FNDPro: Evaluating the Importance of Propagations during Fake News Spread

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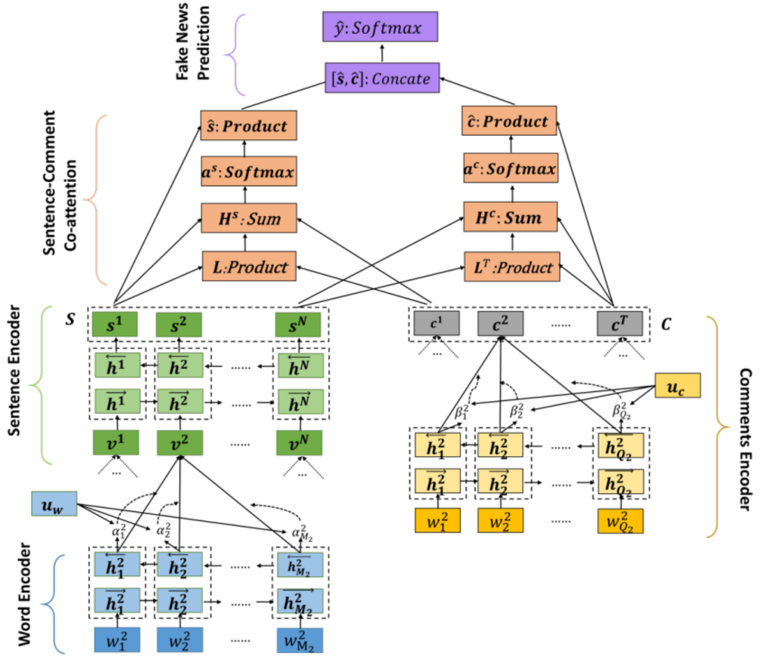
Background

- The rise of social media has led to an unprecedented spread of misinformation and disinformation.

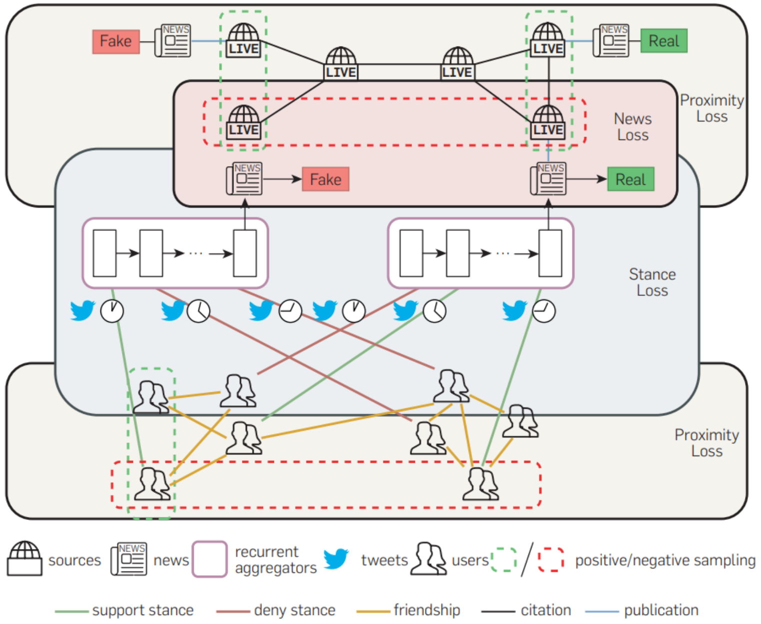
- Fake news can disrupt social order and has harmful societal effects.

Previous Works

- The majority of the existing approaches are text-based and graph-based.



