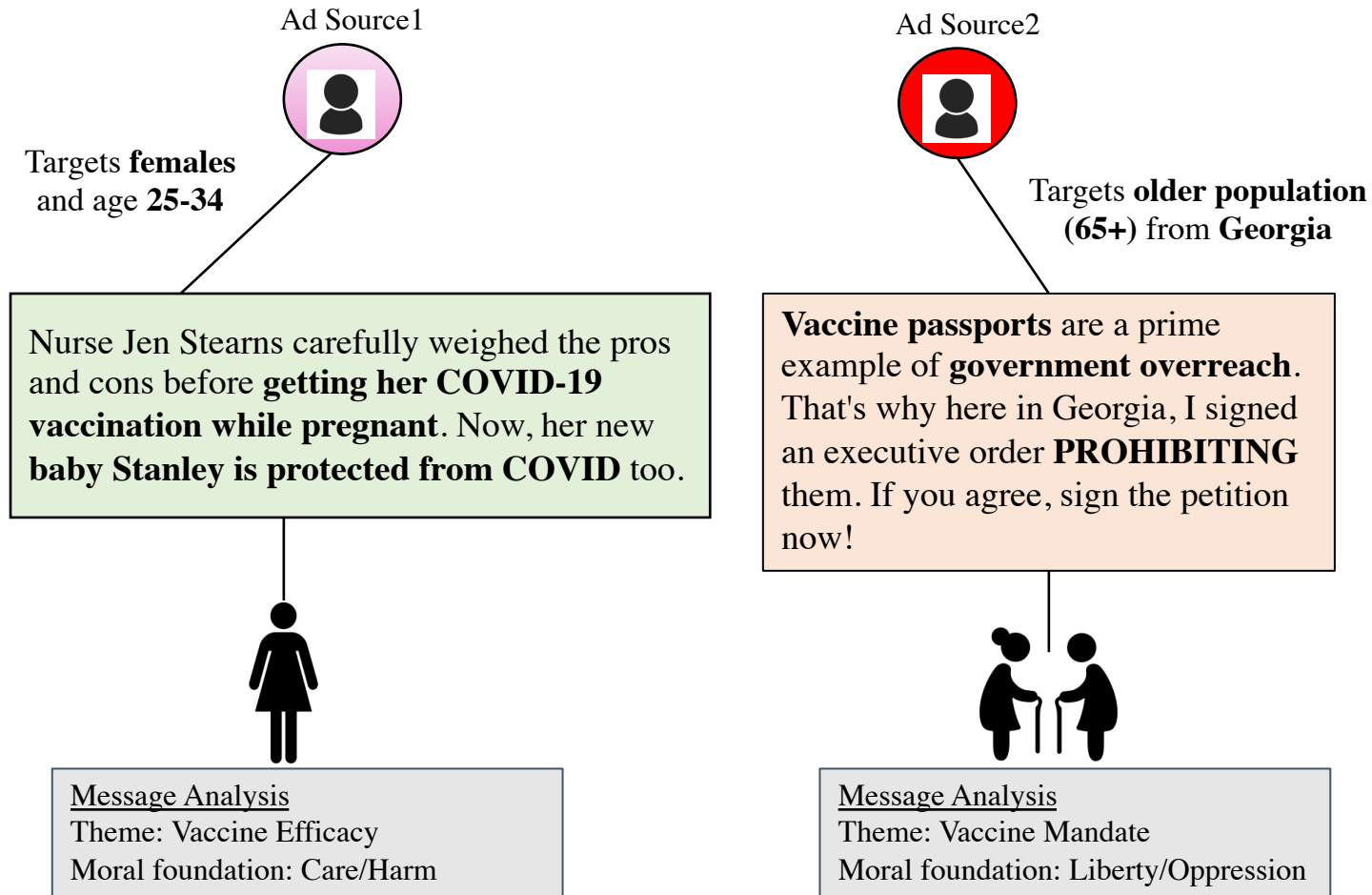
Microtargeting & Messaging Analysis



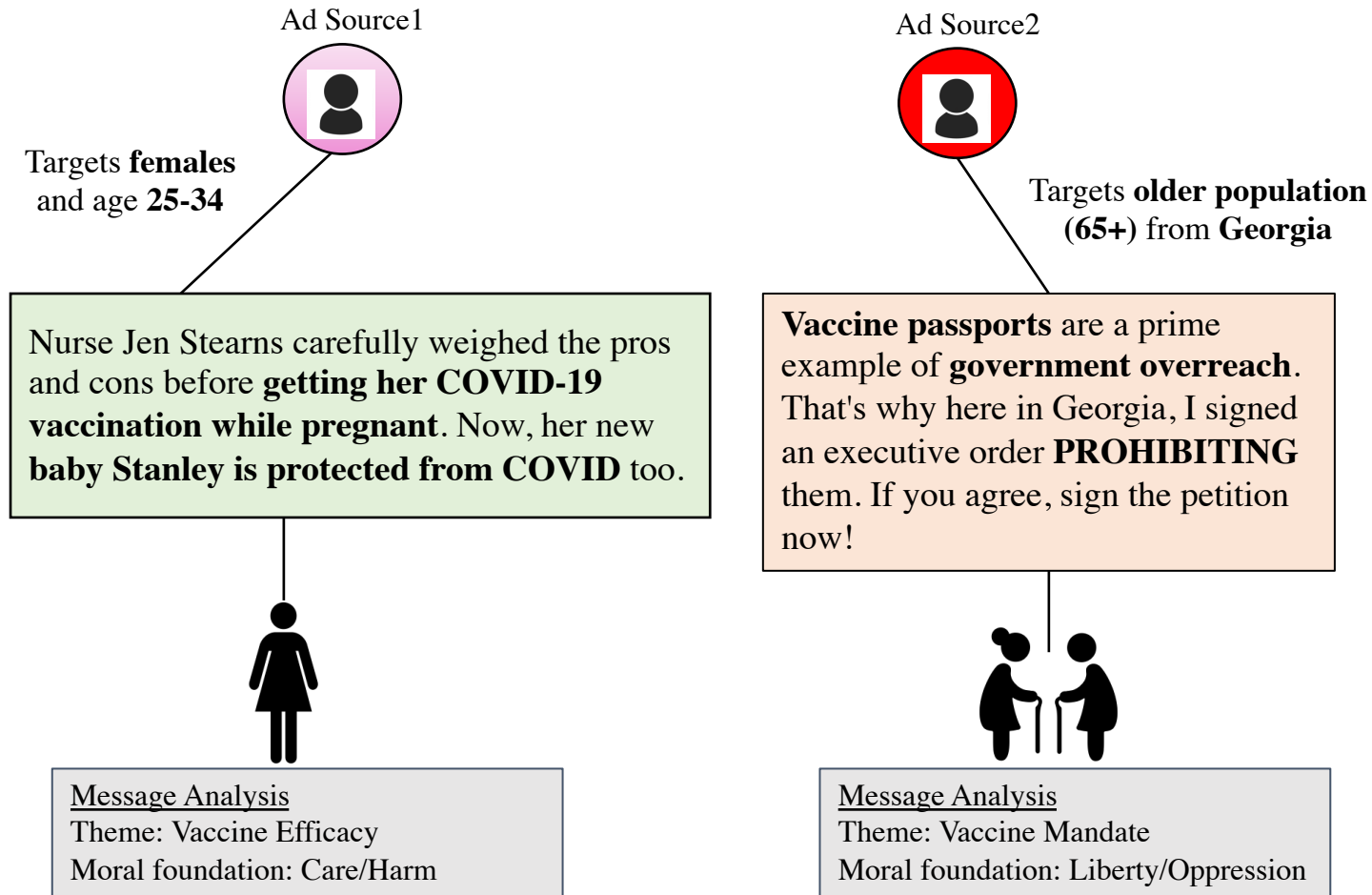
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Our Work:
Analyze and shed light on
how messaging is crafted
for the different
demographic groups.

Vaccine Campaigns on Facebook



Ken King

Sponsored • Paid for by Ken King for State Representative

Biden's radical vaccine mandate would force companies with 100 or more employees to require proof of vaccination or have their employees undergo weekly testing. I have joined my conservative colleagues and Texans for Responsible Government in an amicus curiae brief to overturn this outrageous order. No one should be forced to have a medical procedure in order to keep thei...



Long Beach Department of Health & Human Services (LBDHHS)

Sponsored • Paid for by Long Beach Dept. of Health & Human Services

It's everyone's turn. You wouldn't drive your kids to school without the protection of seatbelts. Protect your loved ones 12 and older by getting the COVID-19 vaccine. #SleeveUpLB



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Theme:
Vaccine Mandate



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Moral Foundation:
Liberty/Oppression



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Vaccine Campaigns on Facebook

Theme:
Encourage Vaccination



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Moral Foundation:
Loyalty/Betrayal



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Theme: Vaccine Mandate
Moral Foundation: Liberty/Oppression



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Theme: Encourage Vaccination
Moral Foundation: Loyalty/Betrayal

Our Goal

- Formulate a novel problem of using **minimal supervision** to analyze the **landscape of vaccine campaigns** on Facebook.


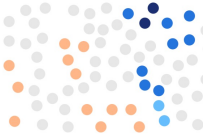
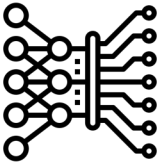

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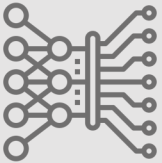

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- Conduct details analysis of messaging across different **demographics, geographic, and timelines**.

Roadmap

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|  | Dataset Details |
|  | Weak Label Generation |
|  | Brief Description of the Framework |
|  | Analysis of Messaging |

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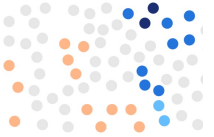
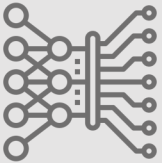

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- Inter-annotator agreement: **Cohen’s Kappa** coefficient
 - Theme: **65.60%**
 - MF: **73.80%**

Roadmap

| | |
|--|------------------------------------|
|  | Dataset Details |
|  | Weak Label Generation |
|  | Brief Description of the Framework |
|  | Analysis of Messaging |

Weak Label for *Themes*

- **Set of themes from recent works:** reasons of **supporting vaccination** and **vaccine hesitancy**.

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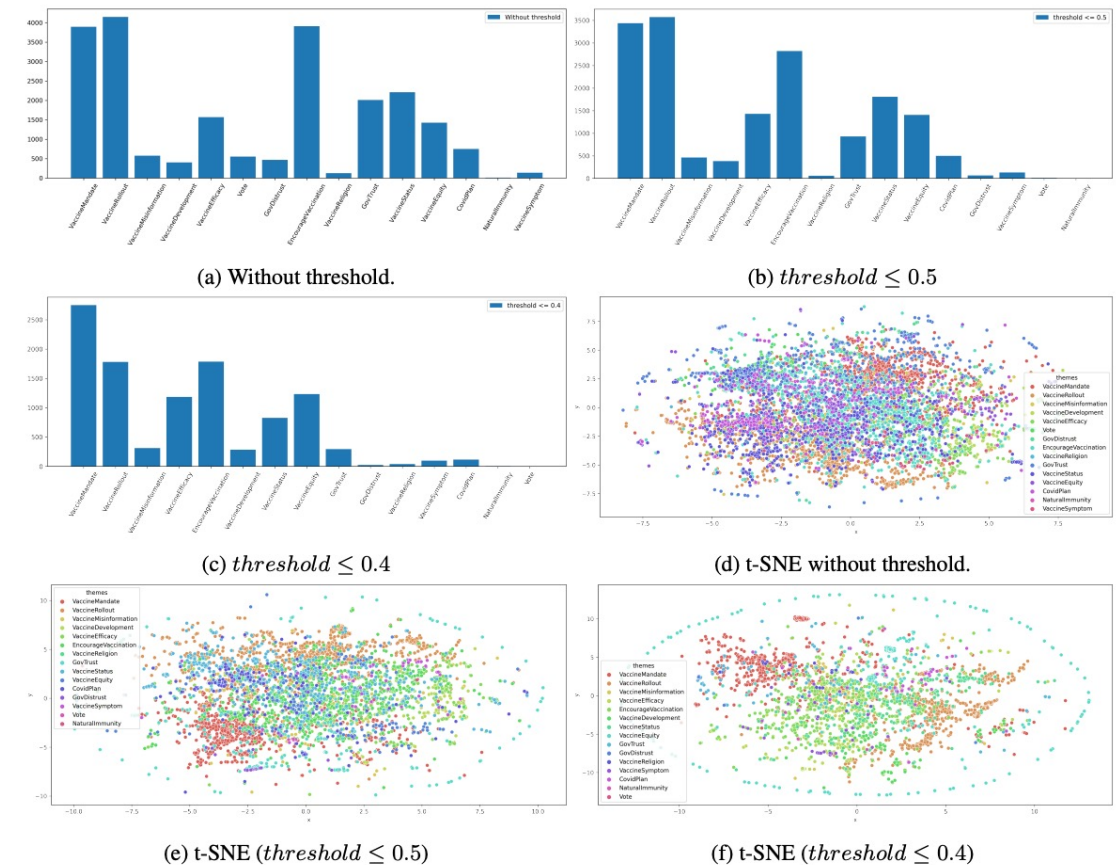
- **Add new themes and phrases** related to COVID-19 vaccine campaigns.

