



Mining User-aware Multi-Relations for Fake News Detection in Large Scale Online Social Networks

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code: <https://github.com/xingsumq/Us-DeFake>

Reported by Xiaoke Li



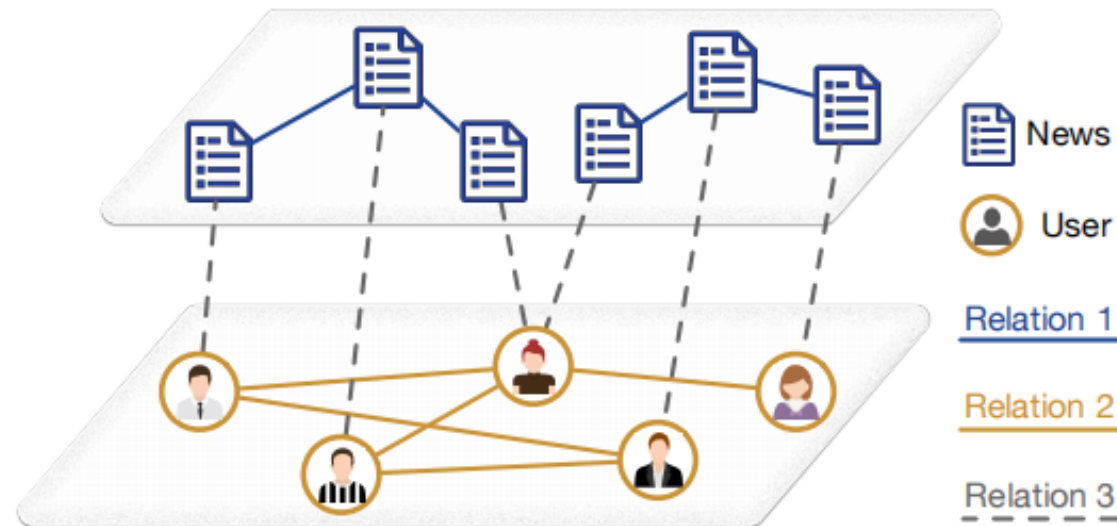
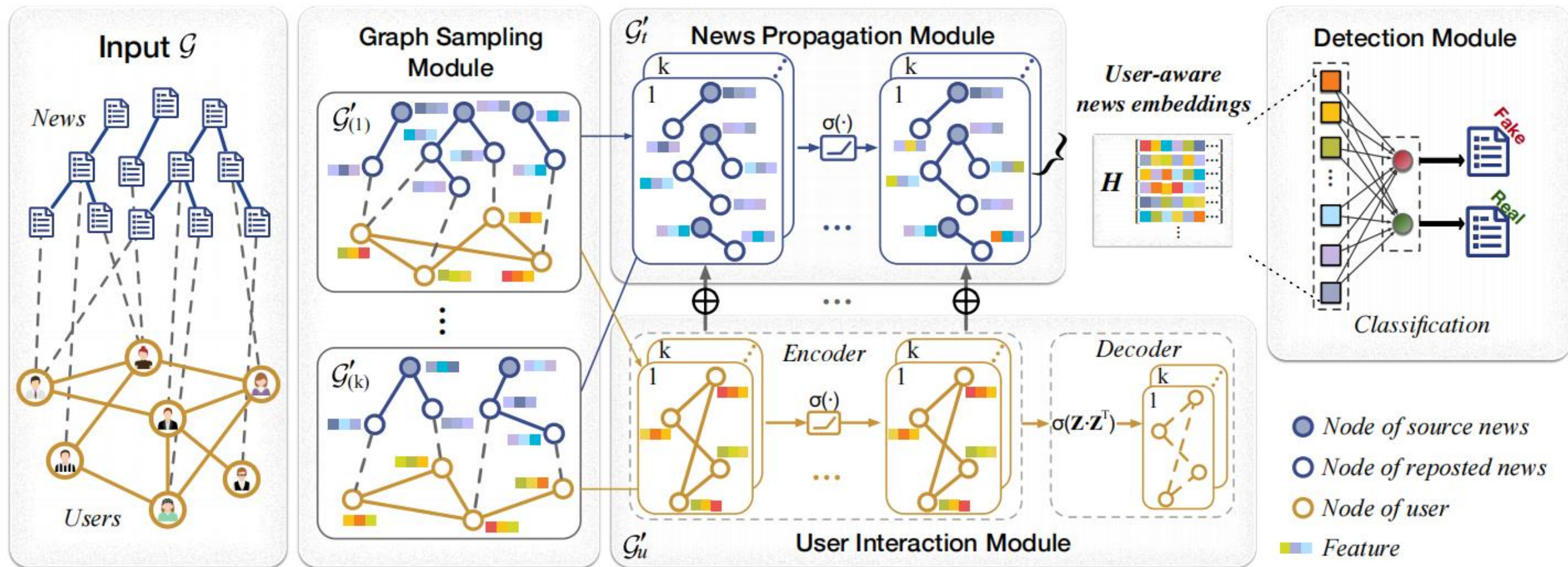
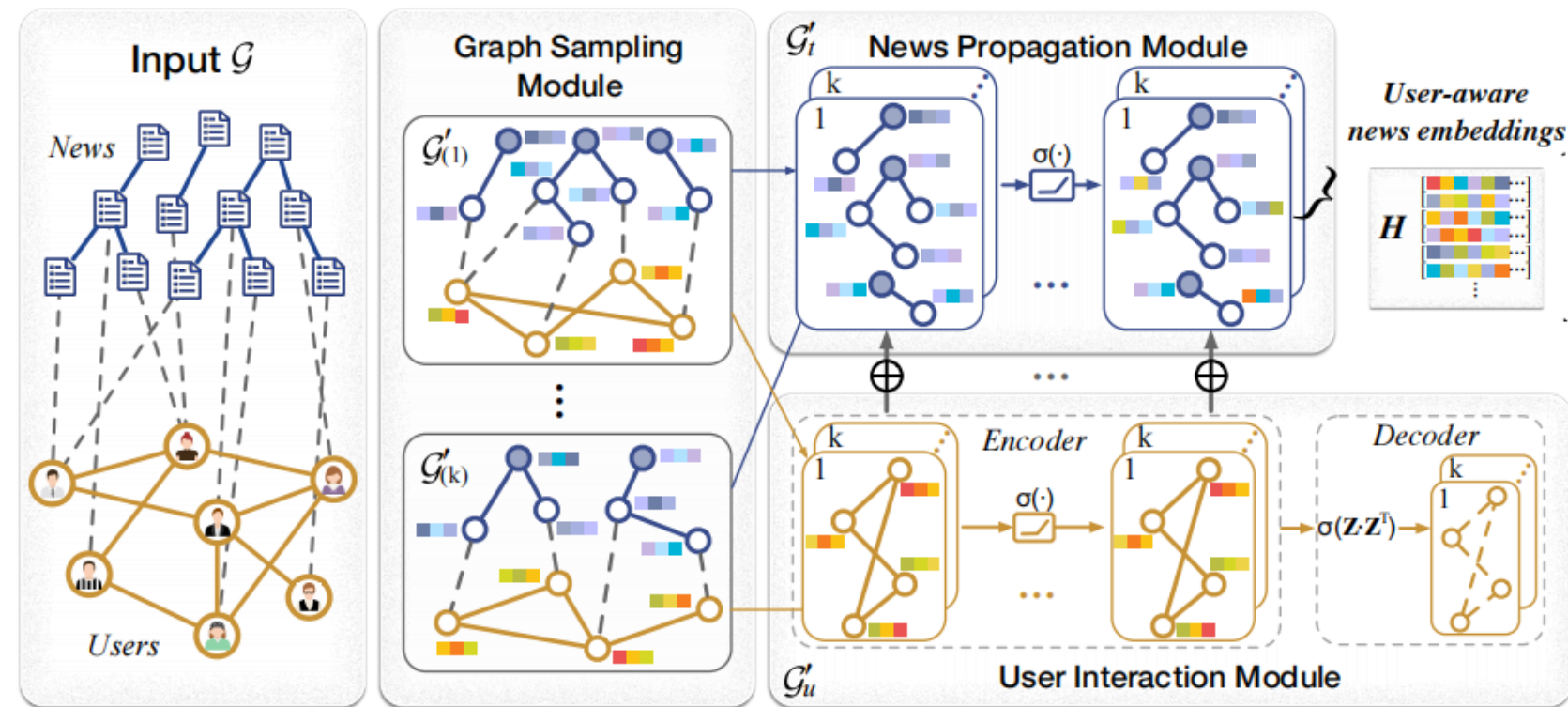


