Medley: Predicting Social Trust in Time-Varying Online Social Networks

Wanyu Lin, Baochun Li
Hong Kong Polytechnic University, University of Toronto

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

Department of Computing
電子計算學系

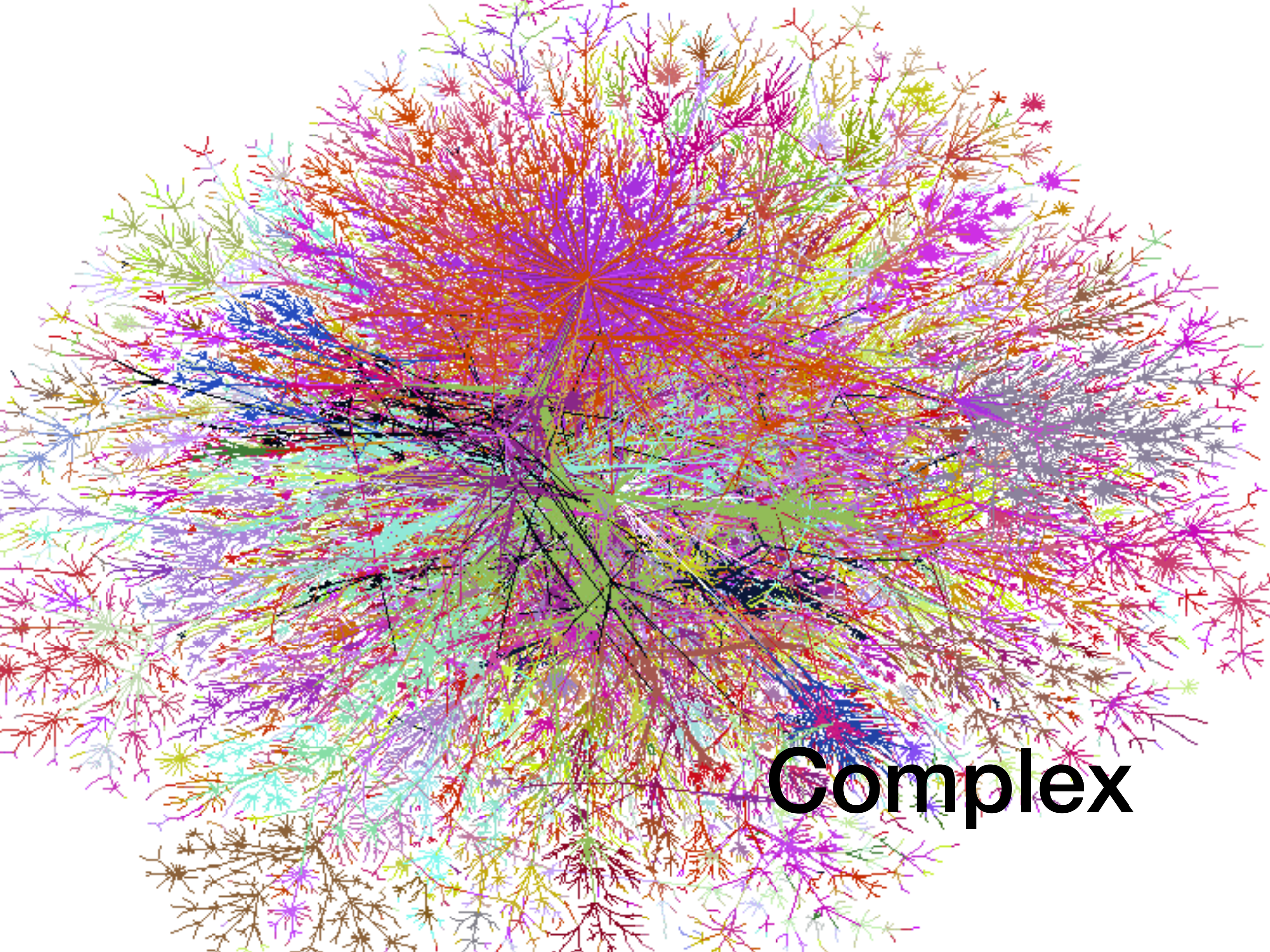
*i*Qua
The *interflow* of *Quality*.

Almost 4.66 billion people were active internet users as of 2021.

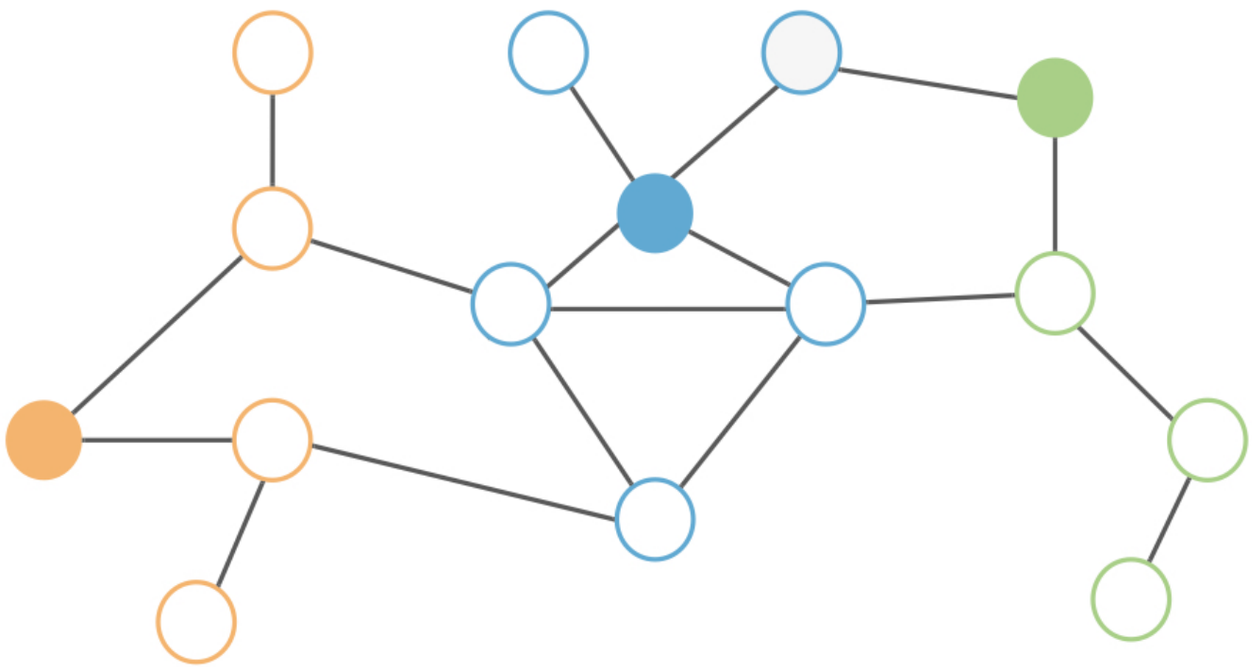
— *Statista*

Social trust is the basis of online social networks.