e.g.,

“Protect our community by getting vaccinated” **Theme:** *Encourage Vaccination*

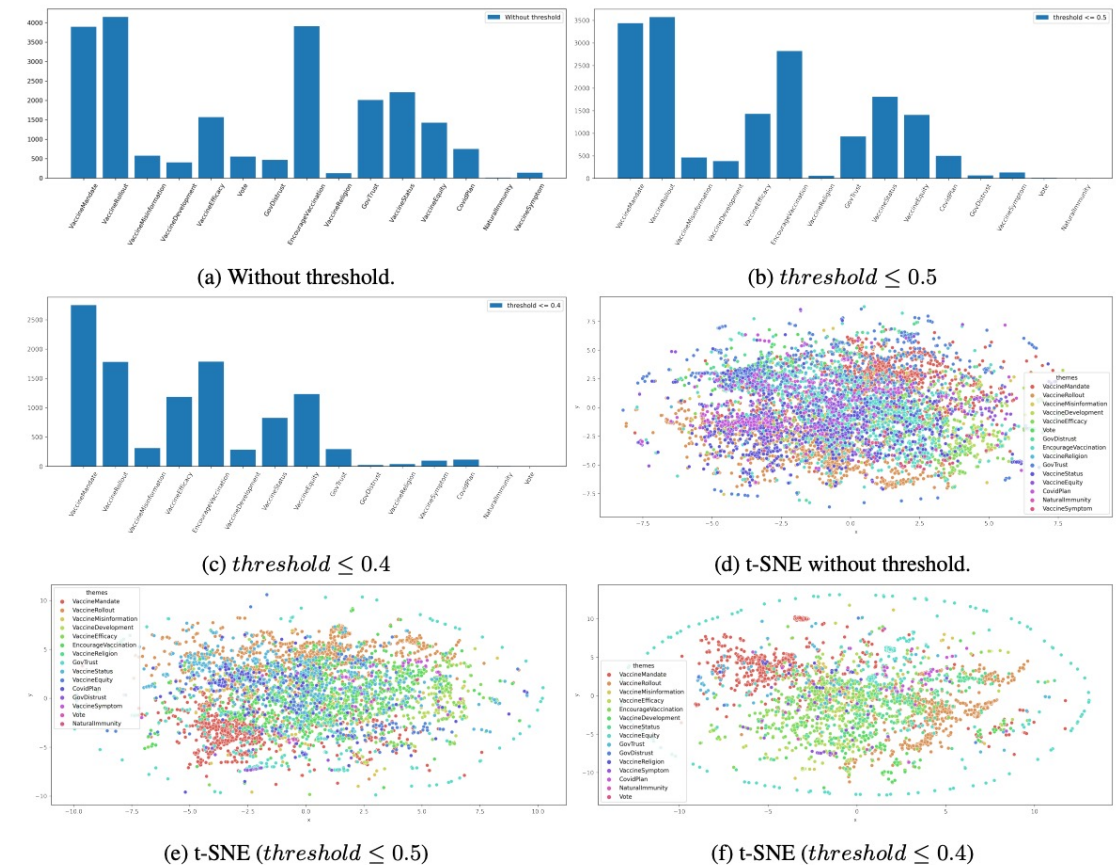
Assign *Themes*

- Ground the phrases in a set of COVID-19 vaccination ads and match similarity between their **Sentence BERT** embeddings.



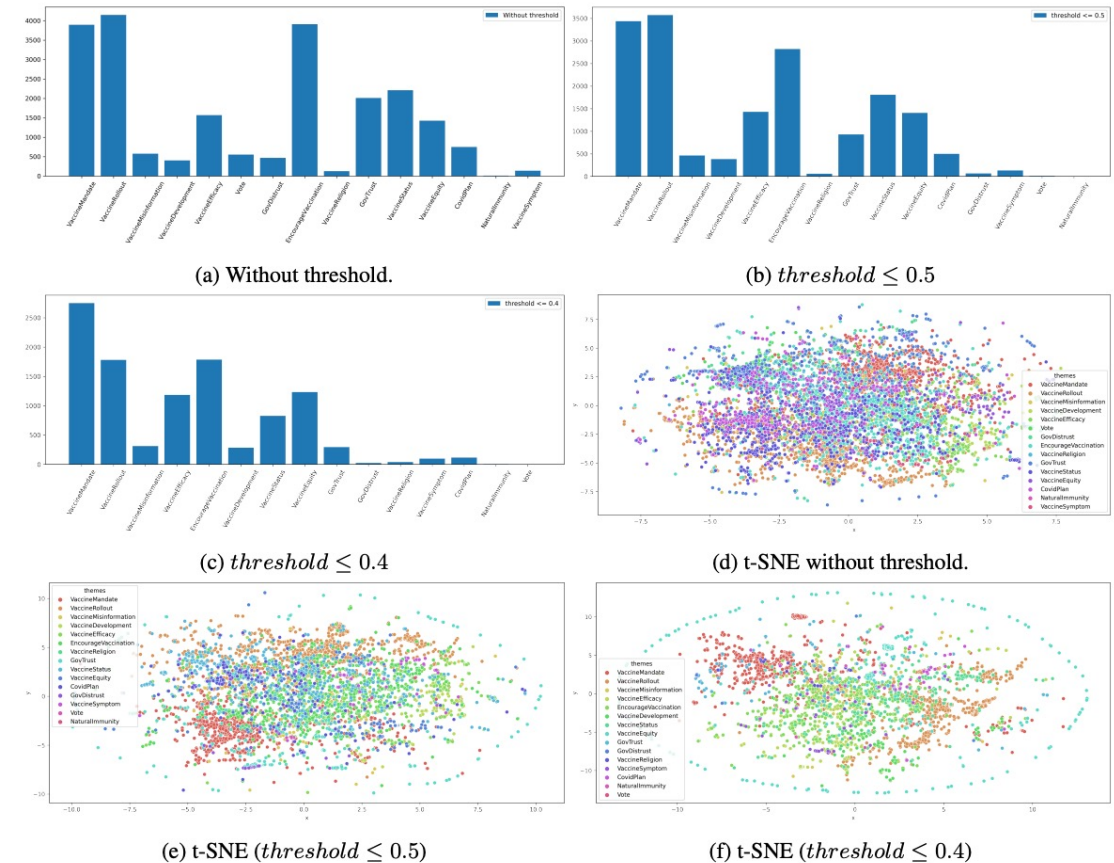
Assign Themes

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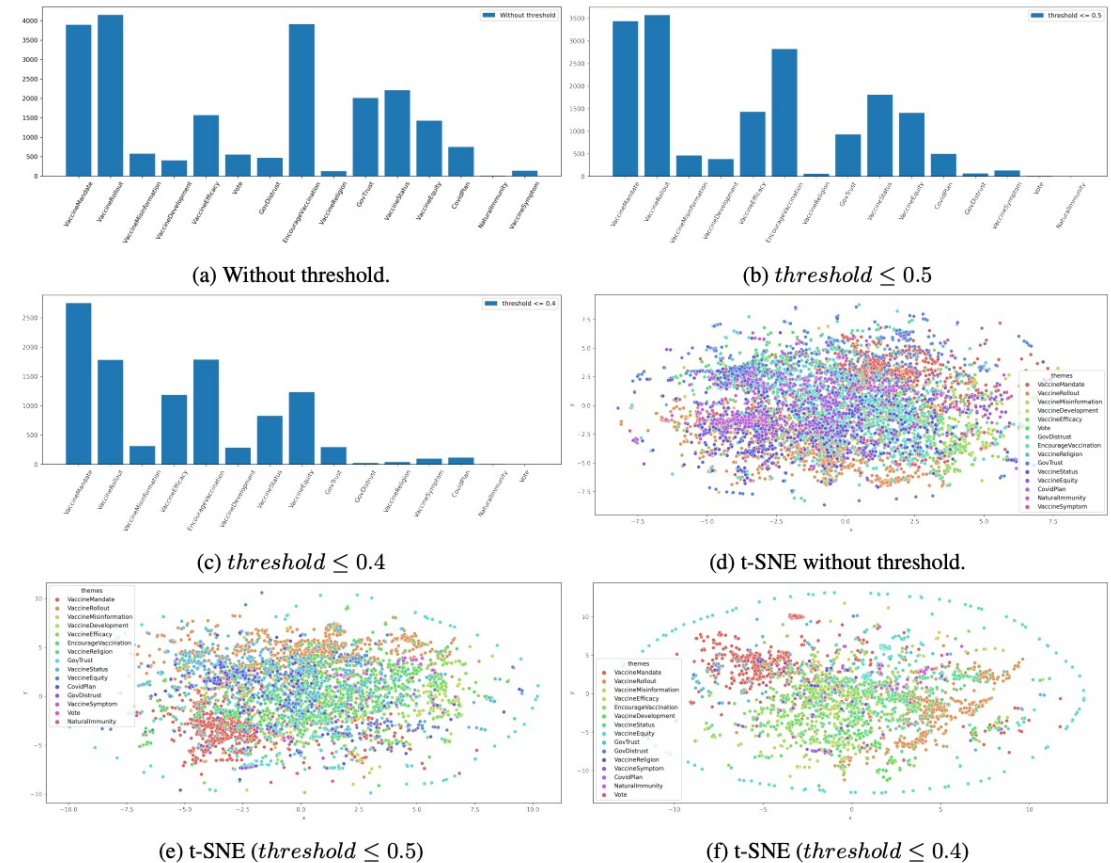
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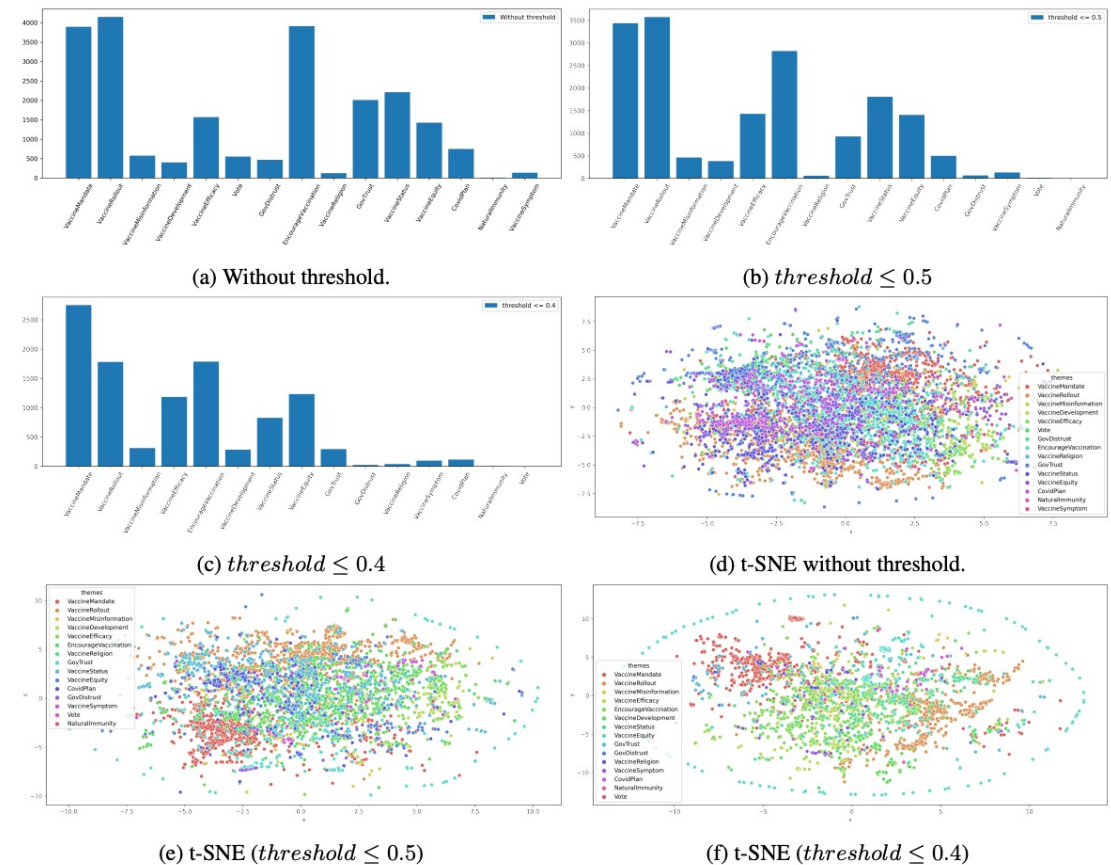
Assign Themes

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 - threshold ≤ 0.5 resulting **21,851 ads**.



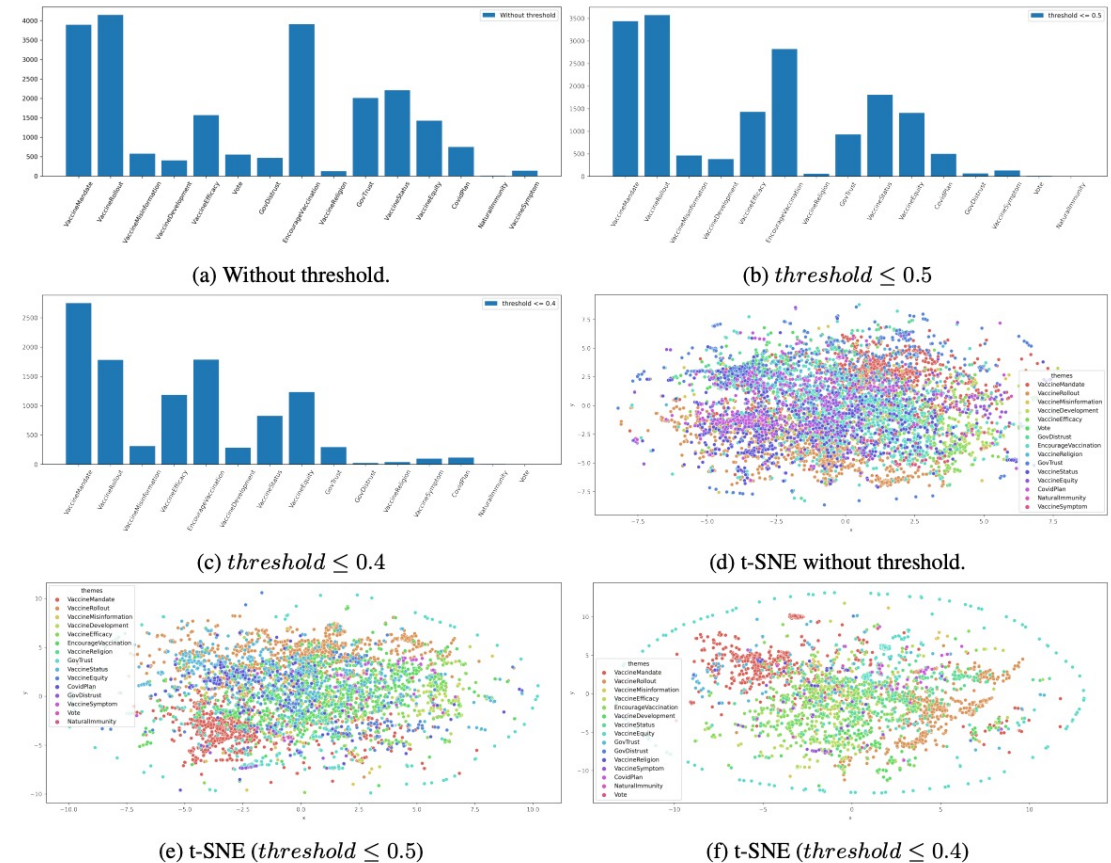
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- Quality of weak label:
 - Accuracy: **51.3%**
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 - Significantly better than random (**6.7%**)