Figure 1: An illustrative example of multiple relations in an online social network for fake news detection. *Relation 1* represents the propagation relation of news, *Relation 2* represents the interaction relation of users, and *Relation 3* represents the posting relation between users and news.





$$\begin{aligned} \mathbf{h}_i^{(\ell)} &= \sum_{v \in \mathcal{V}'_t} \frac{\tilde{A}_{i,v}}{\alpha_{v,i}} \left(\mathbf{W}^{(\ell-1)} \right)^T \mathbf{h}_v^{(\ell-1)} \mathbb{1}_{v|i} \\ &= \sum_{v \in \mathcal{V}'_t} \frac{\tilde{A}_{i,v}}{\alpha_{v,i}} \tilde{\mathbf{h}}_v^{(\ell-1)} \mathbb{1}_{v|i}, \end{aligned} \quad (1)$$

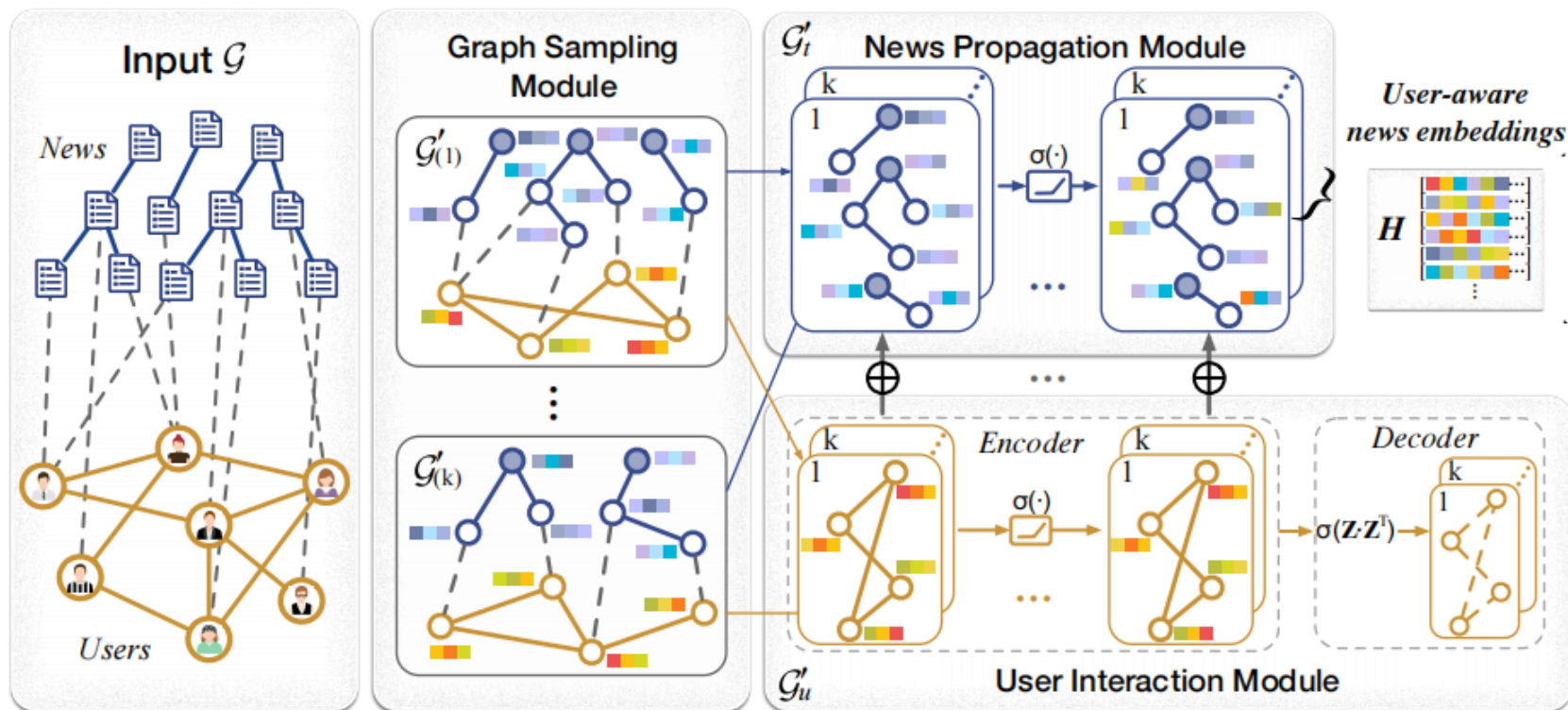
$$\mathbf{h}_i^{(0)} = \mathbf{x}_i, \text{ and } \tilde{\mathbf{h}}_v^{(\ell-1)} = \left(\mathbf{W}^{(\ell-1)} \right)^T \mathbf{h}_v^{(\ell-1)}.$$