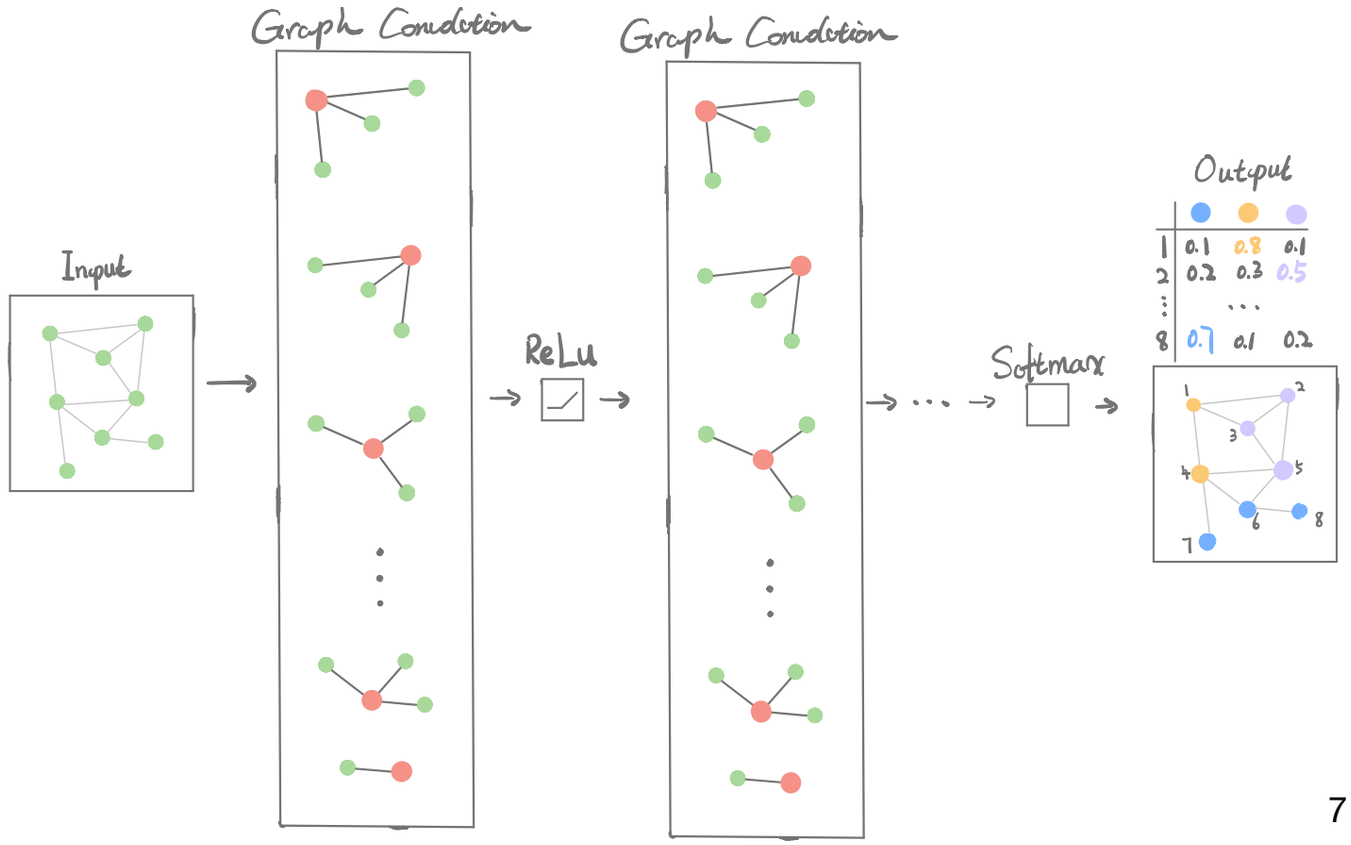
Estimates of **social trust** help indicate to what extent a user could expect someone else to perform given actions, therefore has many applications, such as trust-based recommendations.


Complex

Graph neural networks — an efficient variant of convolutional neural networks on graphs—have been proved to be very effective for social trust evaluation.



Graph neural networks (GNNs) — focus on a particular snapshot of the social interaction graph.



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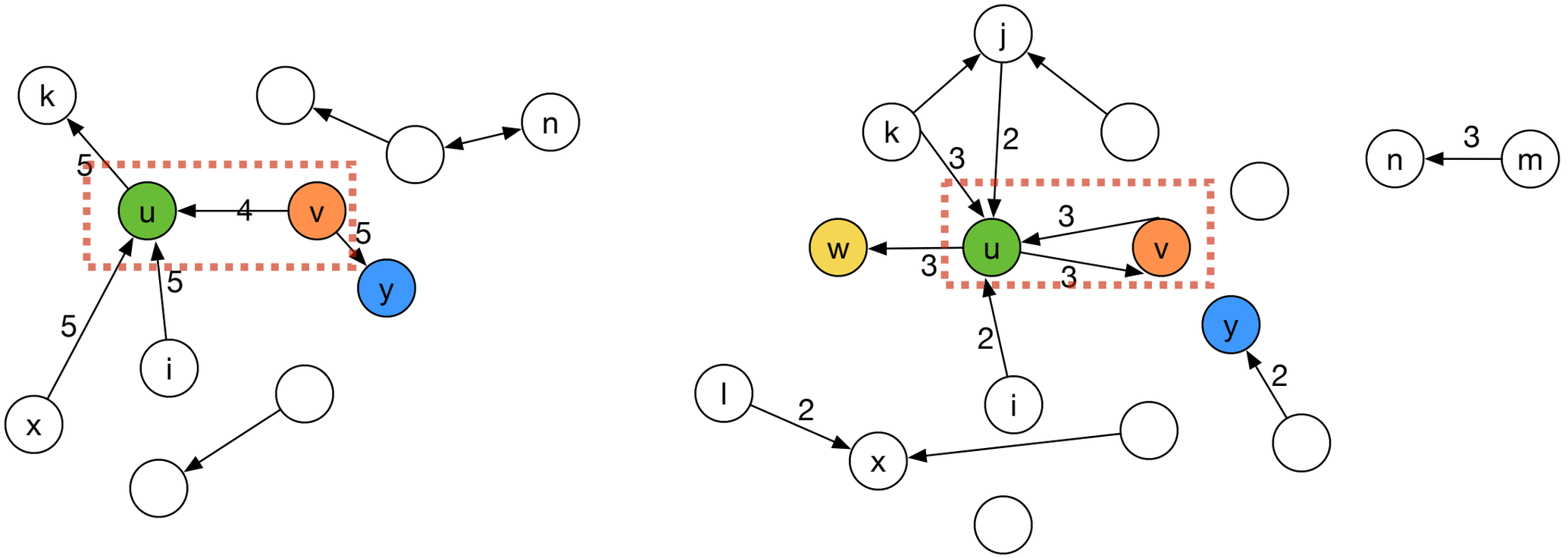
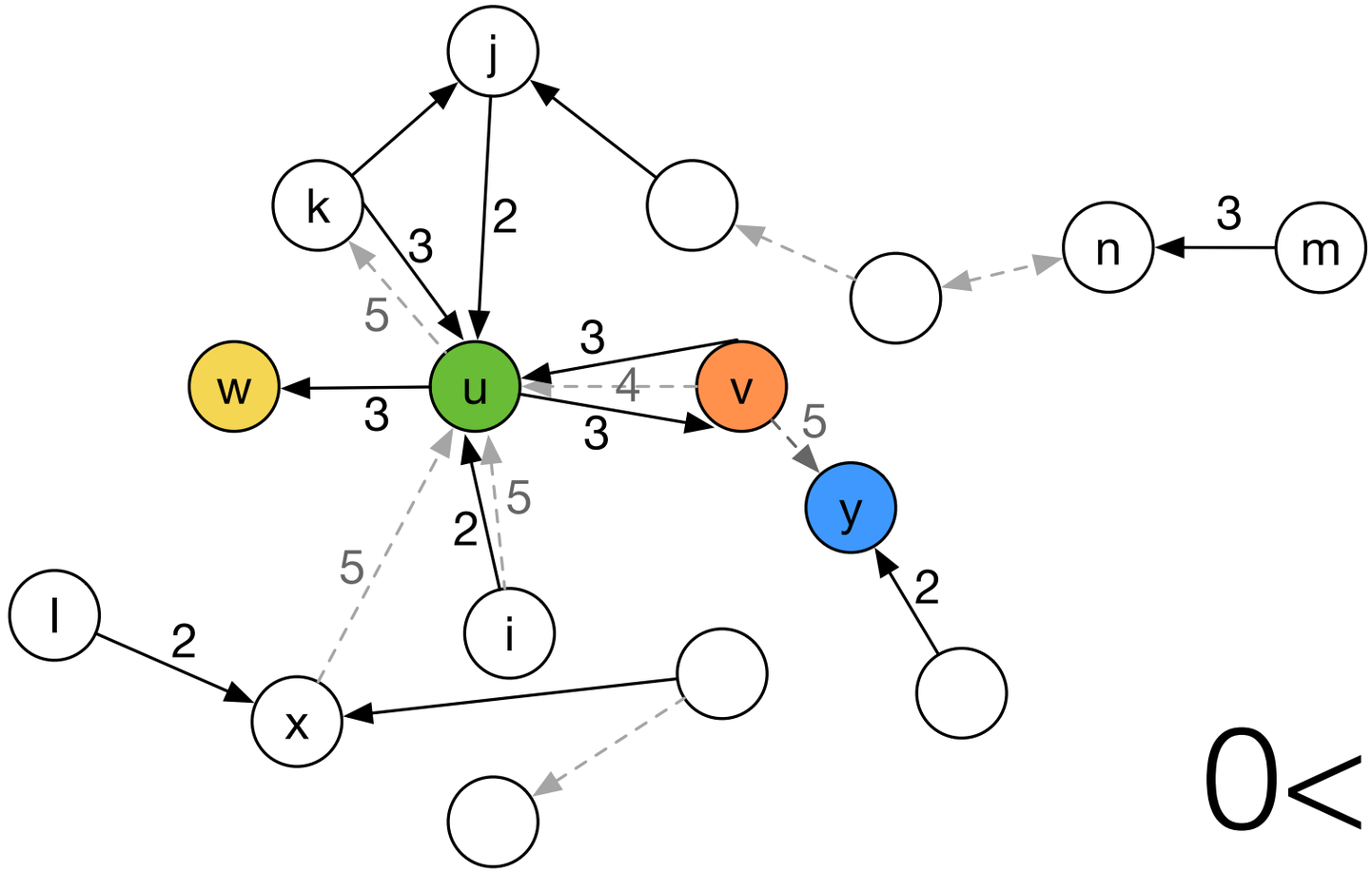