Weak Label for *MF*

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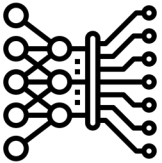

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 - Ad contains \geq two keywords.
- Quality of weak label:
 - Accuracy: **41.7%**
 - Macro-avg F1: **24.8%**

Weak Label for *MF*

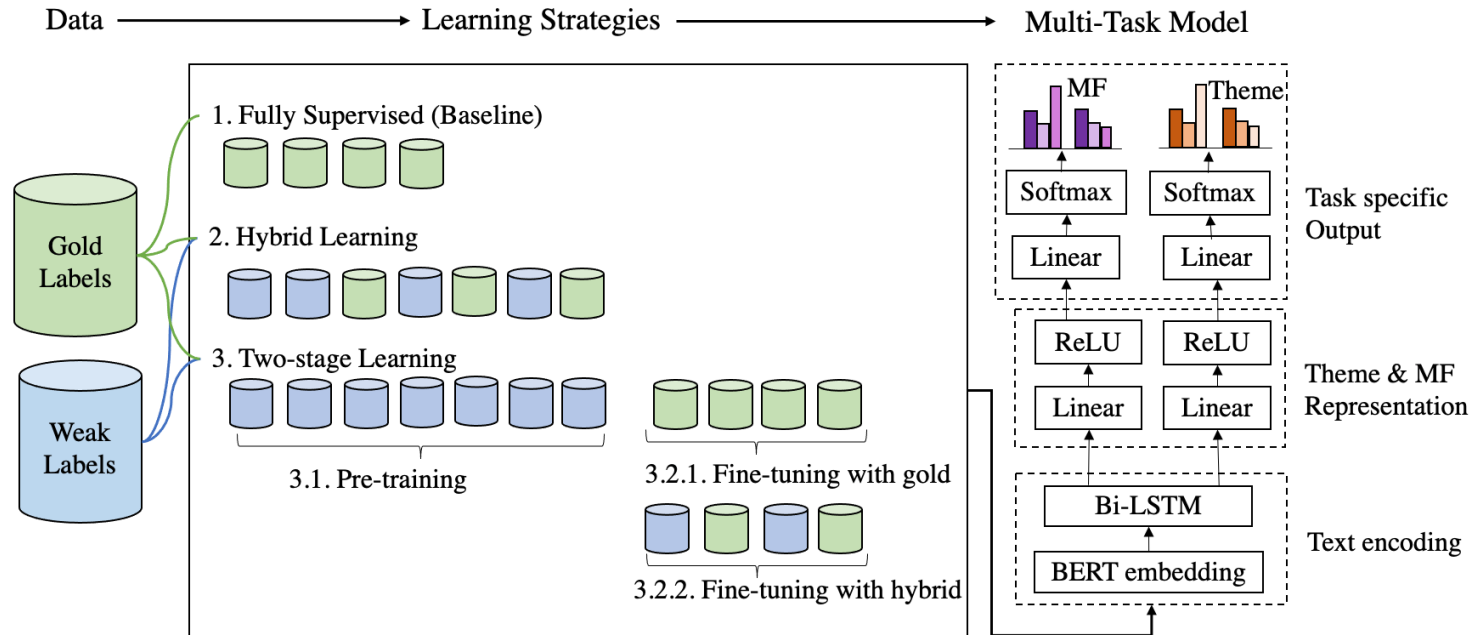
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 - Ad contains \geq two keywords.
- Quality of weak label:
 - Accuracy: **41.7%**
 - Macro-avg F1: **24.8%**
 - Comparatively better than random (**14.3%**)

Roadmap

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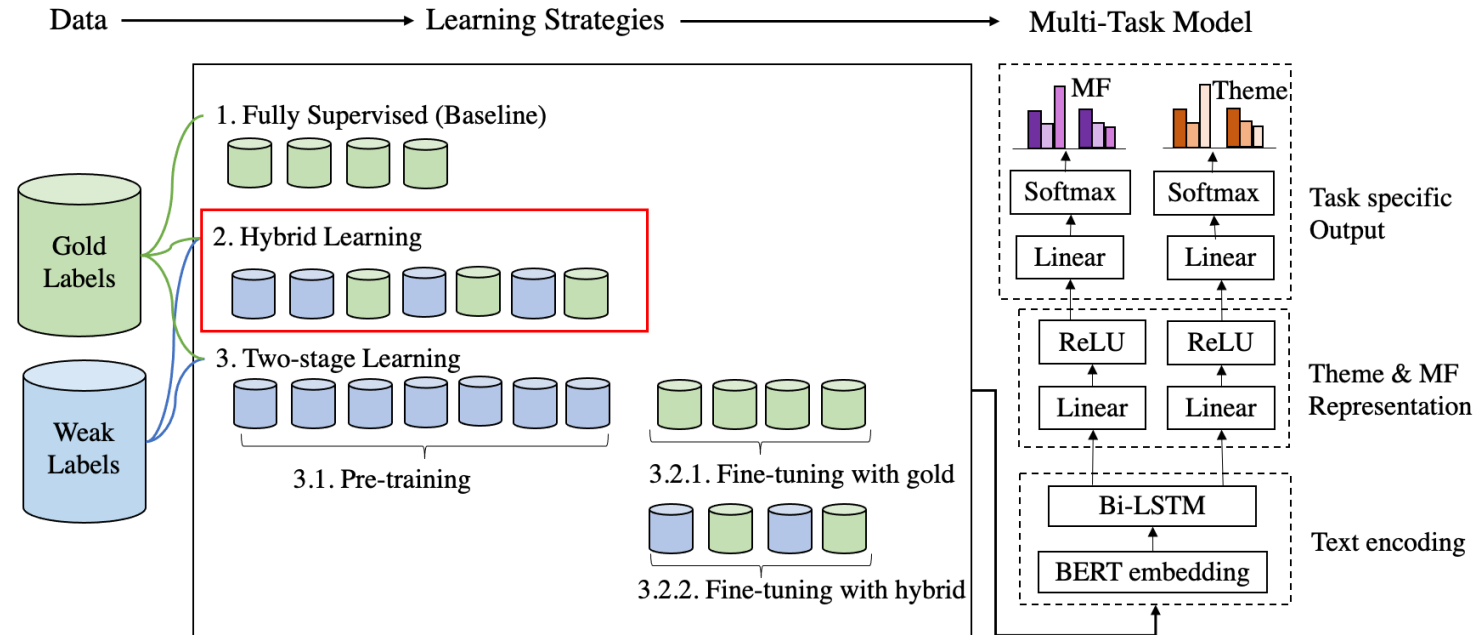
Learning Strategies

- 3 learning strategies.



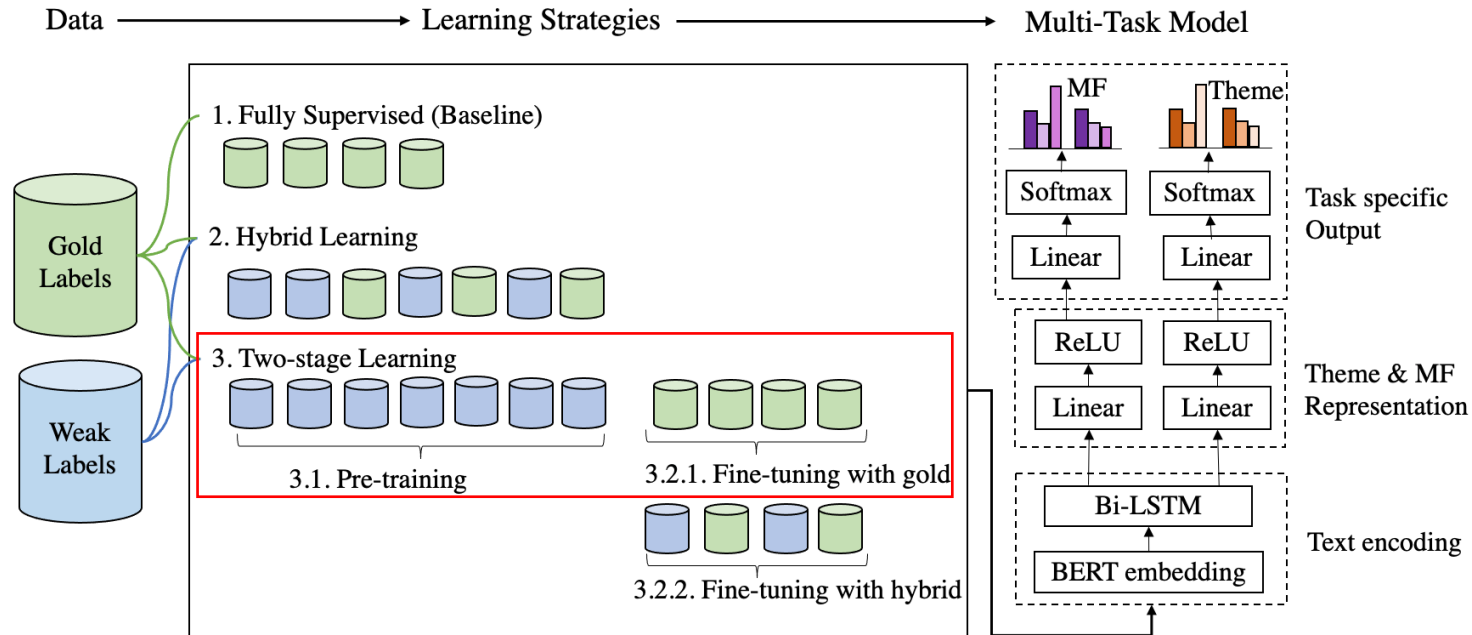
Learning Strategies

- 3 learning strategies.
- **Hybrid Learning:** uses mixture of gold and weak labels for training.



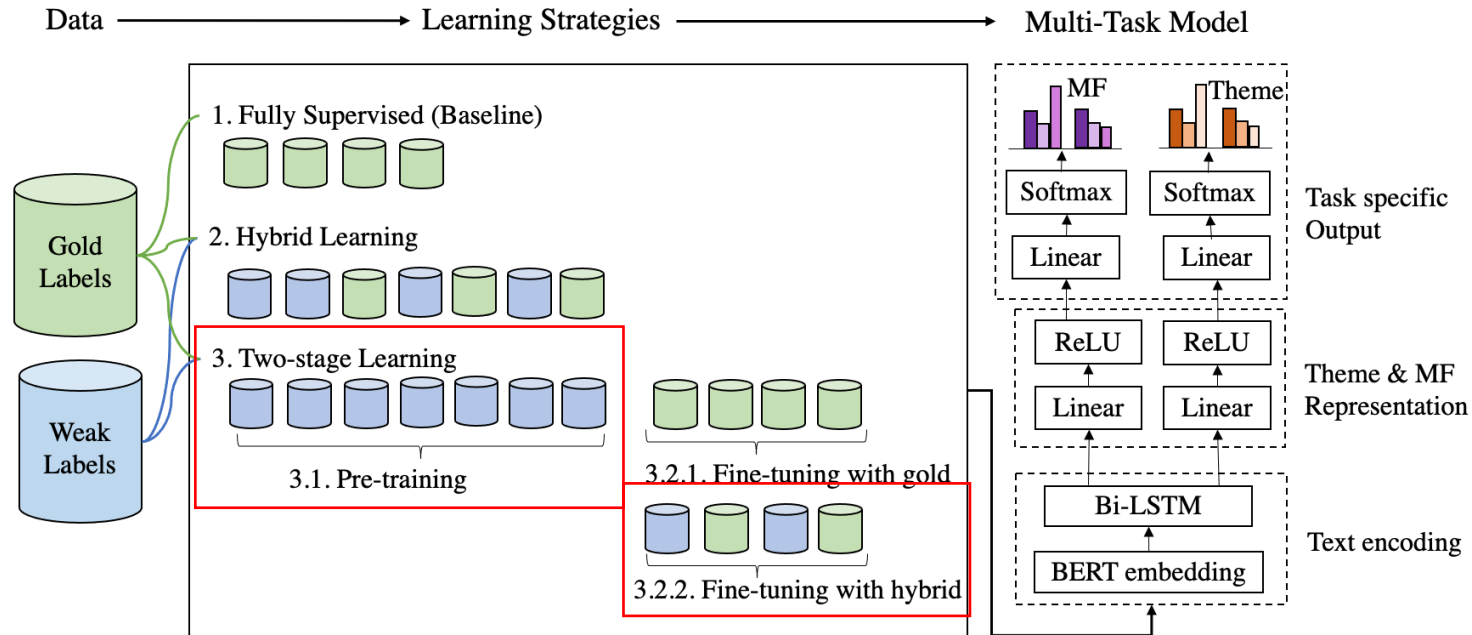
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- **Two-stage learning**: pre-training using a large but noisy dataset, fine-tuning using gold labels.