Text-based model, cite from dEFEND[1]



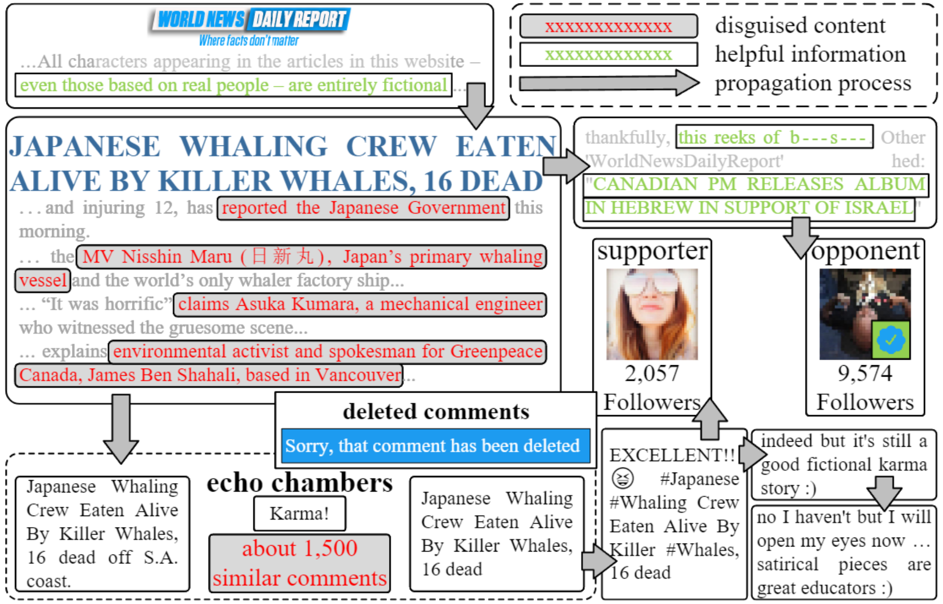
Graph-based model, cite from FANG[2]

[1] Shu, Kai, et al. "defend: Explainable fake news detection." SIGKDD. 2019.
[2] Nguyen, Van-Hoang, et al. "Fang: Leveraging social context for fake news detection using graph representation." CIKM. 2020.

Challenges

- Disguised fake news content makes it hard for content-based models to identify fake news.

- Echo chambers created by repeated fake news and manipulation of comments can confuse traditional graph-based models.