Ignoring time-varying dynamics in social networks can severely reduce the efficacy and optimality of existing solutions.

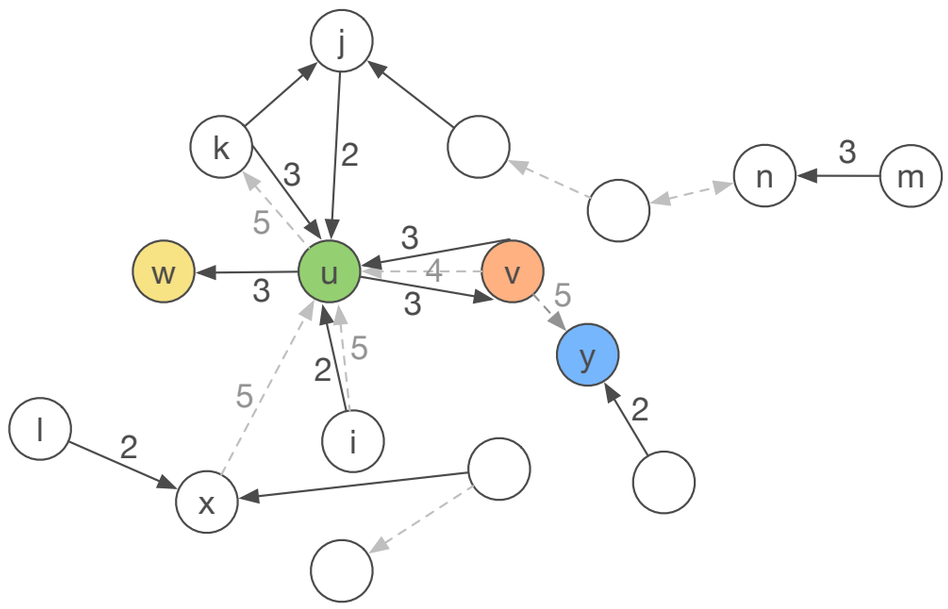
Time-varying?

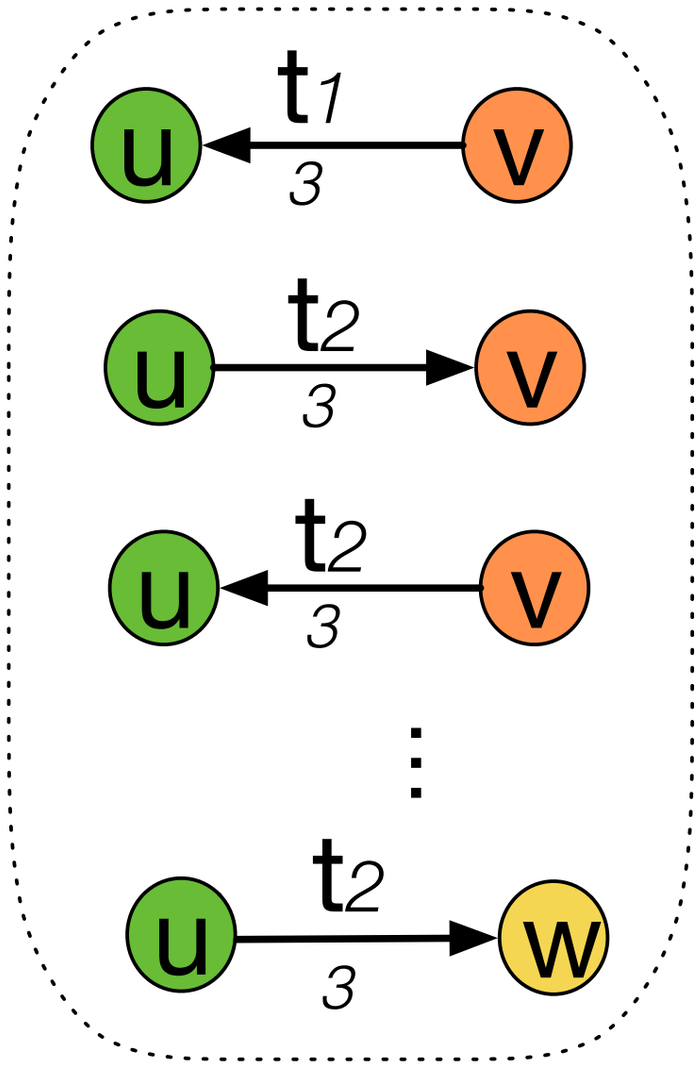
Given the social interactions formed at t_1 and t_2, can we infer if u trusts v at t_3? And, to what extent?



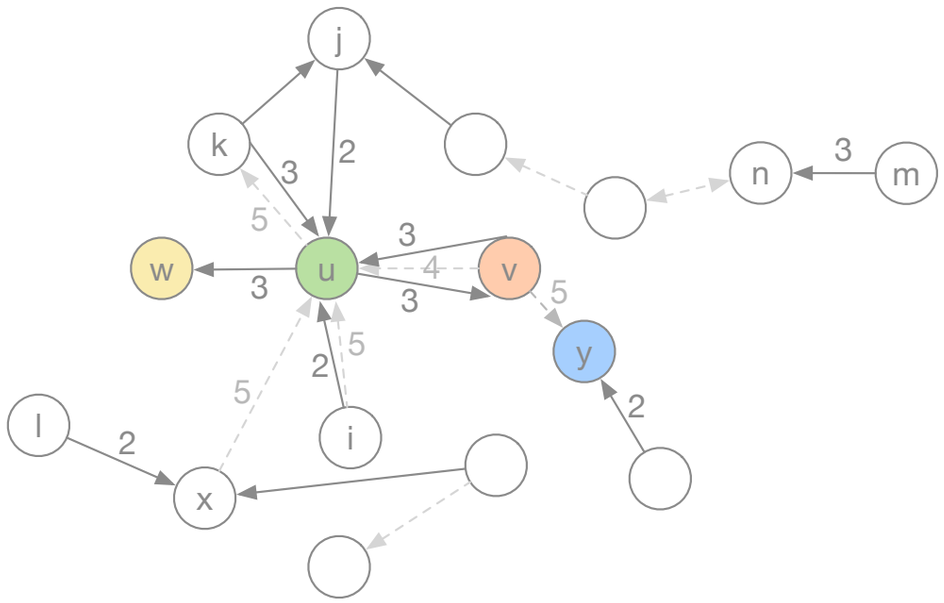
$0 < t_1 < t_2 < t_3$

Medley: an end-to-end learning framework for social trust evaluation in time-varying online social networks.