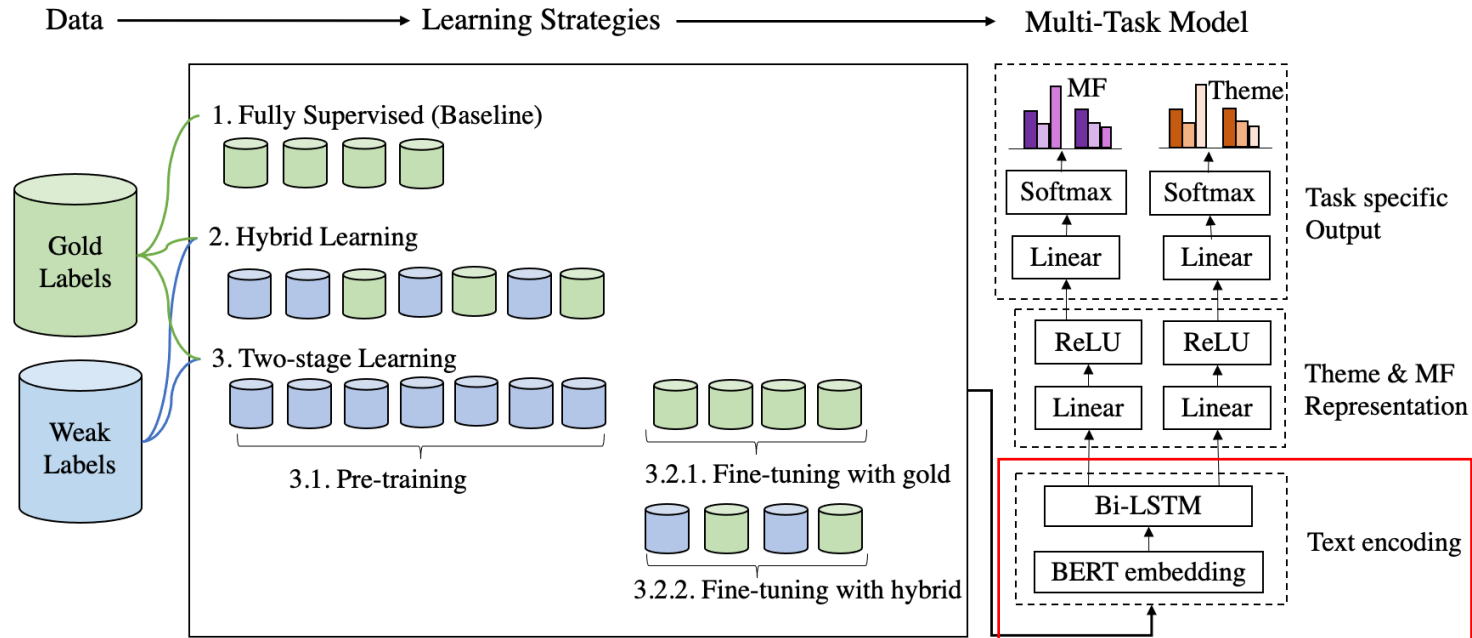
Learning Strategies

- 3 learning strategies.
- **Hybrid Learning**: uses mixture of gold and weak labels for training.
- **Two-stage learning1**: pre-training using a large but noisy dataset, fine-tuning using gold labels.
- **Two-stage learning2**: pre-training using noisy dataset, fine-tuning using weak + gold labels.



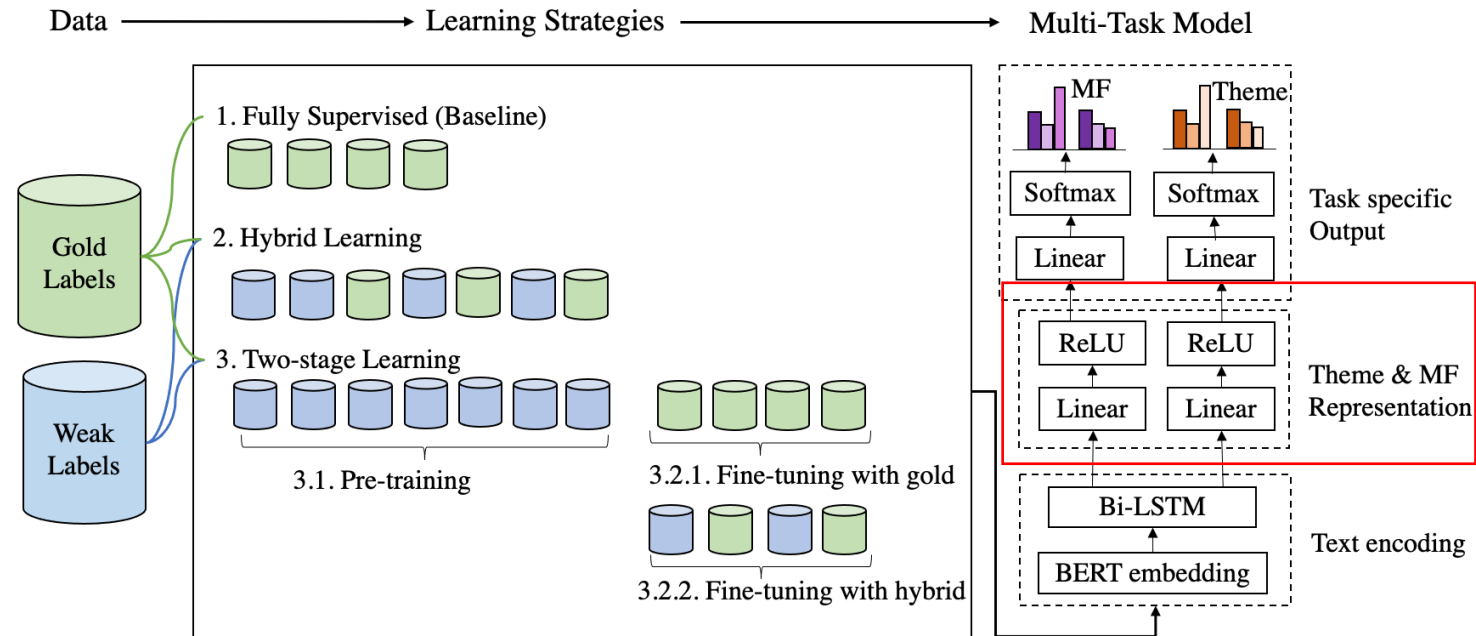
Multi-task Learning

- Text Encoder: BERT embedding + Bi-LSTM



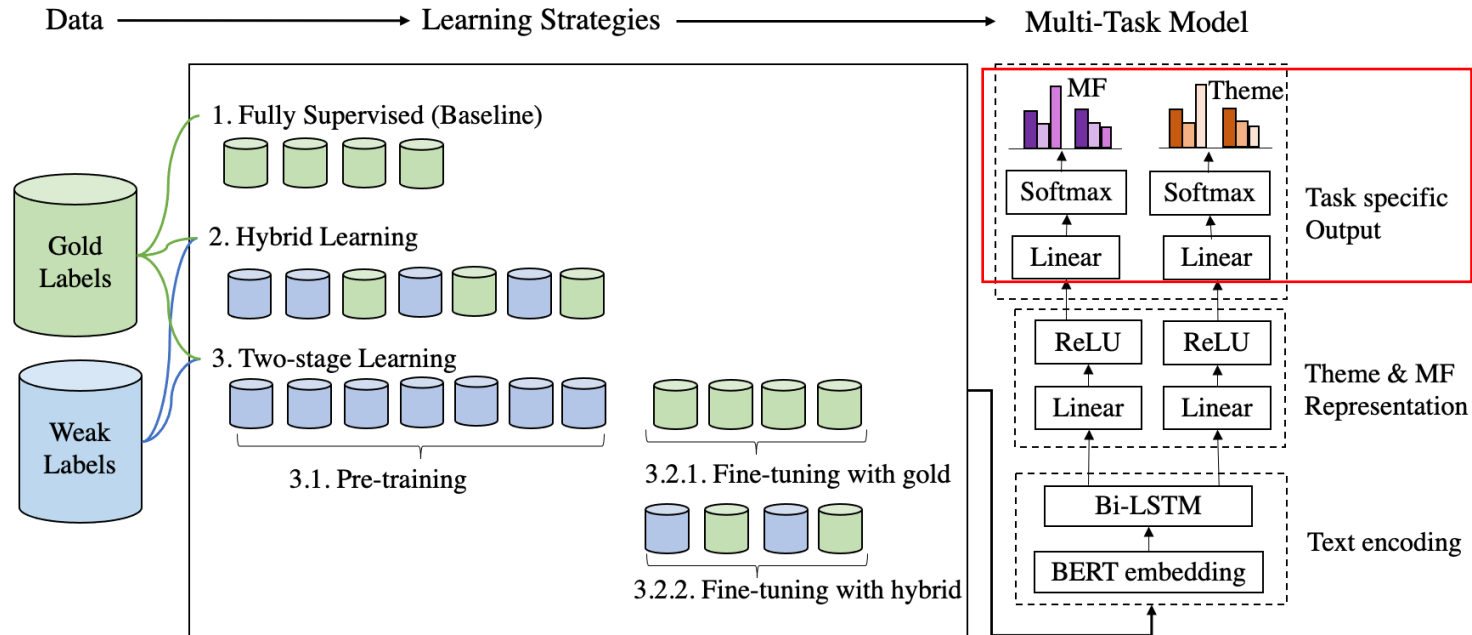
Multi-task Learning

- Text Encoder: BERT embedding + Bi-LSTM
- Text Decoder: Linear + ReLU



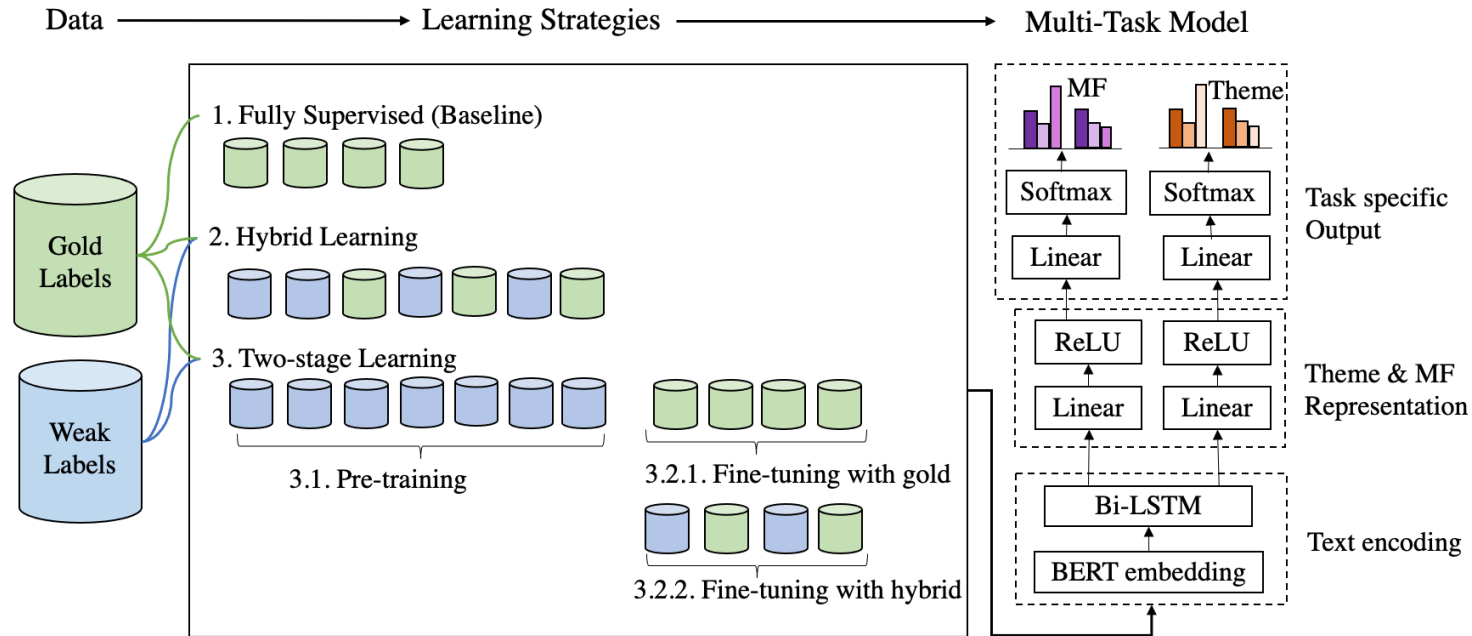
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- Text Decoder: Linear + ReLU
- Task Specific Output: Linear + Softmax.



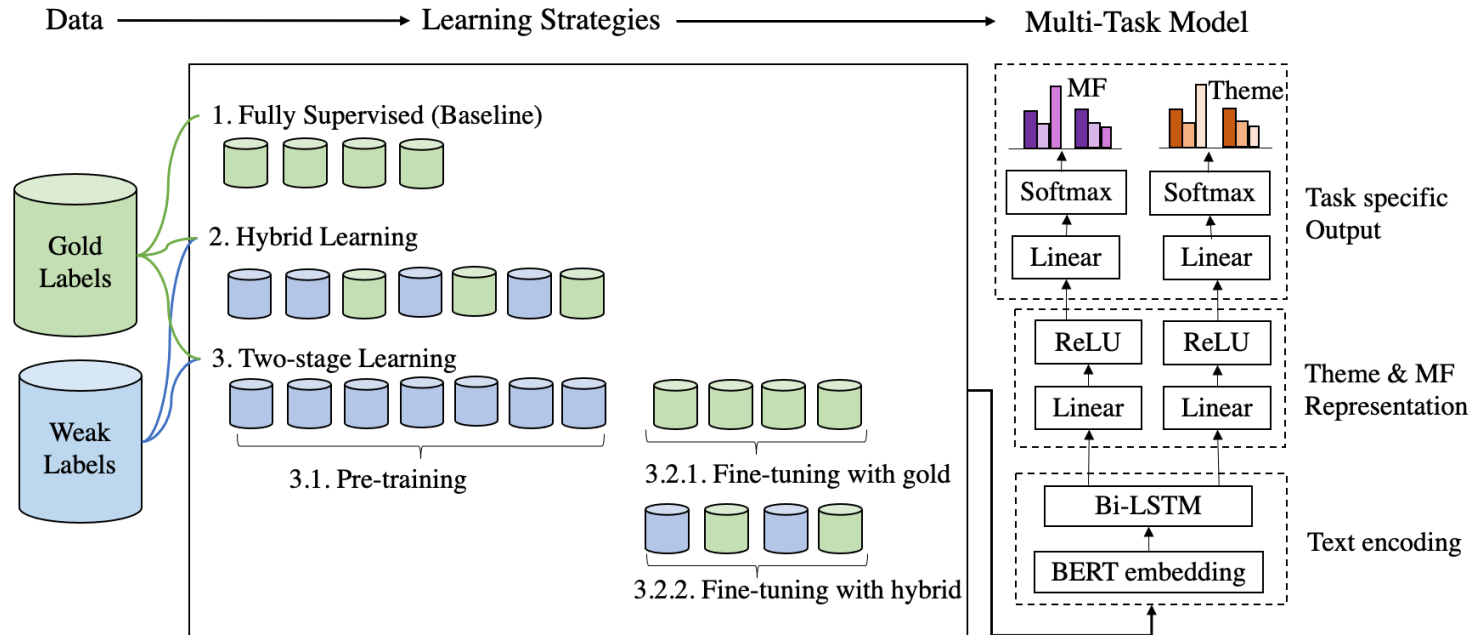
Multi-task Learning

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- Task Specific Output: Linear + Softmax.
- Objective Function: Sum of cross-entropy losses for both tasks.