$$\alpha_{v,i} = \frac{p_{v,i}}{p_i}$$

$$\mathcal{L}_i^t = \sum_{i \in \mathcal{G}'_t} \frac{\mathcal{L}_{CE}}{\lambda_i}, \quad (2)$$

$$\lambda_i = |\mathcal{V}_t| \cdot p_i$$

$$\mathcal{L}_i^t = \sum_{i \in \mathcal{G}'_t} \frac{-y \log \hat{y} - (1 - y) \log(1 - \hat{y})}{\lambda_i}, \quad (3)$$



$$\hat{\mathbf{A}} = \text{sigmoid}(\mathbf{Z}\mathbf{Z}^T), \quad (4)$$

$$\mathcal{L}_j^u = \sum_{j \in \mathcal{G}'_u} \frac{\| \mathbf{a}_j - \hat{\mathbf{a}}_j \|^2}{\lambda_j}, \quad (5)$$

$$\mathbf{h}_i = \mathbf{h}_i \oplus \mathbf{z}_j, \quad (6)$$

$$\hat{y} = \text{Softmax}(\mathbf{W}_f \mathbf{h}_i + \mathbf{b}_f), \quad (7)$$

$$\mathcal{L} = \mathcal{L}^t + \mathcal{L}^u. \quad (8)$$

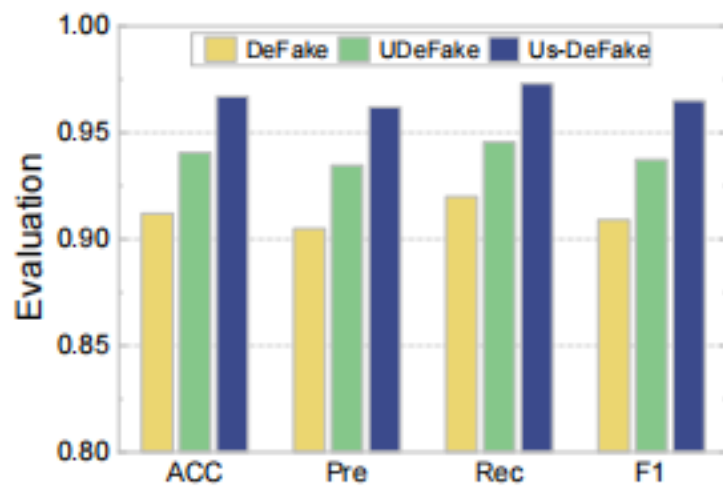


Table 1: The Dataset Statistics.