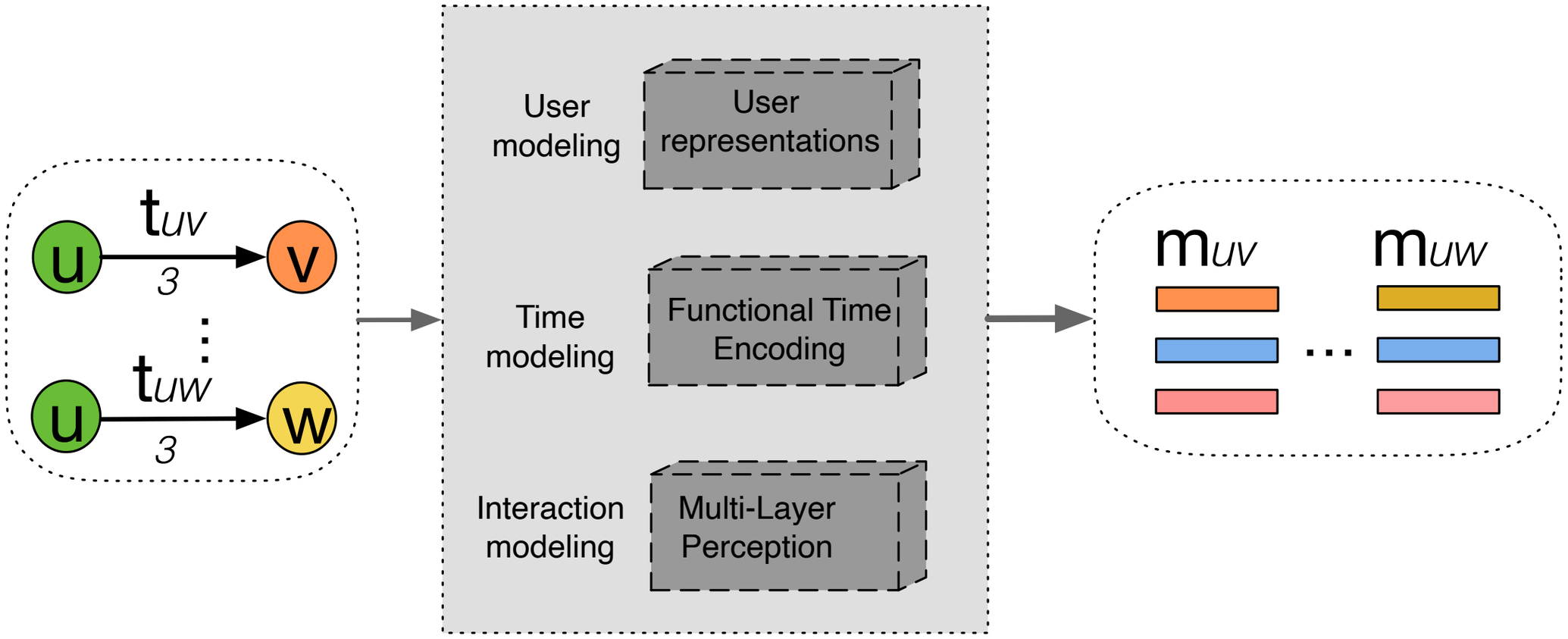




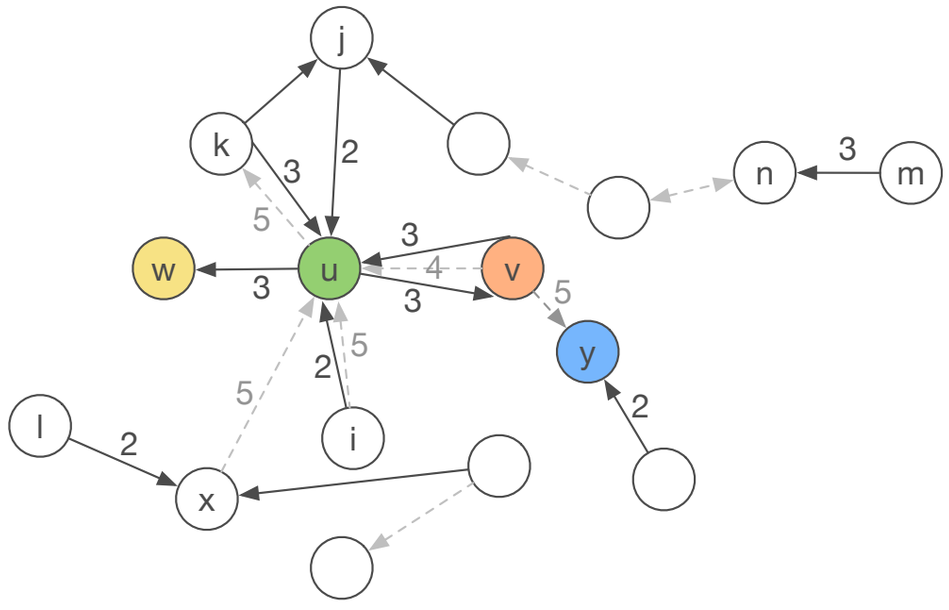
user features
time stamps
established trust levels



An effective way of evaluating trust should be able to characterize these time-varying trust signals simultaneously.