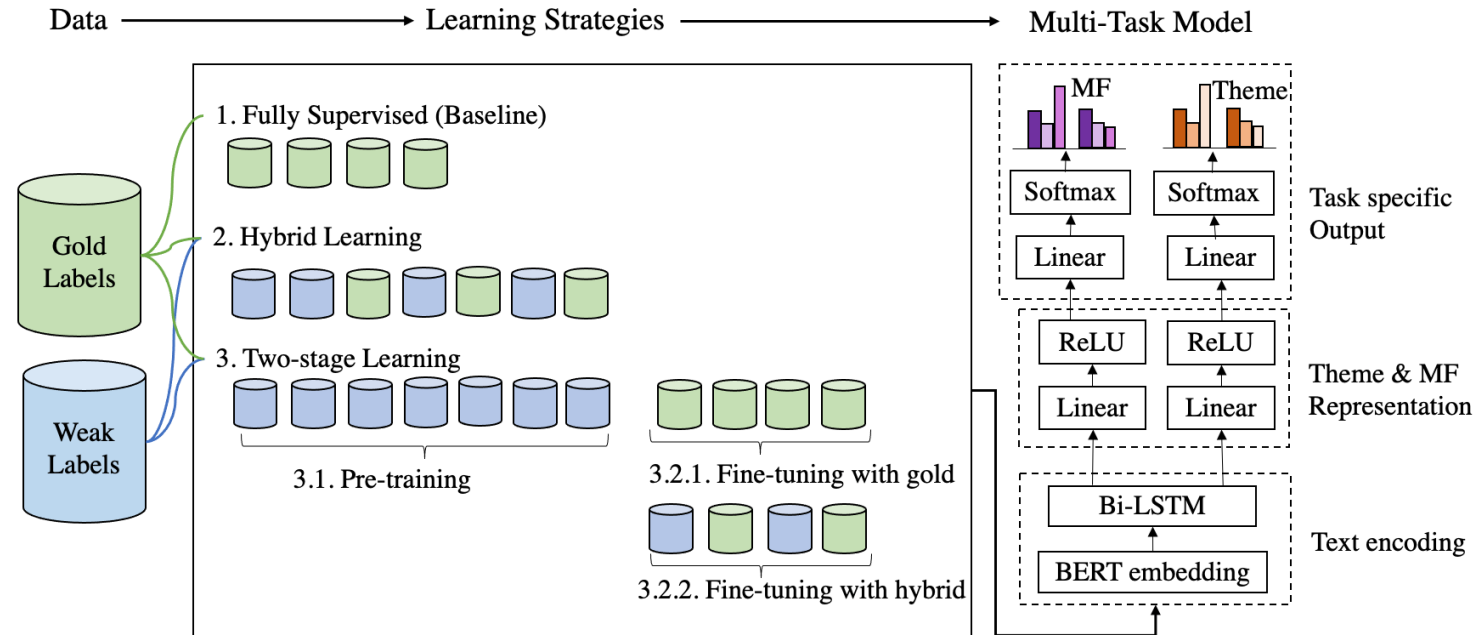
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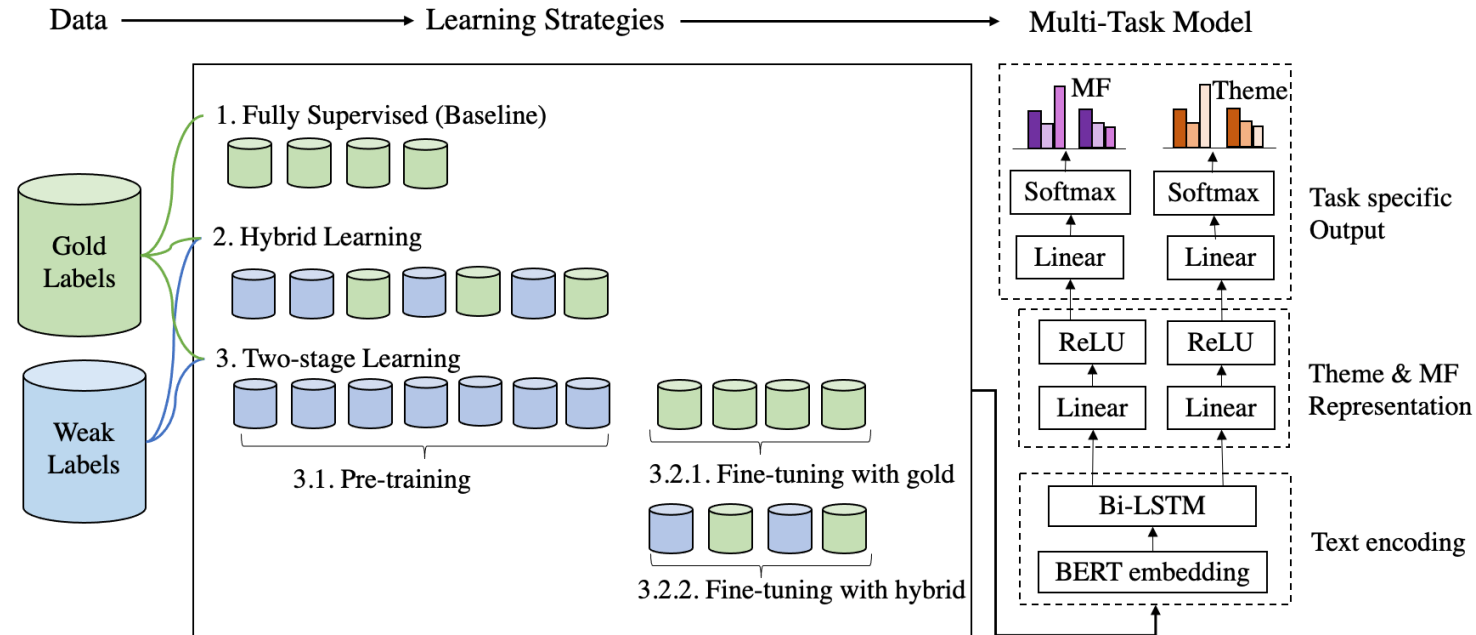
Results

- Text Encoder: BERT embedding + Bi-LSTM
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- **Hybrid learning** strategy achieves the best result.
 - **Theme:**
 - Accuracy: **69.0%**,
 - Macro-avg F1 **57.9%**.



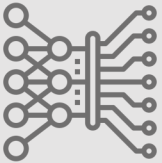



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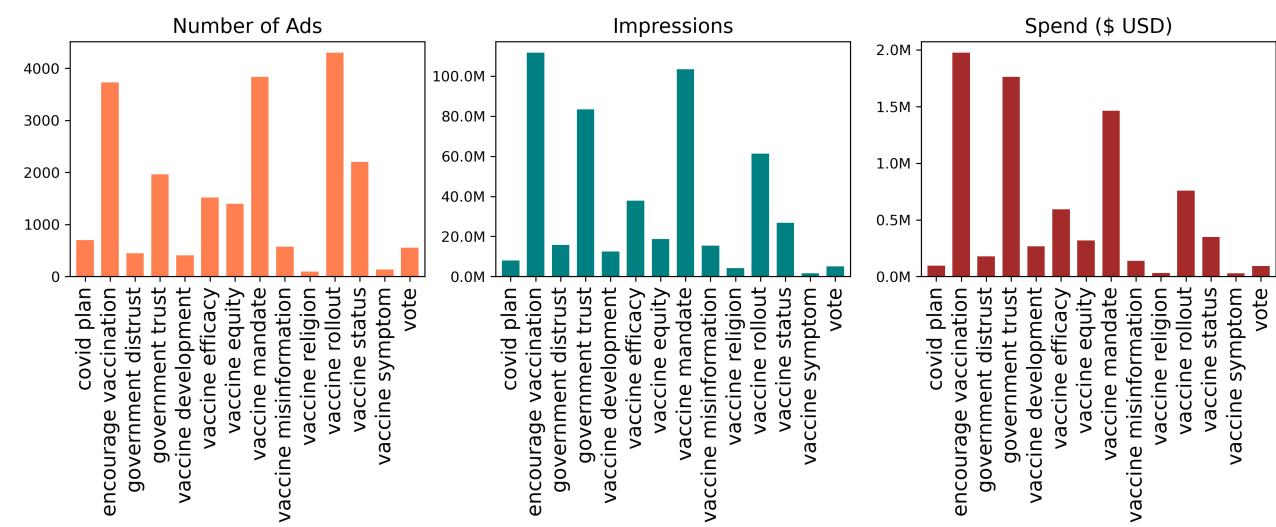
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- **Hybrid learning** strategy achieves the best result.
 - **Theme:**
 - Accuracy: **69.0%**,
 - Macro-avg F1 **57.9%**.
 - **MF:**
 - Accuracy: **75.2%**,
 - Macro-avg F1: **51.0%**.



Roadmap

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RQ1: What are the narratives of the messaging?



Encourage
vaccination

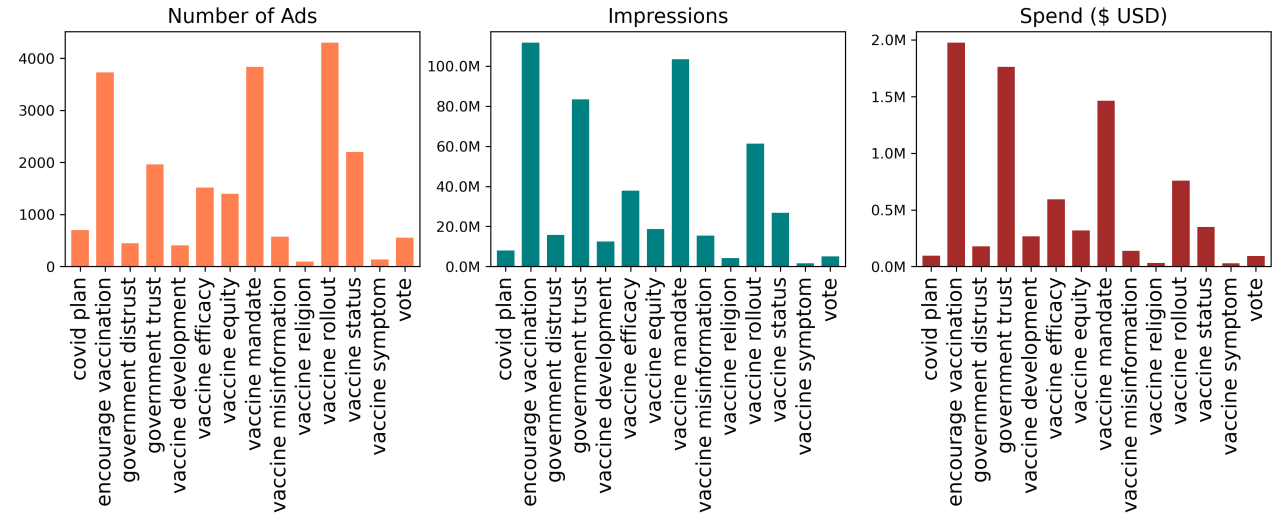
Vaccine
mandate

Government
trust

Vaccine
rollout

RQ1: What are the narratives of the messaging?

- Most popular theme **encourage vaccination** promoting vaccination to *protect their loved one, family, friends, and community* using **loyalty/betrayal** MF.