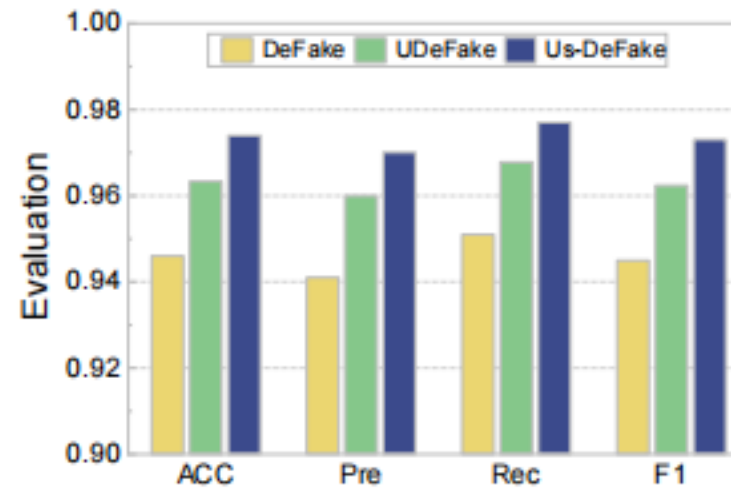
Statistics	Politifact	Gossipcop
Source News	395 (R: 180 / F: 215)	4047 (R: 2444 / F: 1603)
Tweets and Retweets	366,374	378,289
Users	195,389	128,912
Relations	T-T: 370,025 U-T: 328,608 U-U: 16,193,727	T-T: 386,649 U-T: 328,020 U-U: 2,724,896

Table 2: Overall performance for fake news detection of different methods.

Methods	Politifact				Gossipcop			
	Acc	Pre	Rec	F1	Acc	Pre	Rec	F1
TextCNN	0.509 ± 0.066	0.518 ± 0.062	0.516 ± 0.062	0.506 ± 0.065	0.442 ± 0.015	0.489 ± 0.012	0.491 ± 0.009	0.432 ± 0.014
HAN	0.491 ± 0.026	0.508 ± 0.03	0.507 ± 0.027	0.484 ± 0.027	0.472 ± 0.027	0.513 ± 0.017	0.512 ± 0.015	0.466 ± 0.03
BERT	0.772 ± 0.042	0.823 ± 0.028	0.783 ± 0.035	0.801 ± 0.026	0.768 ± 0.024	0.767 ± 0.022	0.756 ± 0.021	0.758 ± 0.022
ALBERT	0.585 ± 0.029	0.603 ± 0.166	0.551 ± 0.035	0.502 ± 0.069	0.609 ± 0.024	0.619 ± 0.166	0.539 ± 0.029	0.505 ± 0.075
TextGCN	0.739 ± 0.026	0.742 ± 0.017	0.738 ± 0.025	0.733 ± 0.022	0.75 ± 0.024	0.649 ± 0.122	0.623 ± 0.106	0.627 ± 0.107
GraphSage	0.914 ± 0.025	0.906 ± 0.025	0.927 ± 0.02	0.911 ± 0.025	0.941 ± 0.017	0.934 ± 0.018	0.95 ± 0.014	0.939 ± 0.017
UPFD	0.829 ± 0.006	0.881 ± 0.007	0.767 ± 0.014	0.827 ± 0.006	0.95 ± 0.023	0.947 ± 0.031	0.954 ± 0.016	0.95 ± 0.023
Us-DeFake-A	0.979 ± 0.011	0.975 ± 0.013	0.981 ± 0.011	0.978 ± 0.012	<u>0.954 ± 0.011</u>	<u>0.951 ± 0.016</u>	<u>0.964 ± 0.009</u>	<u>0.955 ± 0.014</u>
Us-DeFake-C	<u>0.967 ± 0.03</u>	<u>0.962 ± 0.033</u>	<u>0.973 ± 0.024</u>	<u>0.965 ± 0.029</u>	0.974 ± 0.013	0.97 ± 0.015	0.977 ± 0.012	0.973 ± 0.014



(a) Politifact



(b) Gossipcop

Figure 3: Ablation study.

Table 3: Part of user attributes of four randomly-selected users for a case study.