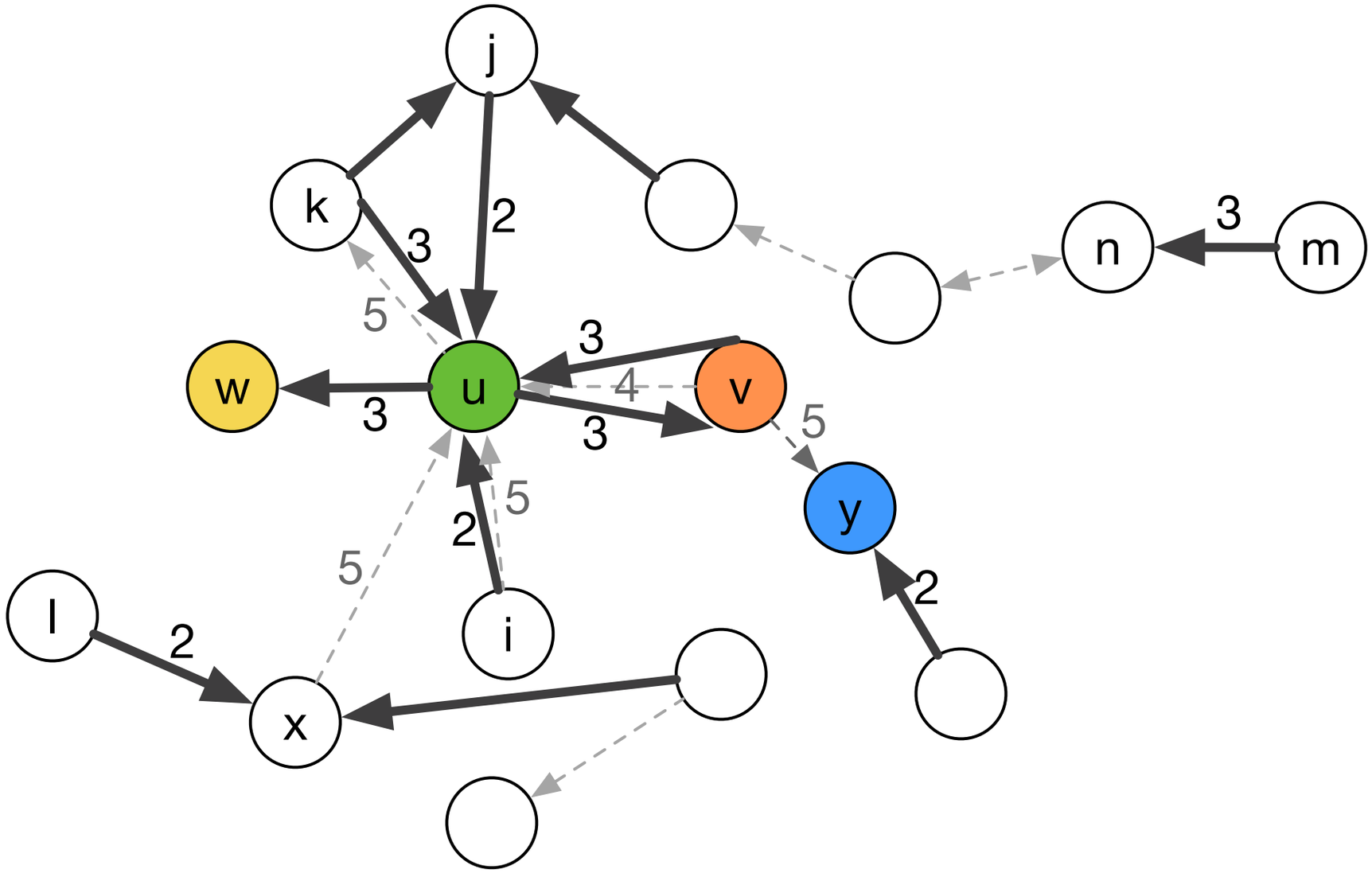


Message modeling

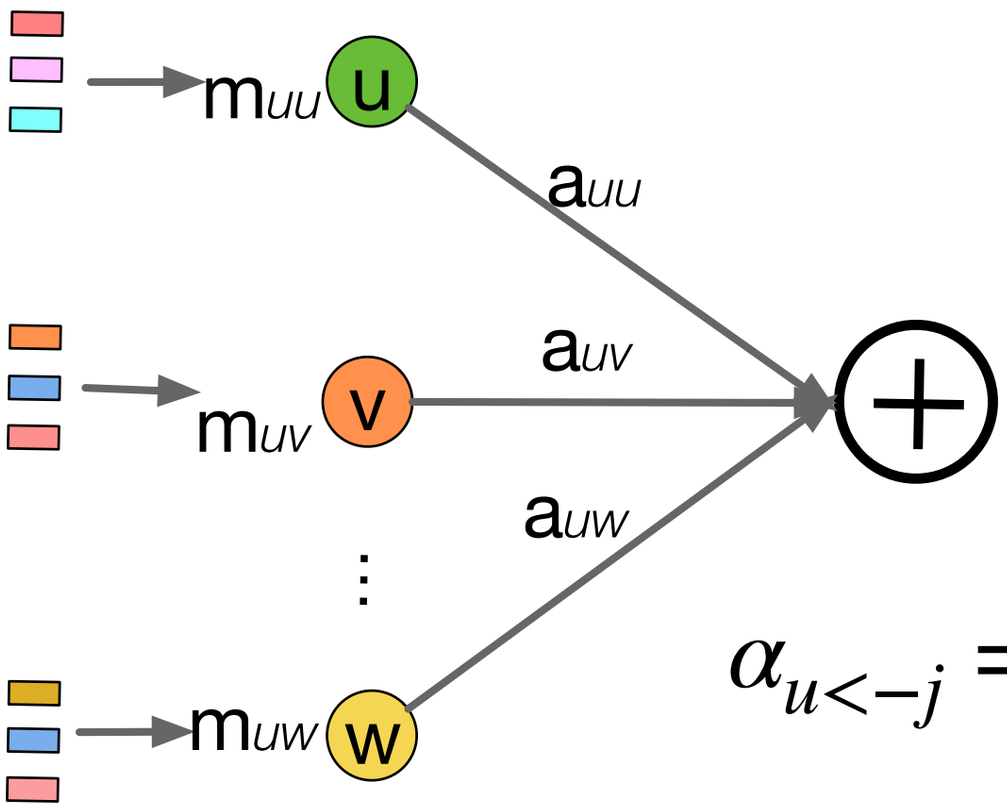


One more thing…

More recent interactions should have higher weights.