Encourage
vaccination

Vaccine
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Government
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Vaccine
rollout

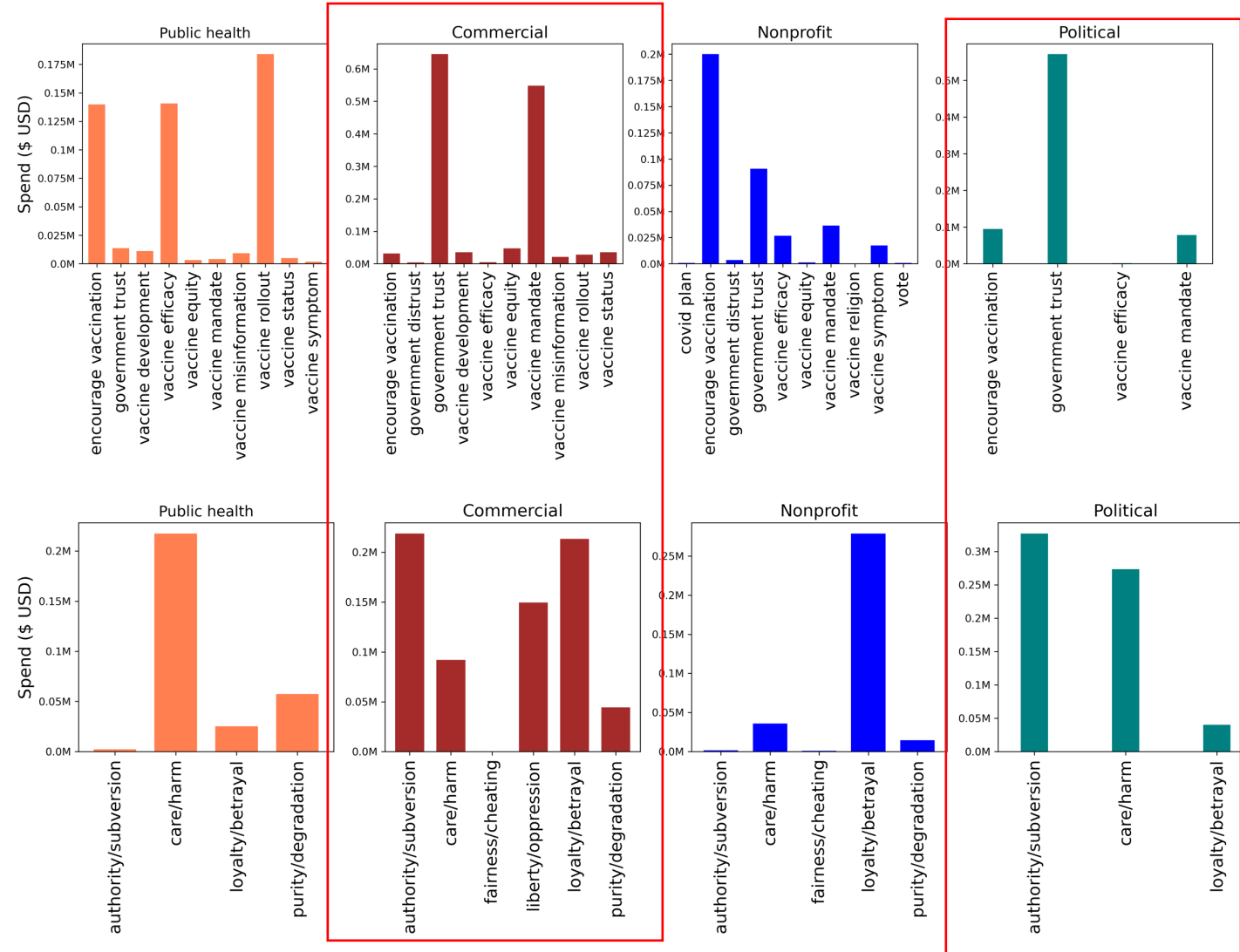
RQ2: How does entity type fulfill messaging roles?

- Categorize funding entities into four types and select **top 5/category** based on **expenditure**.
 - Public health
 - Commercial
 - Nonprofit
 - Political

| Type | Entity |
|---------------|--|
| Public health | Children's Health System of Texas |
| Public health | New York City Department of Health and Mental Hygiene |
| Public health | South Carolina Department of Health & Environmental Control |
| Public health | South Dakota Department of Health |
| Public health | Washington State Department of Health |
| Commercial | Pfizer Inc. |
| Commercial | ATTN: INC. |
| Commercial | Daily Wire |
| Commercial | BMO Harris Bank |
| Commercial | NEWSMAX MEDIA, INC. |
| Political | JB for Governor |
| Political | Kemp for Governor Inc |
| Political | Save America Joint Fundraising Committee |
| Political | Future Majority, Inc |
| Political | Terry for Virginia |
| Nonprofit | Turning Point USA, Inc. |
| Nonprofit | American Health Care Association and National Center for Assisted Living |
| Nonprofit | PICO California Action Fund |
| Nonprofit | Ad Council |
| Nonprofit | PROJECT HOPE |

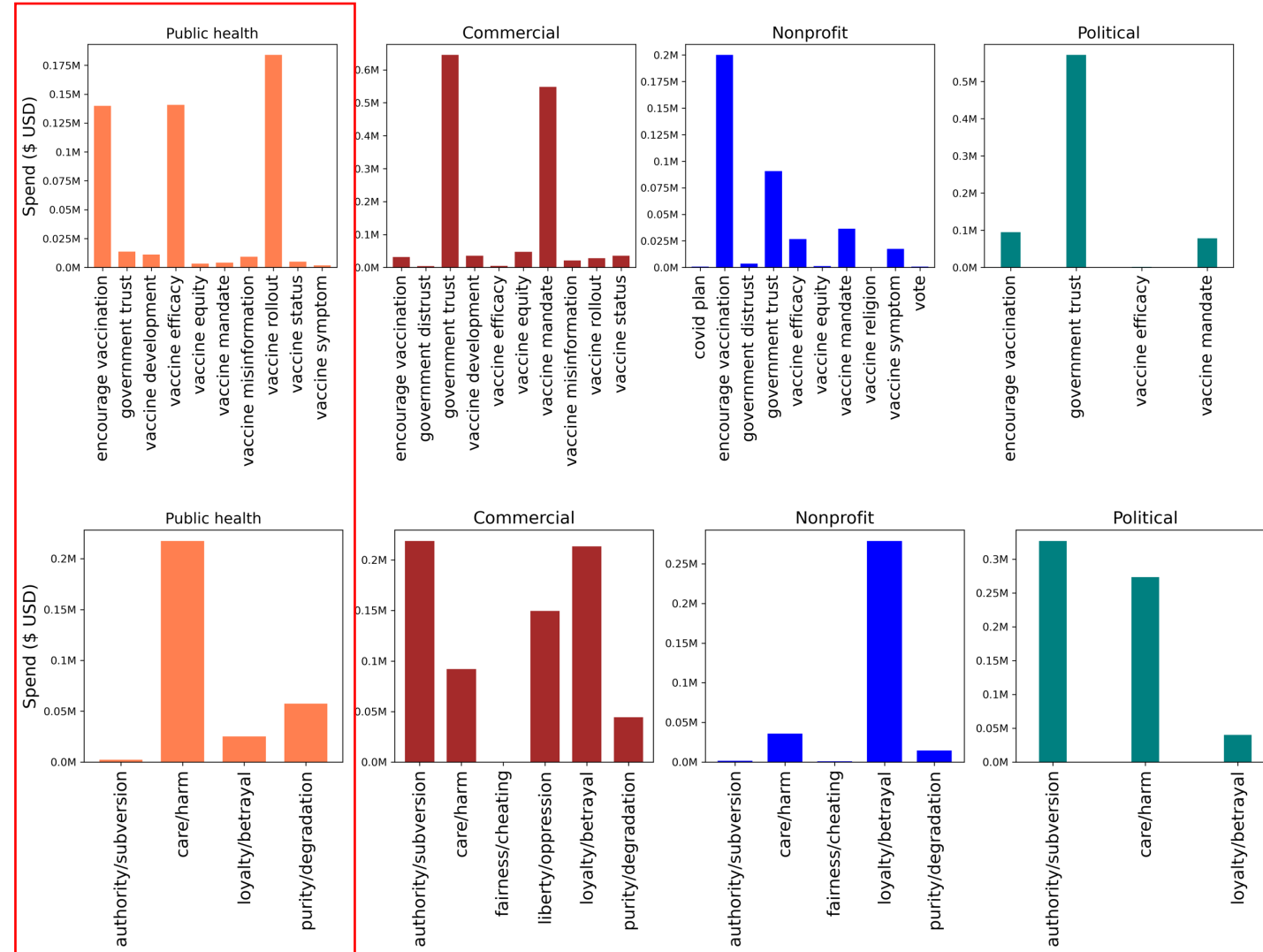
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- High spend on **government trust** narratives comes mostly from **commercial** and **political** entities focusing on **authority/subversion** MF.



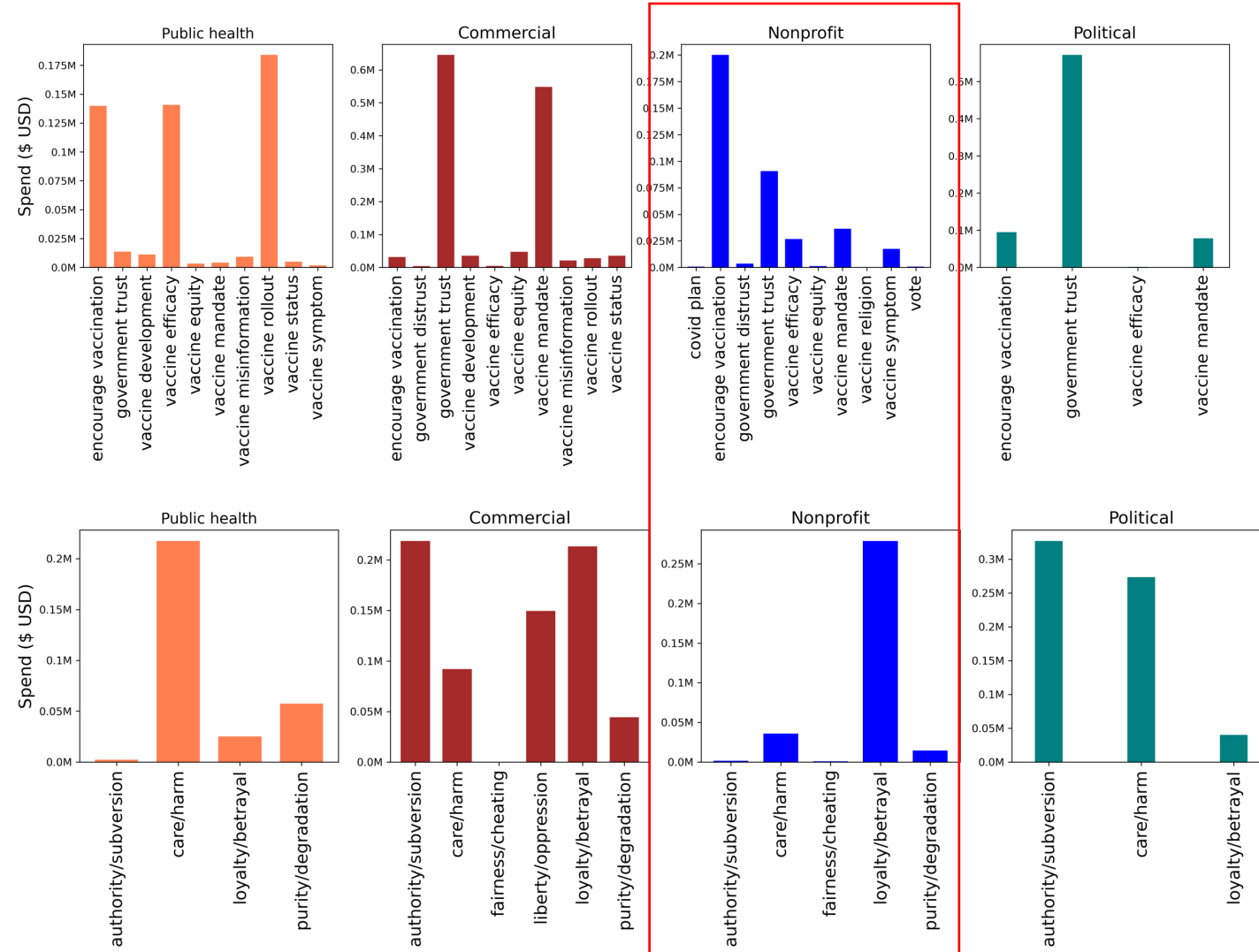
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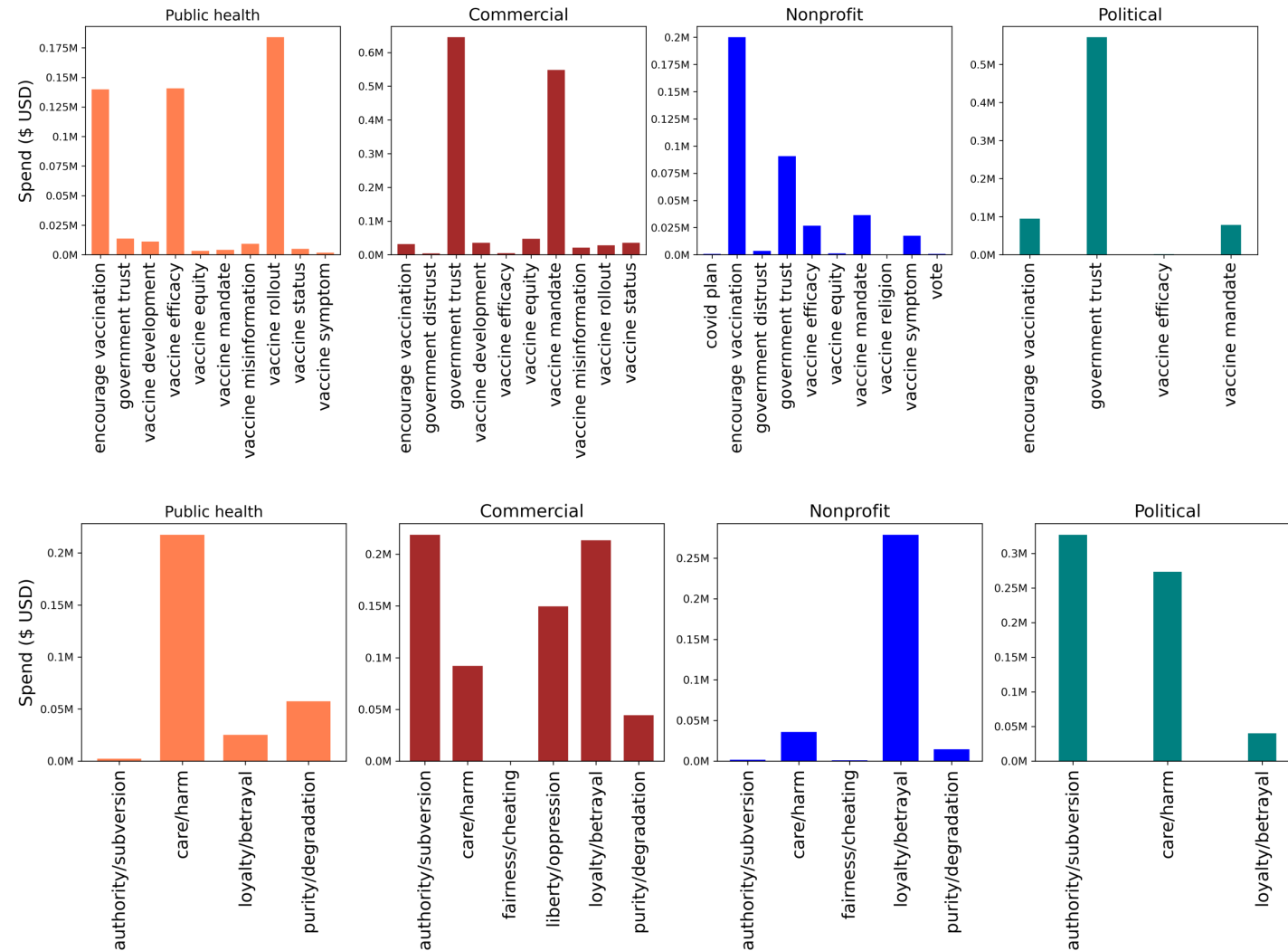
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- Statistically significant (**p-value < 0.05**).