User	Friends	Followers	Status	Listed	Verified
User1	870	51,693,630	463,743	213,104	✓
User2	6775	7579	138197	608	×
User3	2388	210	71540	12	×
User4	94	0	327	0	×

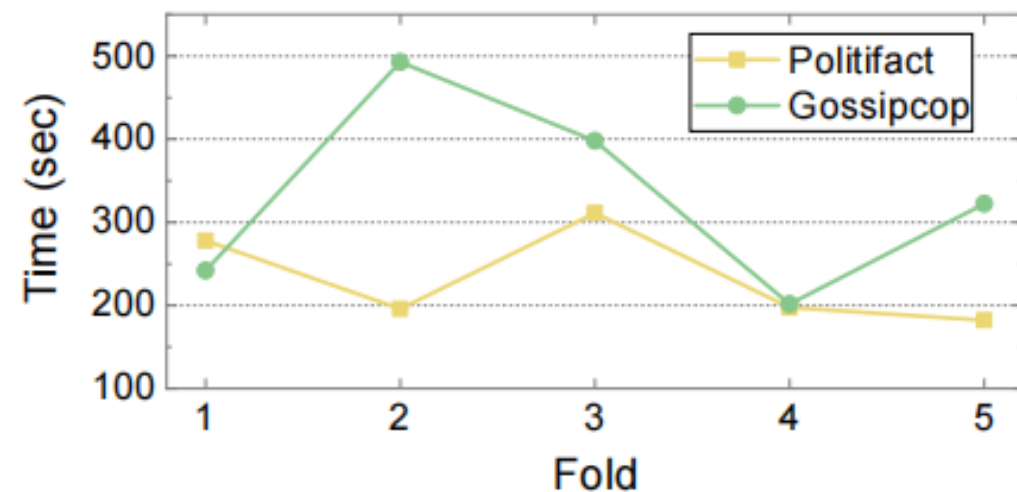
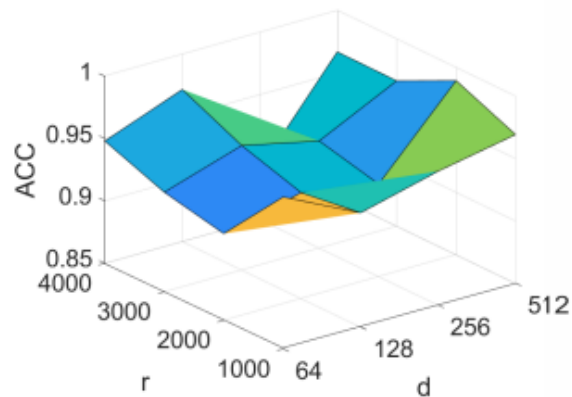
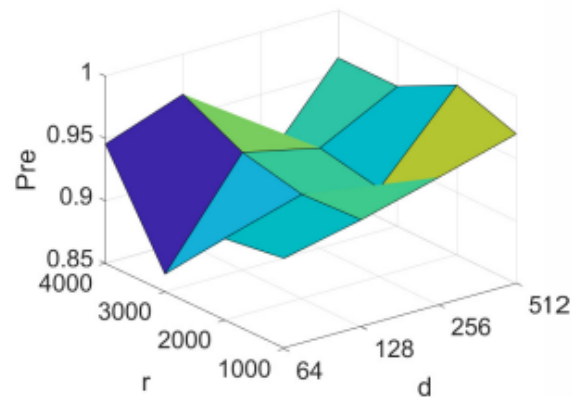


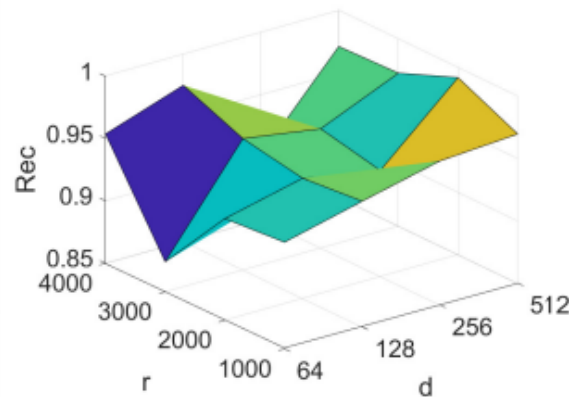
Figure 6: Runtime of Us-DeFake.