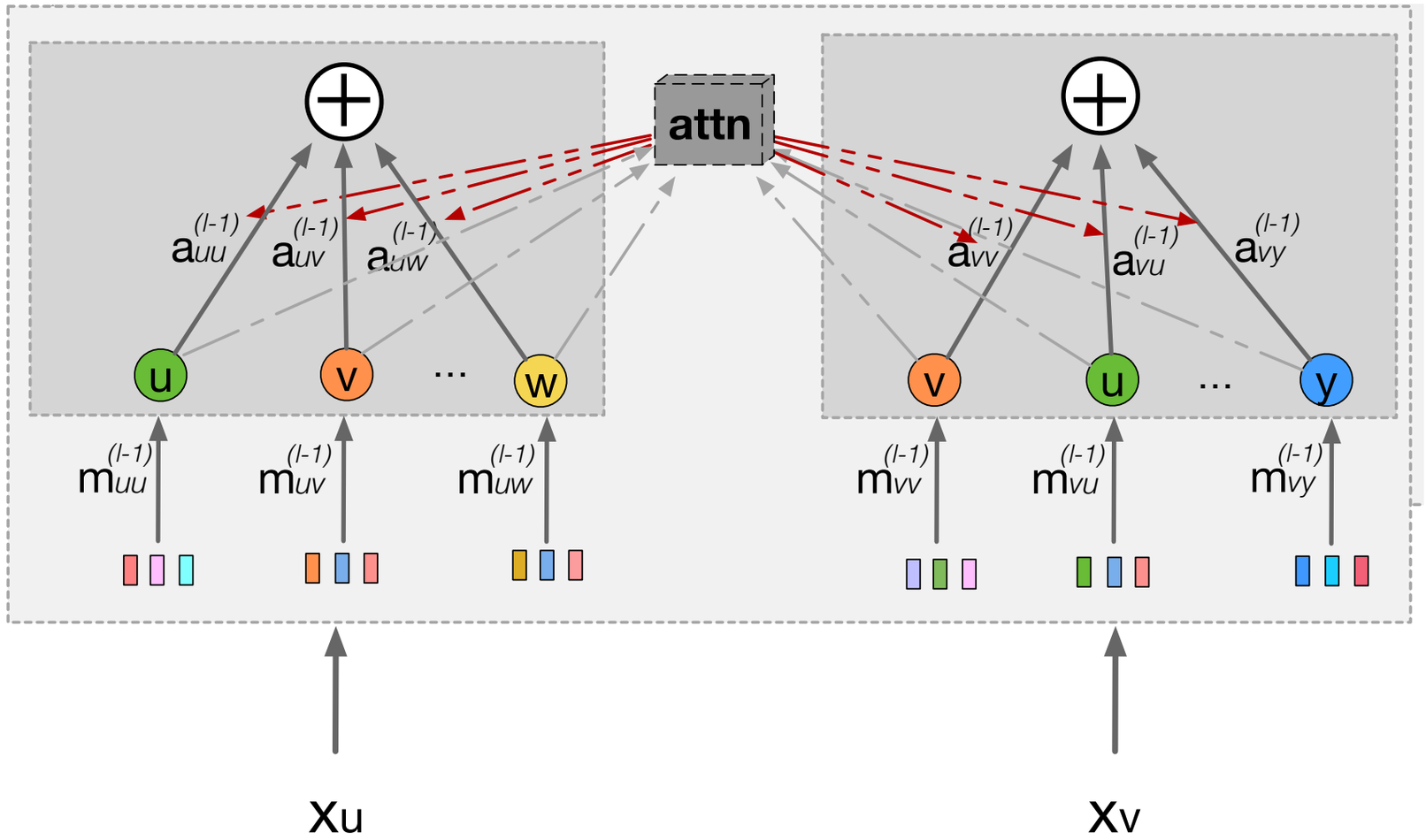


Graph attention mechanisms

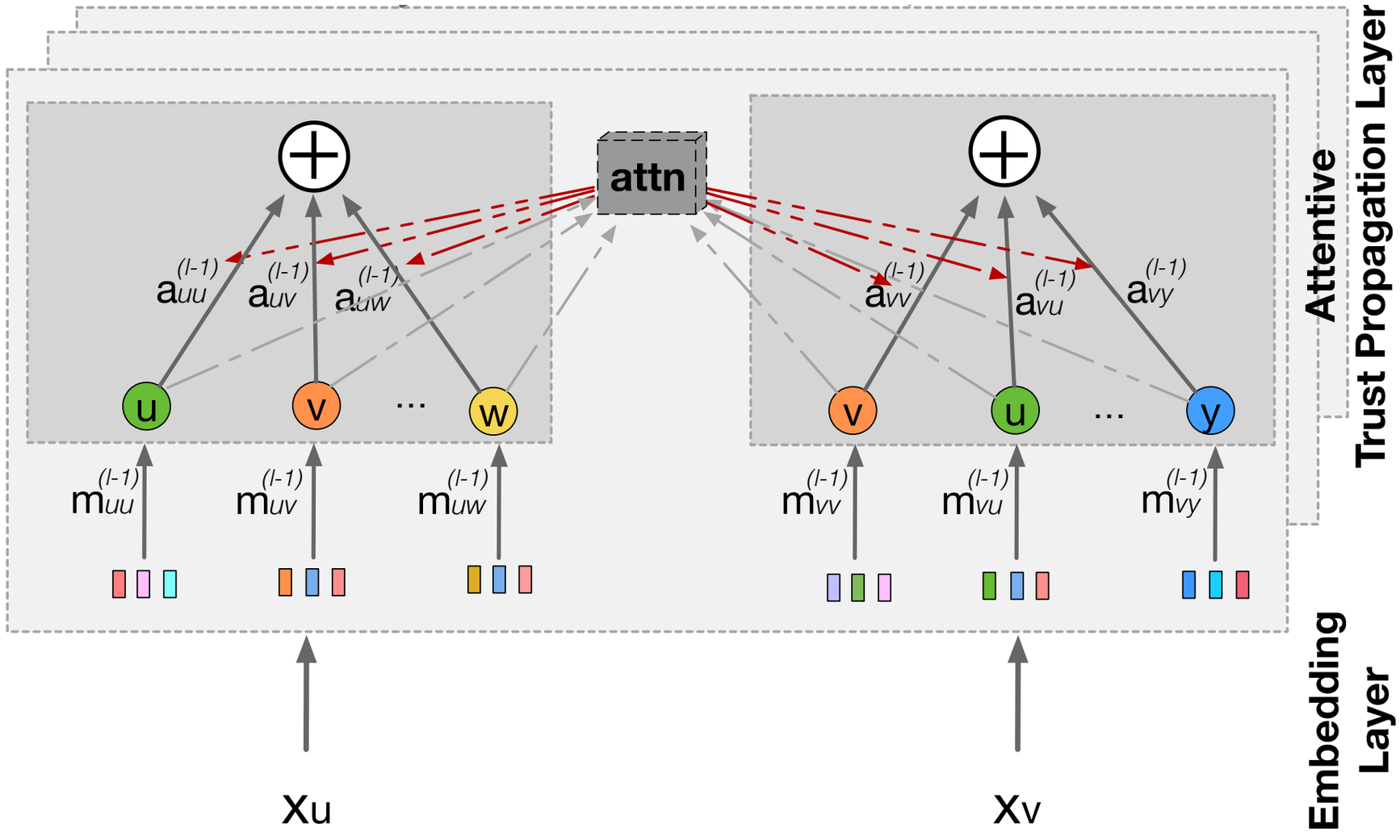


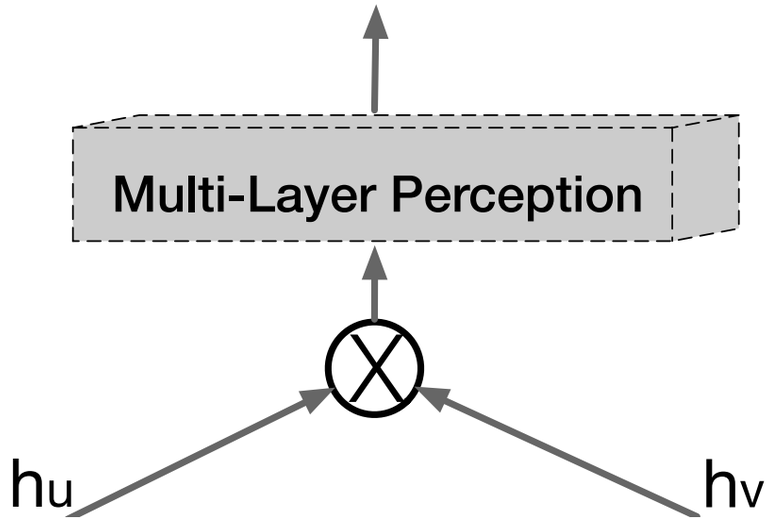
$$\alpha_{u<-j} = \mathbf{attn}(W * m_{uu}, W * m_{uj})$$