RQ2: How does entity type fulfill messaging roles?

- **Messaging by Advertisers' Political View**
 - **16 political** funding entities and views at [OpenSecrets.org](https://www.opensecrets.org).

| Liberal | Conservative |
|--|--|
| Friends for Kathy Hochul House Majority Forward INDIVISIBLE ACTION Alexandria Ocasio-Cortez for Congress Charlie Crist for Governor Election Fund of Steven Fulop 2021 JAY CHEN FOR CONGRESS Elicker 2021 | North Carolina Republican Party TEXANS FOR SENATOR JOHN CORNYN INC. JIM JORDAN FOR CONGRESS Friends of Matt Gaetz RAND PAUL FOR US SENATE UNSILENCED MAJORITY Schmitt for Senate Dr Scott Jensen for Governor |

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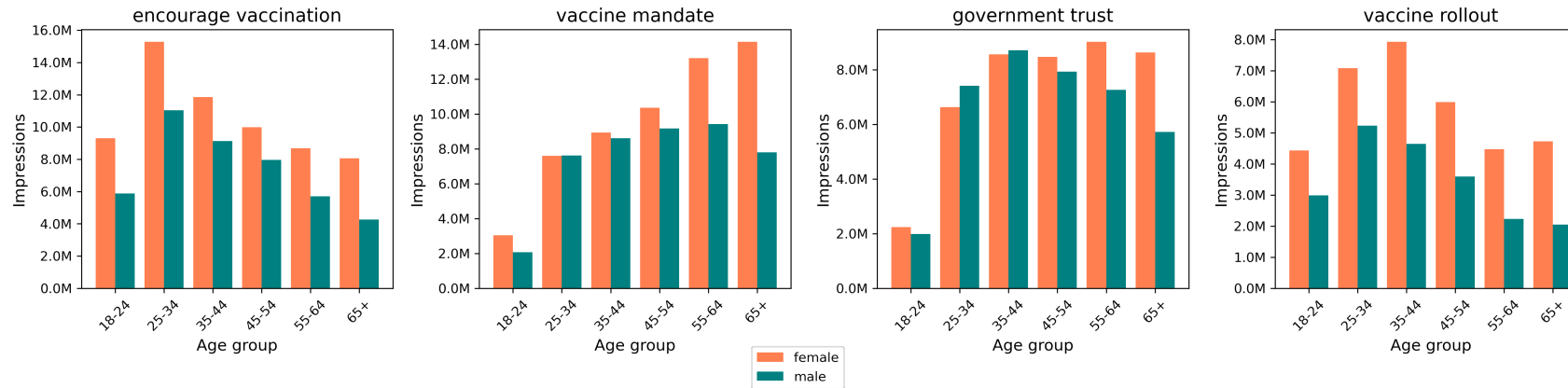
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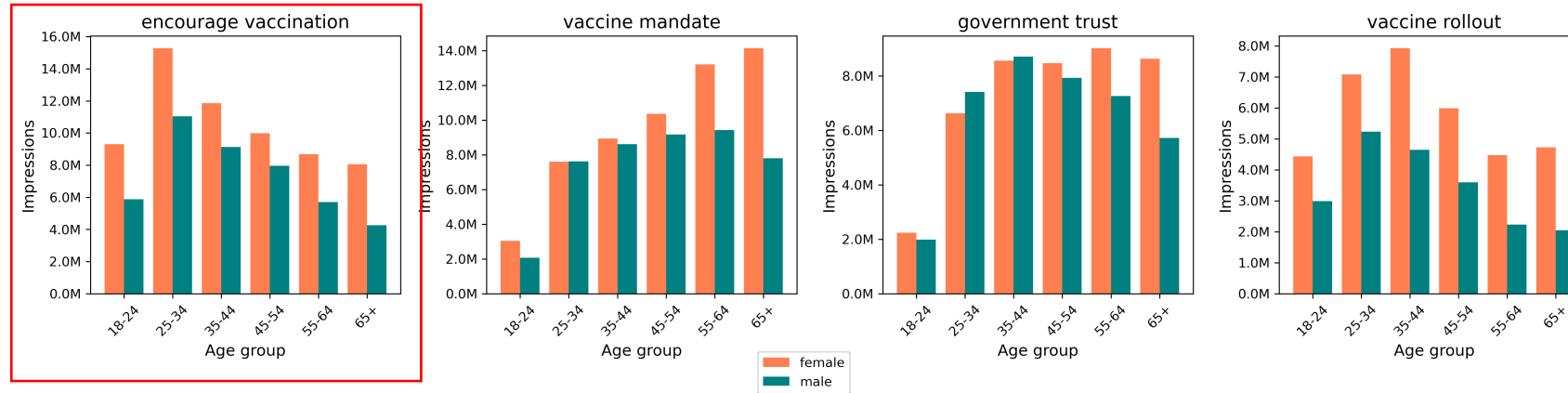
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RQ3: Which demographics and geographic are reached by the advertisers and their messages?

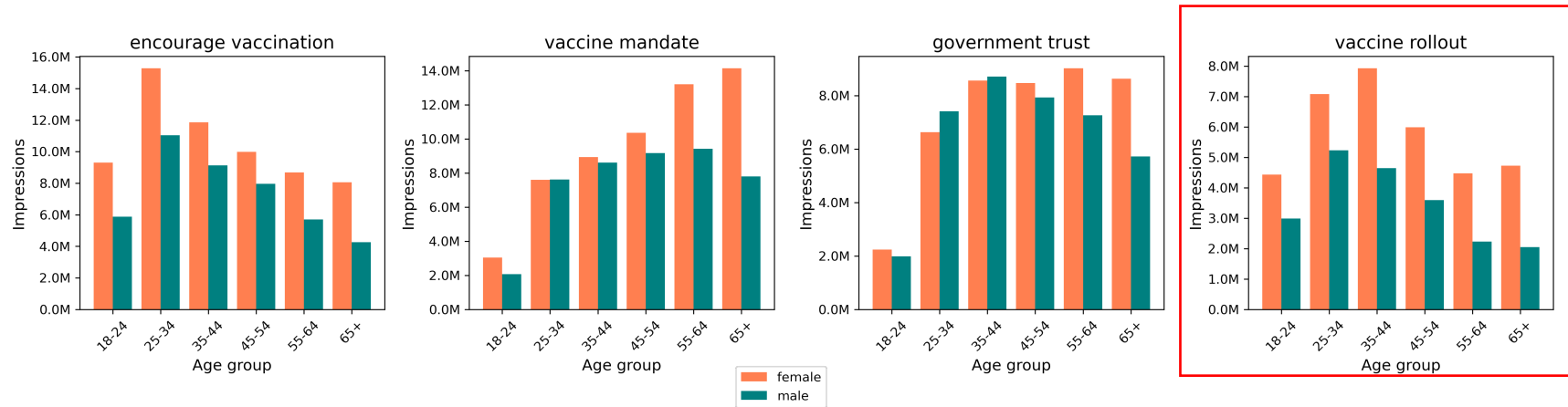


RQ3: Which demographics and geographic are reached by the advertisers and their messages?



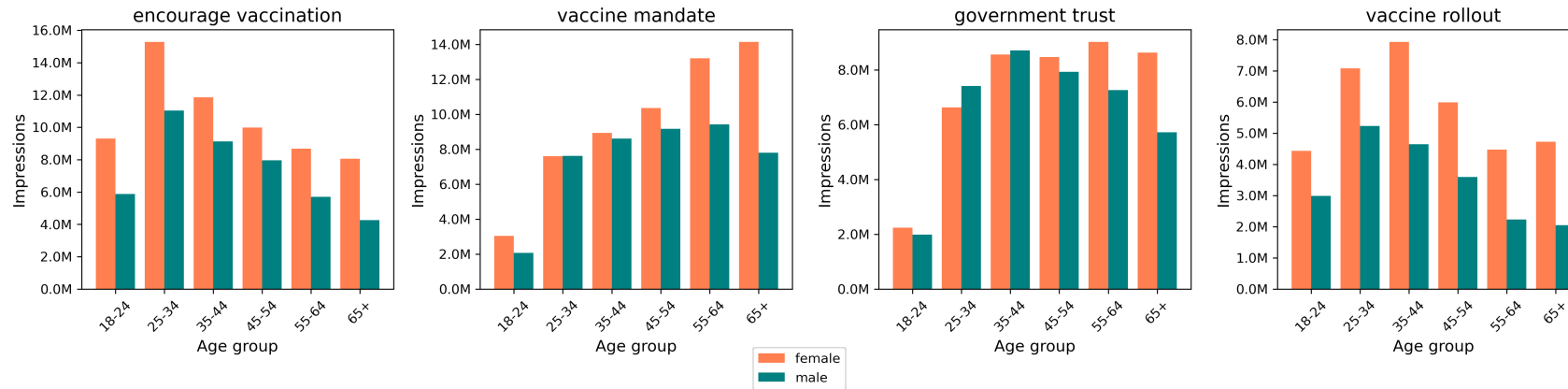
- More females than males from age group 25 – 34 view **encourage vaccination** ads.

RQ3: Which demographics and geographic are reached by the advertisers and their messages?



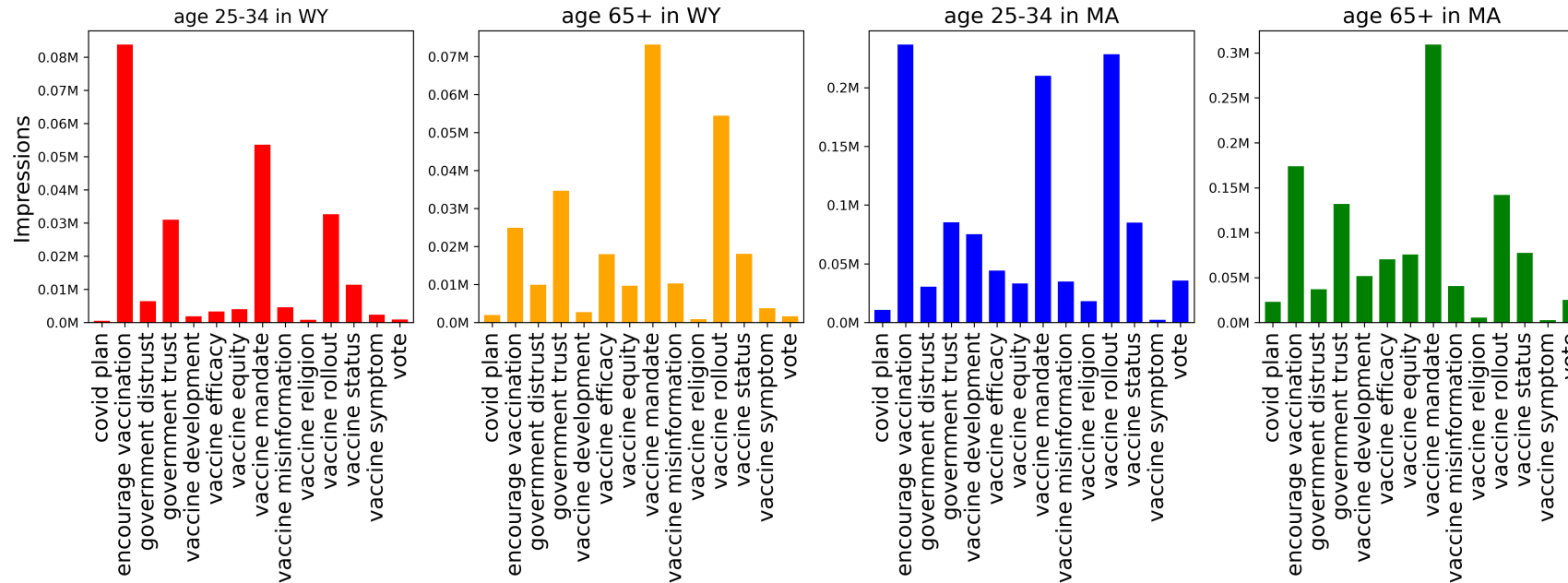
- More females than males from age group 25 – 34 view **encourage vaccination** ads.
- More females than the males from age range 35-44 view **vaccine rollout** ads.

RQ3: Which demographics and geographic are reached by the advertisers and their messages?