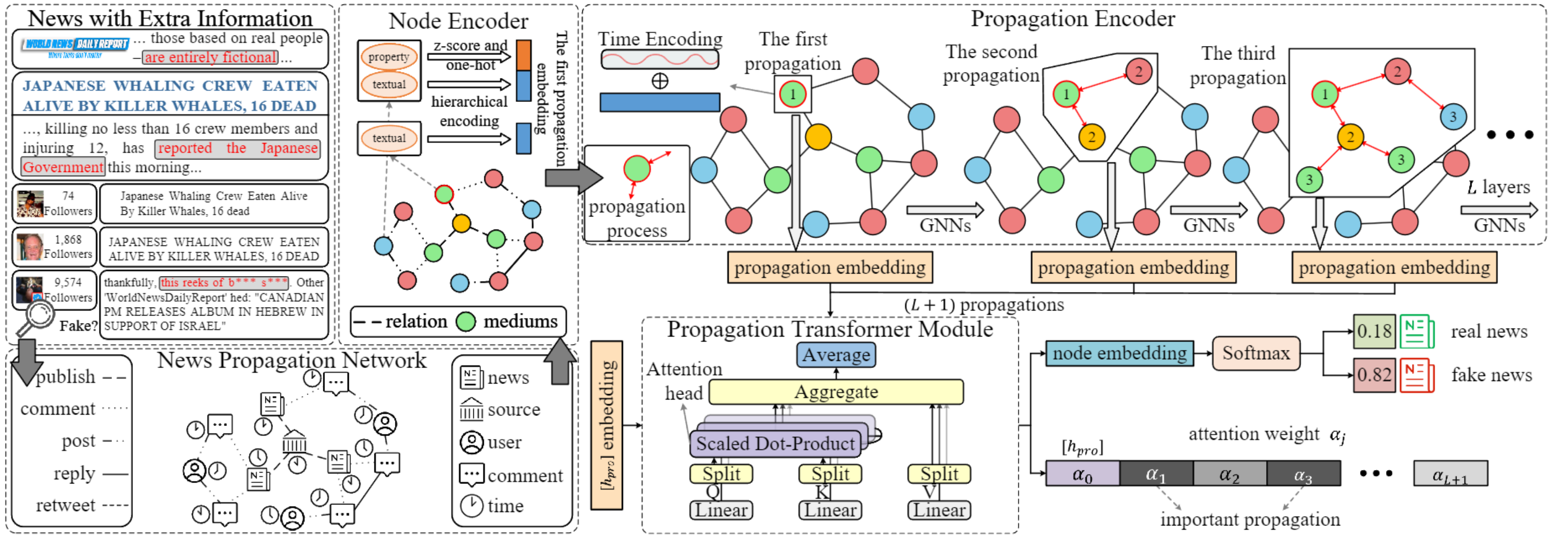


A model that can *dynamically evaluate the contribution of each propagation* and identify critical ones during the news spread.

Our Approach

- Overview
  - FNDPro models the news propagation process as a heterogeneous dynamic graph.
  - It treats news as the first propagation and ℓ-hop neighbors as the $(\ell+1)$-th propagation.

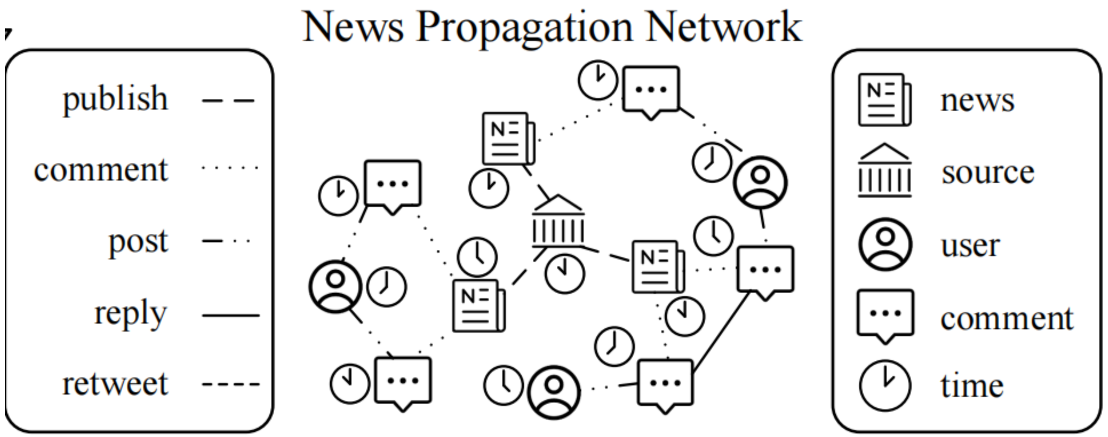
Our Approach



- **Multi-modality encoder**: Encodes each media.
- **Propagation encoder**: Encodes each propagation.
- **Propagation transformer module**: Interacts with propagation embeddings to obtain the importance score of each propagation.

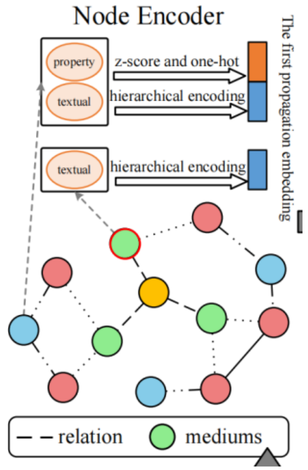
Technical Approach

- Graph Construction
  - News, sources, users, comments, and different edges among the media form the heterogeneous dynamic graph.