Attentive-trust propagation layer



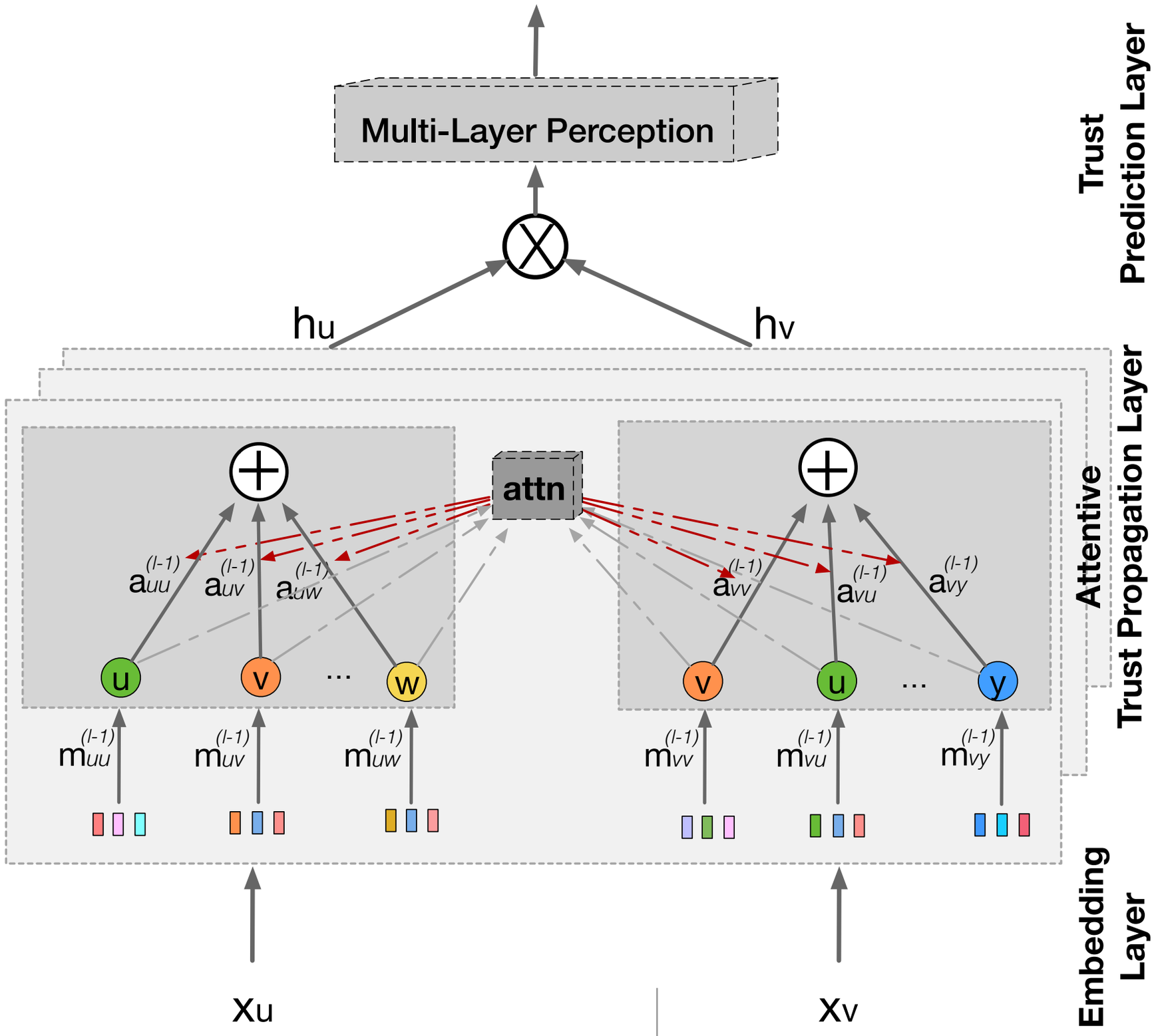
Stack multiple attentive-trust propagation layers





Trust Prediction Layer

Prediction layer


Multi-Layer Perception
hu
hv
attn
u
v
...
w
v
u
...
y
Trust Prediction Layer
Attentive Propagation Layer
Embedding Layer
Xu
Xv

Medley

Our experimental results…

Datasets used

Bitcoin-Alpha and Bitcoin-OTC adopt the concept of the “web of trust,” and both include two different levels of trust.

Dataset	# of nodes	# of trust edges	# of distrust edges	Avg. degree
Alpha	3,775	22,650	1,536	12.79
OTC	5,881	32,029	3,563	12.1

Data preparation

We split the time-stamped interactions chronologically into 70%-15%-15% for training, validation, and testing according to their timestamps.

Observed users: the users appeared in the training set.

Unobserved users: the users only appeared during validation or testing period.

Accuracy

Evaluation Accuracy on Bitcoin-OTC on observed users (%)

Methods	AUC	F1-Micro	F1-Weighted	AP
Medley-IP	**72.2**	**86.9**	83.7	**93.3**
Medley-CAT	69.0	**86.9**	83.8	92.0
Guardian	66.0	85.9	80.4	91.6

Accuracy

Evaluation Accuracy on Bitcoin-OTC on unobserved users (%)

Methods	AUC	F1-Micro	F1-Weighted	AP
Medley-IP	**73.3**	*86.9*	**84.3**	93.6
Medley-CAT	69.7	87.2	84.3	92.3
Guardian	66.7	86.1	80.7	92.0

Accuracy

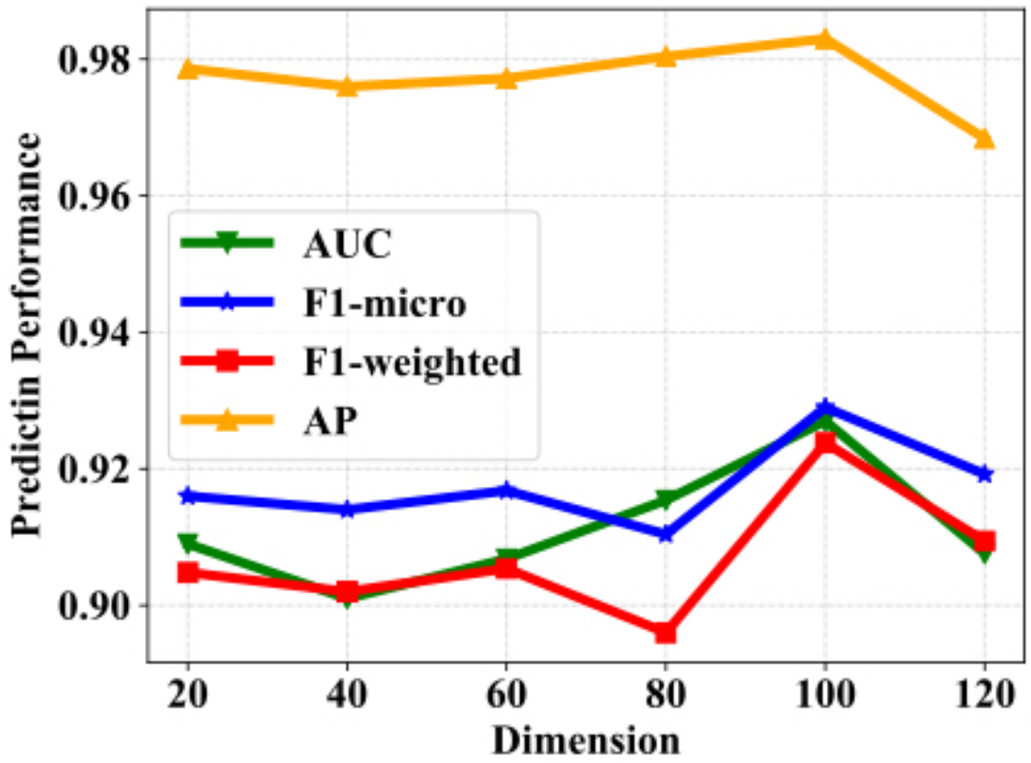
Evaluation Accuracy on Bitcoin-Alpha observed users (%)

Methods	AUC	F1-Micro	F1-Weighted	AP
Medley-IP	**92.7**	**92.9**	**92.4**	98.3
Medley-CAT	90.1	91.6	90.5	97.6
Guardian	66.9	84.6	77.6	91.7