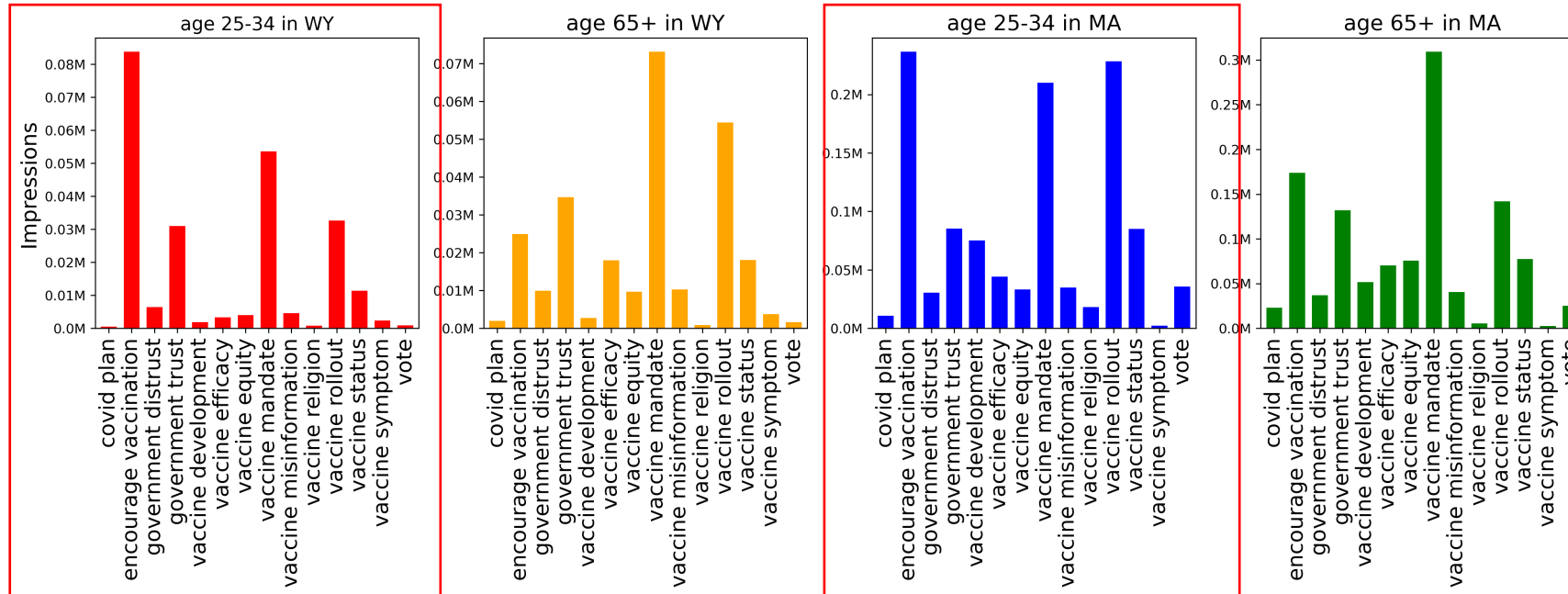


- More females than males from age group 25 – 34 view **encourage vaccination** ads.
- More females than the males from age range 35-44 view **vaccine rollout** ads.
- Highly statistically significant (**p-value < 0.01**).

RQ3: Which demographics and geographic are reached by the advertisers and their messages?

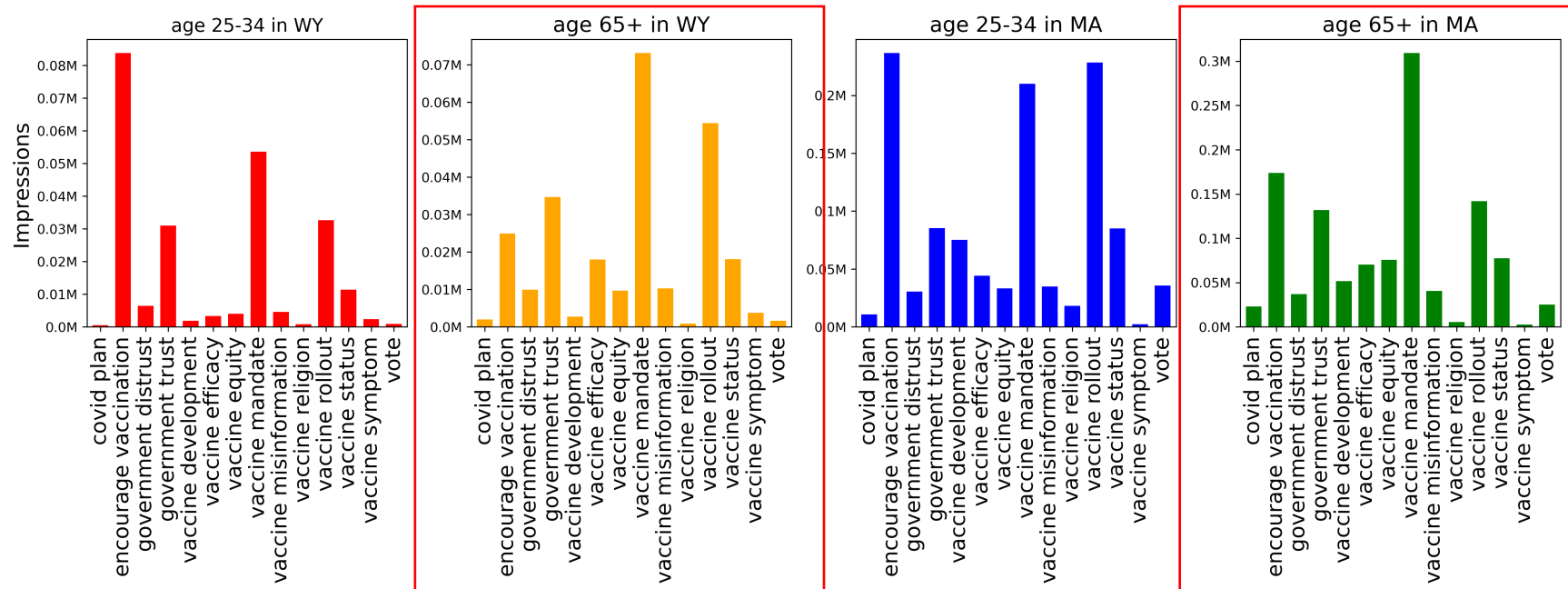


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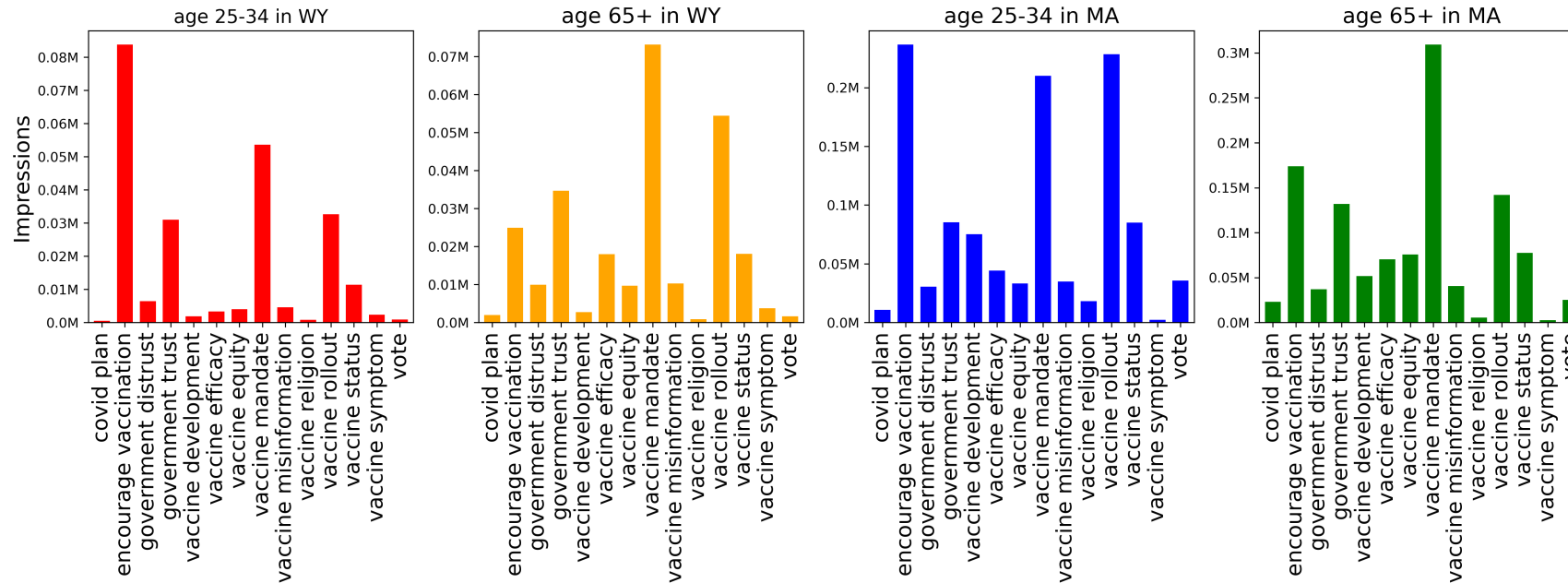
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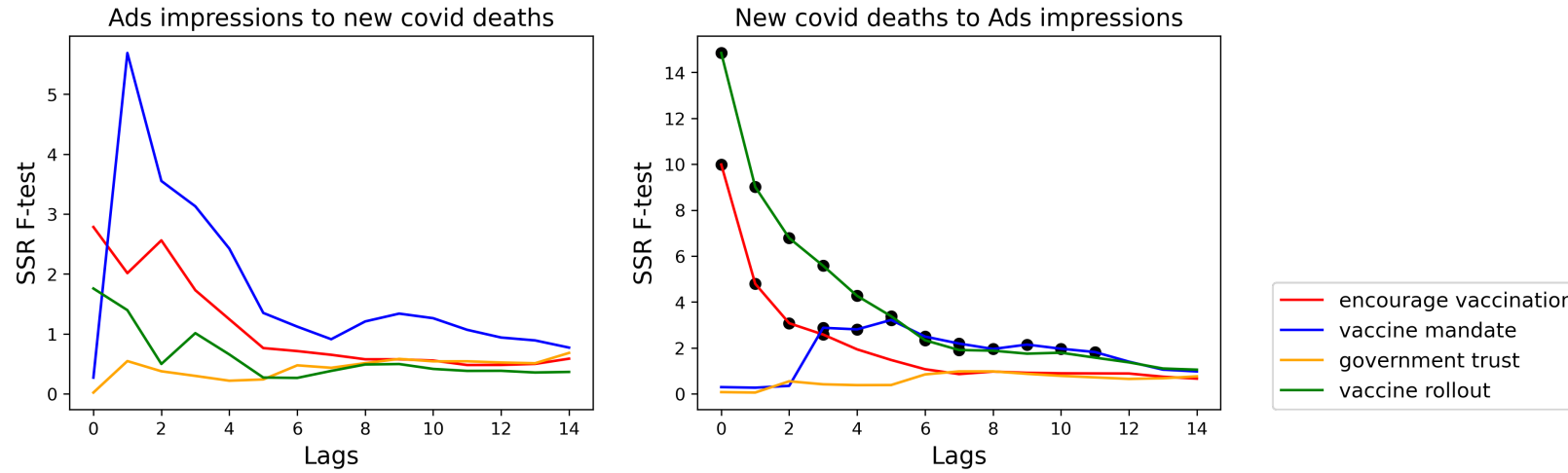
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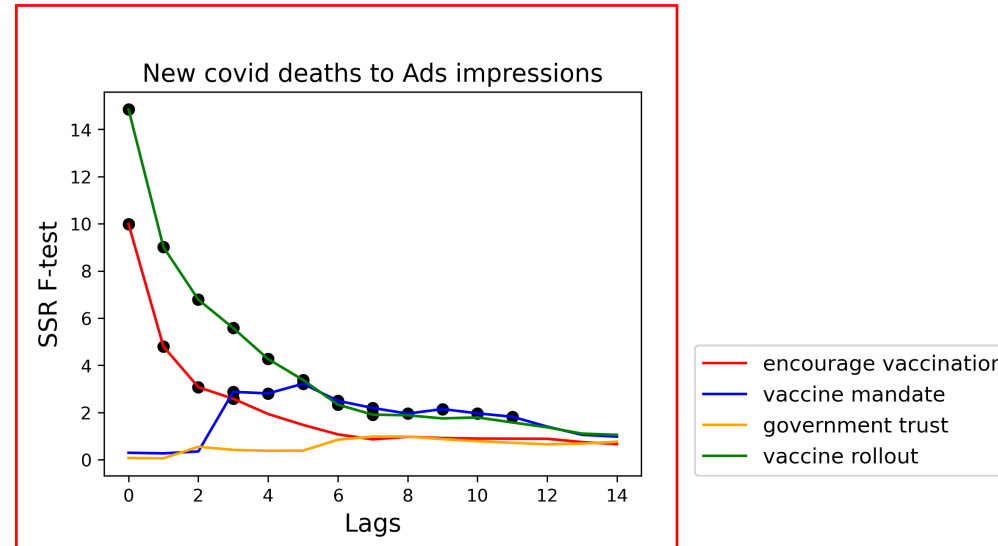
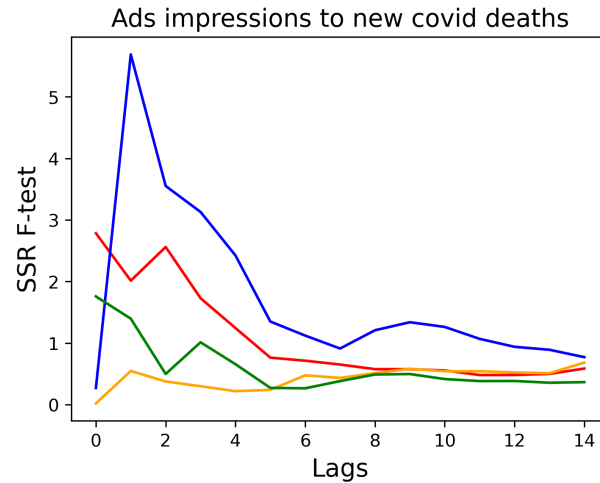


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RQ4: Do ads follow current covid status?



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- Significant F-test for the hypothesis of **number of new COVID death per day *Granger causes* ad impressions** on specific theme (**p-value < 0.05**).

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Key Takeaways

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- Investigate the COVID vaccine ads on Facebook from four angles: **narratives** (thematic and moral foundation analysis), **entity types** (who is funding the ad), **reach** (who saw the ads), and **whether the ads reflect current COVID situations**.
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- As we make our dataset available to the community, we hope the **advertising domain will become a crucial part of public discourse on public health**.

THANK YOU 😊

Slide: https://tunazislam.github.io/files/IEEEBigData2022_CovidFBad.pdf

Questions?

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Purdue University, West Lafayette, IN.

Email: islam32@purdue.edu

 <https://tunazislam.github.io/>

 [@Tunaz_Islam](https://twitter.com/Tunaz_Islam)