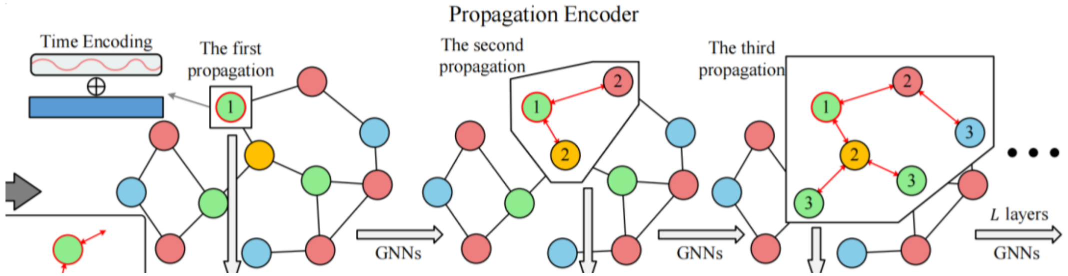
Technical Approach

- Propagation Embedding
  - Multi-modality encoder extracts and fuses node information.
  - Time encoding and graph neural networks extract temporal and spatial information.



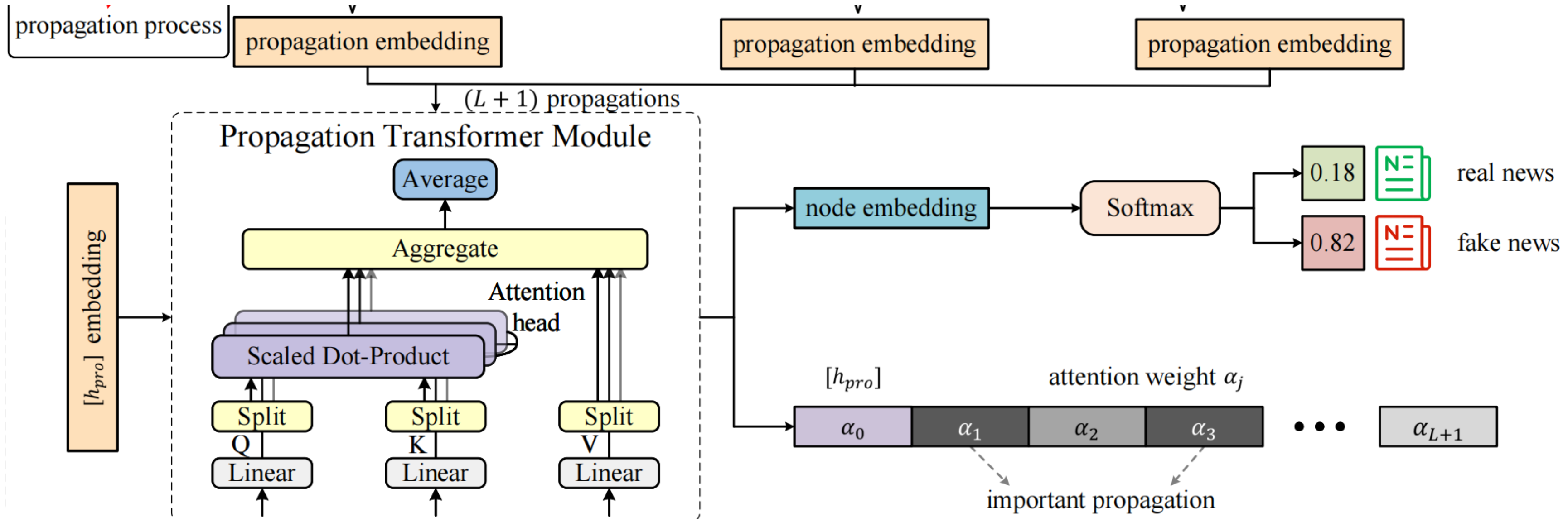
$$r_v = \overline{r}_v + \underset{(u,v)\in\mathcal{E}}{\text{mean}}\left(\text{enc}_{\psi(u,v)}(\mathcal{T}(u) - \mathcal{T}(v))\right)$$

$$h^{(\ell)}_{\mathcal{N}_{\mathcal{R}}(u)} = \text{Prop}(\{h_v^{(\ell-1)} : v \in \mathcal{N}_{\mathcal{R}}(u)\}), \mathcal{R} \in \mathcal{R}^e,$$
$$h_u^{\ell} = \text{Aggr}(\{h^{\ell}_{\mathcal{N}_{\mathcal{R}}(u)} : \mathcal{R} \in \mathcal{R}^e\}, h_u^{(\ell-1)}).$$



Technical Approach

- Propagation Transformer Module
  - Dynamically evaluates the contribution of different propagations.
  - Attention weights indicate the importance of each propagation.