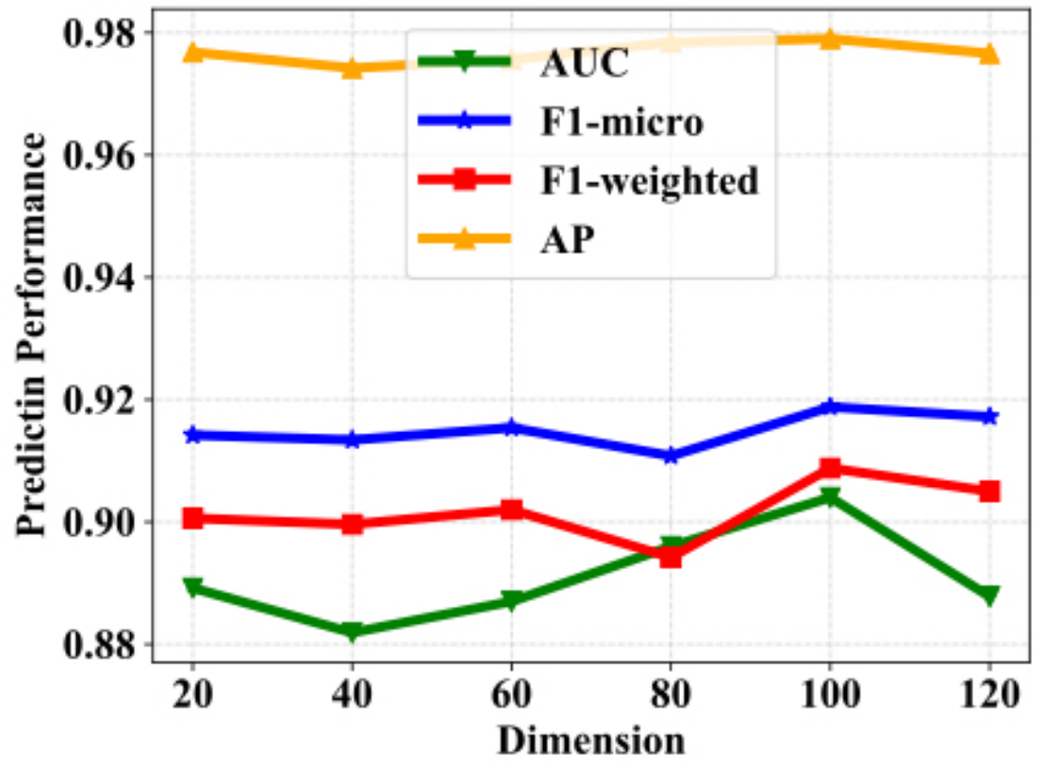
Accuracy

Evaluation Accuracy on Bitcoin-Alpha on unobserved users (%)

Methods	AUC	F1-Micro	F1-Weighted	AP
Medley-IP	**90.4**	**91.9**	**90.9**	97.9
Medley-CAT	88.0	91.5	90.1	97.4
Guardian	65.5	86.1	79.7	92.0

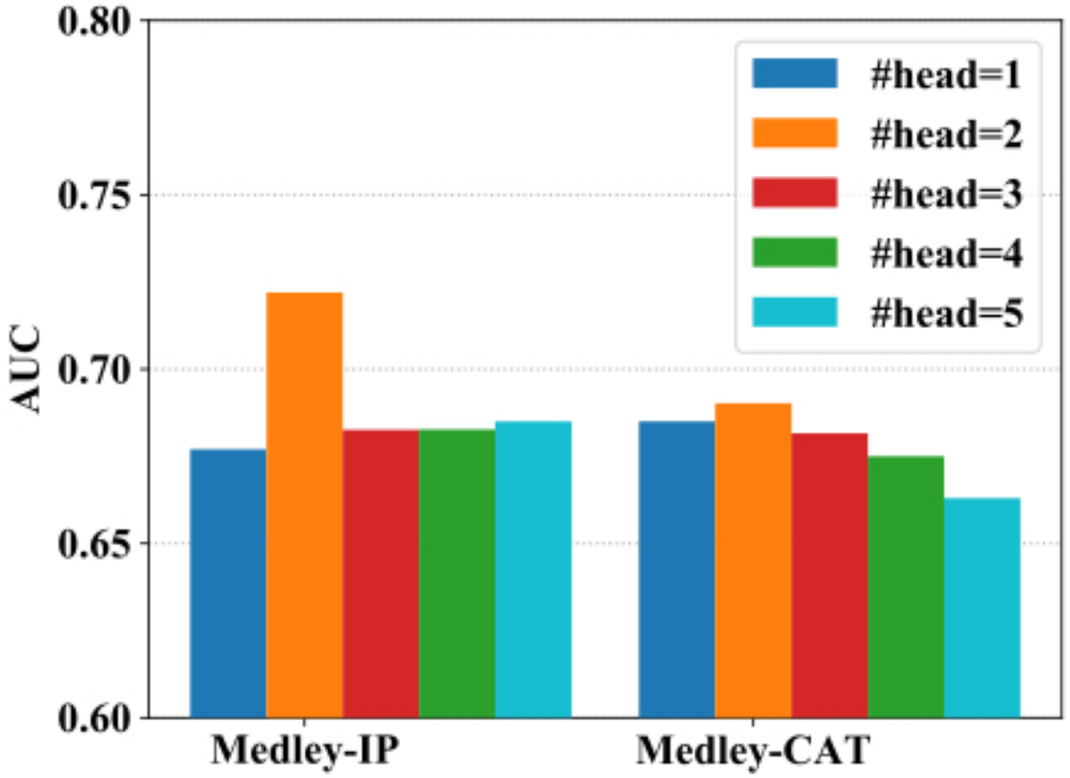


(a) Observed Users on Bitcoin-Alpha

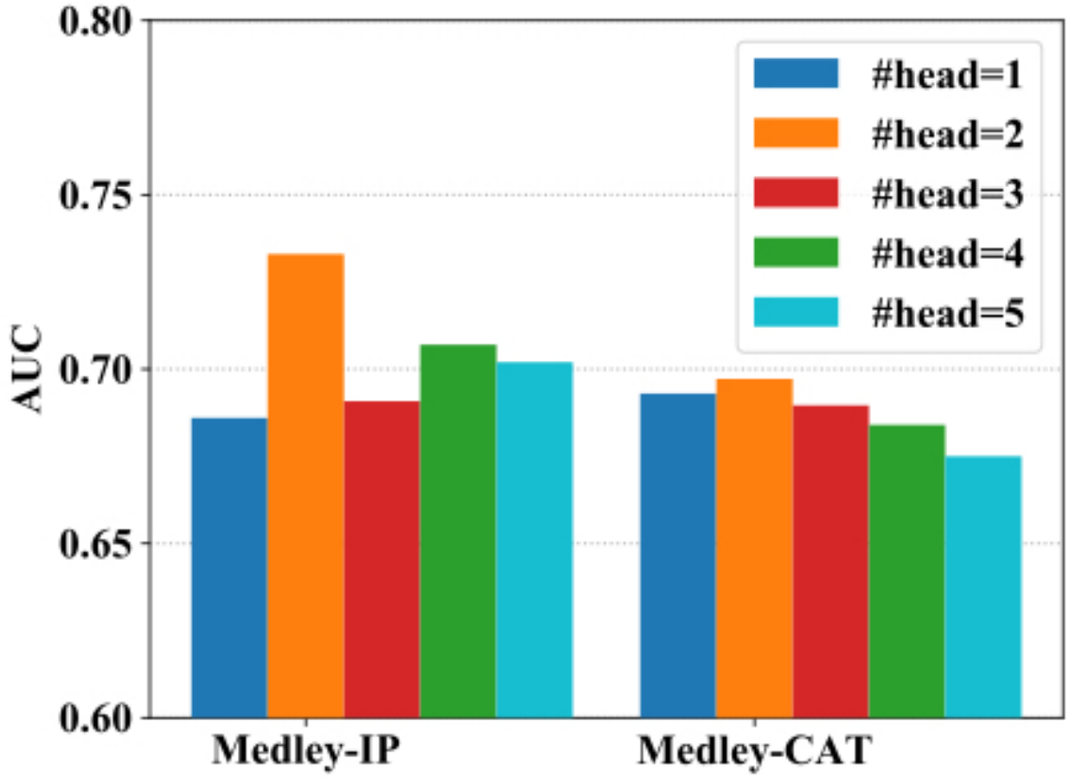


(b) Unobserved Users on Bitcoin-Alpha

Dimension of time encoding



(c) Observed Users on Bitcoin-OTC



(d) Unobserved Users on Bitcoin-OTC

Number of heads

Medley is an end-to-end learning framework, that can achieve the best possible performance for social trust evaluation in time-varying online social networks.

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