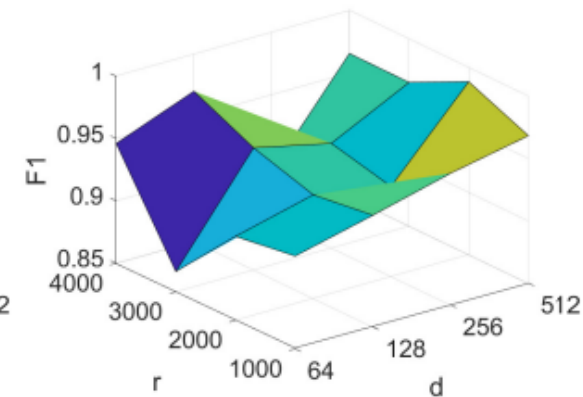
(a)



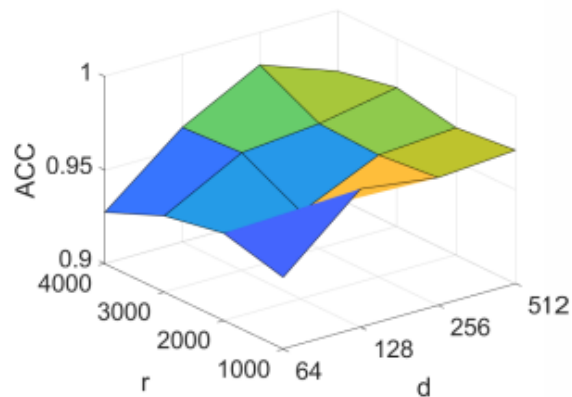
(b)



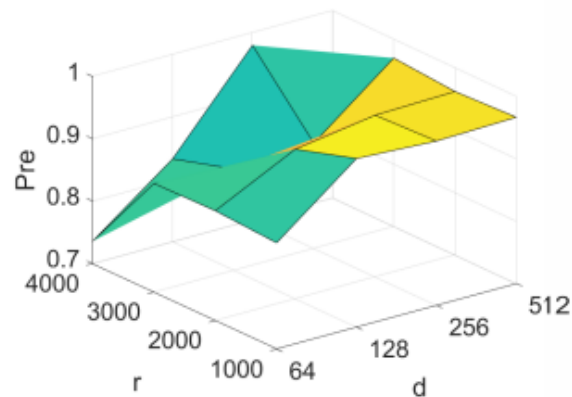
(c)



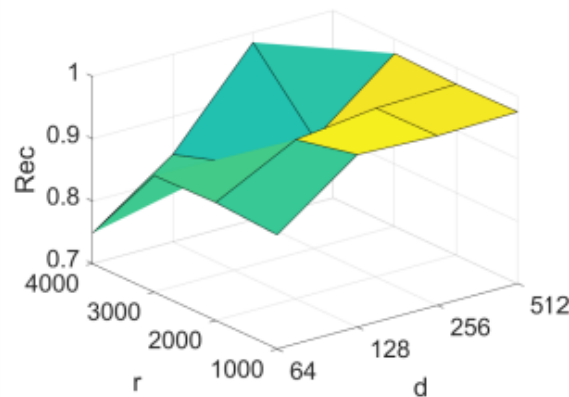
(d)



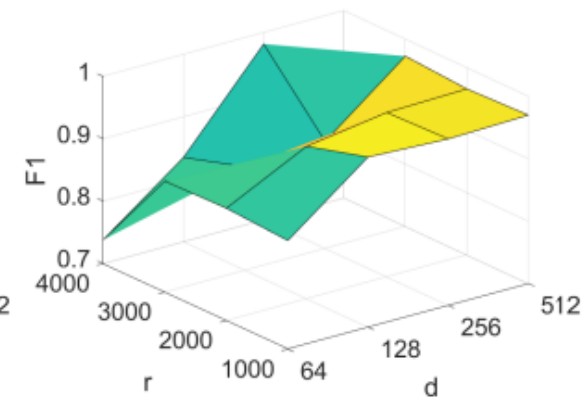
(e)



(f)



(g)



(h)

Figure 5: Parameter analysis of the proposed Us-DeFake. (a)–(d) on Politifact dataset, (e)–(h) on Gossipcop dataset.



Thanks