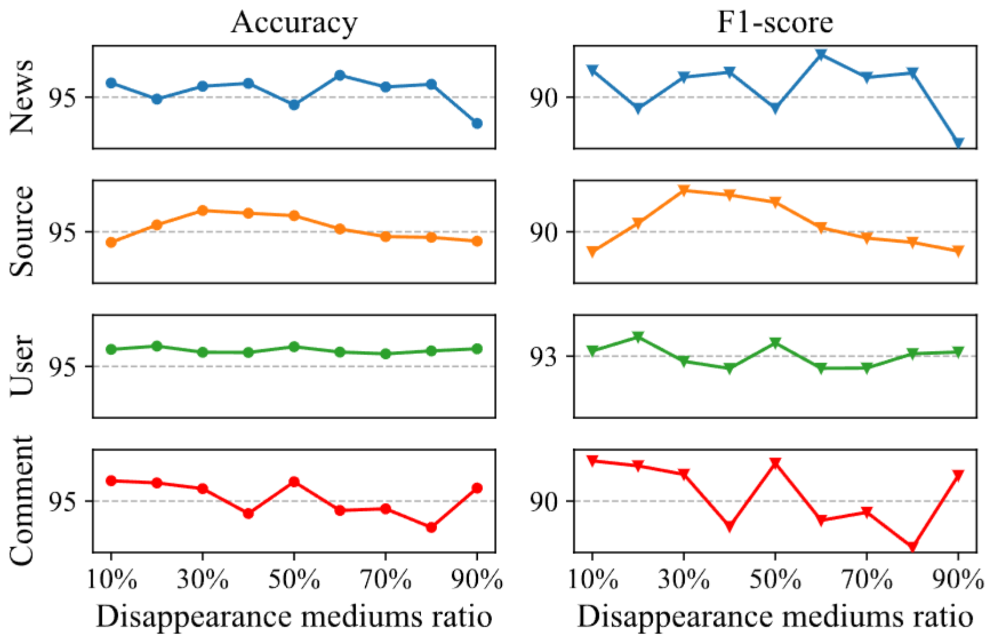
Main Results

Type	Models	Merged		Politifact		Gossipcop	
		Accuracy	F1-score	Accuracy	F1-score	Accuracy	F1-score
Content-based	dEFEND [30]	84.1 (±4.1)*	67.8 (±6.9)*	84.4 (±1.0)*	78.5 (±2.5)*	87.4 (±2.8)*	73.0 (±6.5)*
	RoBERTa [19]	85.5 (±0.2)*	67.6 (±1.1)*	88.8 (±0.3)*	86.4 (±0.3)*	86.3 (±0.3)*	69.7 (±1.0)*
	UPF† [34]	94.4 (±0.2)*	86.0 (±0.4)*	86.8 (±0.6)*	84.4 (±0.7)*	95.2 (±0.0)*	88.0 (±0.1)*
	NEP [29]	81.8 (±0.1)*	58.8 (±1.5)*	87.5 (±0.4)*	84.0 (±0.5)*	82.1 (±0.1)*	59.9 (±1.4)*
	CMTR [9]	91.8 (±0.7)*	82.1 (±3.0)*	83.4 (±1.9)*	77.3 (±3.3)*	93.3 (±0.6)*	86.2 (±0.5)*
	FinerFact† [14]	95.5 (±0.1)*	91.6 (±0.2)*	86.2 (±0.1)*	<u>88.1</u> (±0.2)*	95.9 (±0.1)*	93.1 (±0.2)*
Graph-based	HPN† [32]	87.3 (±0.2)*	82.4 (±0.3)*	78.1 (±0.7)*	81.2 (±0.6)*	87.1 (±0.1)*	81.4 (±0.2)*
	Bi-GCN [1]	90.4 (±0.5)*	90.0 (±0.7)*	77.1 (±1.4)*	74.7 (±2.2)*	90.8 (±0.3)*	90.4 (±0.3)*
	FANG [25]	81.3 (±0.2)*	53.7 (±1.5)*	80.3 (±1.5)*	75.4 (±3.1)*	82.7 (±0.1)*	51.2 (±1.2)*
	UPFN† [5]	93.6 (±1.0)*	<u>93.7</u> (±0.8)***	<u>89.5</u> (±2.1)*	87.2 (±2.6)*	95.8 (±0.8)*	**95.8** (±0.8)***
	Cross-D† [35]	89.8 (±0.3)*	86.1 (±0.4)*	88.3 (±0.9)*	87.8 (±0.9)*	90.3 (±0.3)*	87.1 (±0.5)*
	InfOp [22]	<u>95.8</u> (±0.1)*	91.5 (±0.2)*	85.8 (±1.3)*	81.7 (±1.6)*	<u>96.1</u> (±0.1)*	92.2 (±0.1)*
	GET [41]	91.3 (±0.4)*	81.5 (±1.7)*	88.5 (±0.2)*	83.8 (±0.7)*	91.1 (±1.4)*	82.9 (±0.5)*
	FNDPro	**97.0** (±0.2)	**93.9** (±0.3)	**92.9** (±0.5)	**90.8** (±0.6)	**97.4** (±0.1)	<u>94.7</u> (±0.2)

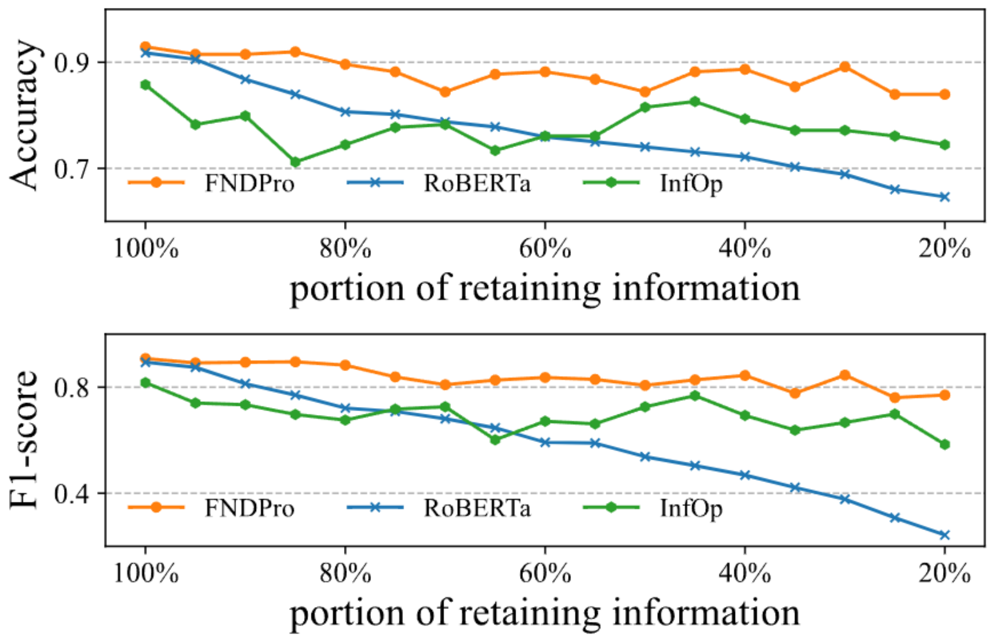
Ablation Study

Module	Accuracy	Difference	F1-score	Difference
First	84.9 (±0.3)*	-12.1	64.9 (±1.3)*	-29.0
Last	96.2 (±0.5)**	-0.9	92.3 (±0.7)**	-1.6
Mean	85.7 (±1.0)*	-11.3	76.0 (±1.2)*	-17.9
Max	95.9 (±0.4)*	-1.1	91.8 (±0.7)*	-2.1
MLP	96.0 (±0.6)**	-1.0	92.0 (±1.1)**	-1.9
GRU	94.3 (±0.9)*	-2.7	89.2 (±1.4)*	-4.7
FNDPro	**97.0** (±0.2)	0	**93.9** (±0.3)	0

Analysis

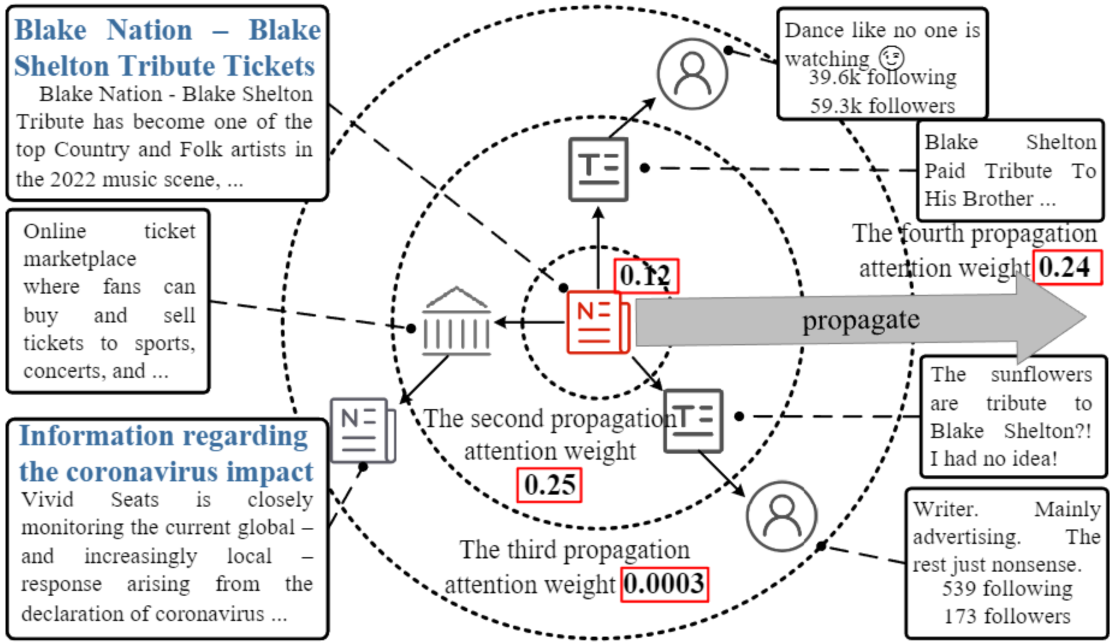


Accuracy
F1-score
News
Source
User
Comment
95
90
93
10%
30%
50%
70%
90%
Disappearance mediums ratio
Disappearance mediums ratio



Accuracy
0.9
0.7
FNDPro
RoBERTa
InfOp
100%
80%
60%
40%
20%
portion of retaining information
F1-score
0.8
0.4
FNDPro
RoBERTa
InfOp
100%
80%
60%
40%
20%
portion of retaining information

Case Study



Blake Nation – Blake Shelton Tribute Tickets
Blake Nation - Blake Shelton Tribute has become one of the top Country and Folk artists in the 2022 music scene, ...
Online ticket marketplace where fans can buy and sell tickets to sports, concerts, and ...
Information regarding the coronavirus impact
Vivid Seats is closely monitoring the current global – and increasingly local – response arising from the declaration of coronavirus ...
Dance like no one is watching
39.6k following
59.3k followers
Blake Shelton Paid Tribute To His Brother ...
The fourth propagation attention weight 0.24
0.12
propagate
The sunflowers are tribute to Blake Shelton?! I had no idea!
The second propagation attention weight 0.25
Writer. Mainly advertising. The rest just nonsense.
539 following
173 followers
The third propagation attention weight 0.0003

Conclusion

- FNDPro dynamically evaluates the importance of propagations during fake news spread.
- It effectively addresses challenges posed by disguised content and echo chambers.

- Thank the conference organizers, collaborators, and funding agencies.

Q&A

- Contact Details

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- GitHub Repository

https://github.com/whr000001/FNDPro