Guardian: Evaluating Trust in Online Social Networks with Graph Convolutional Networks

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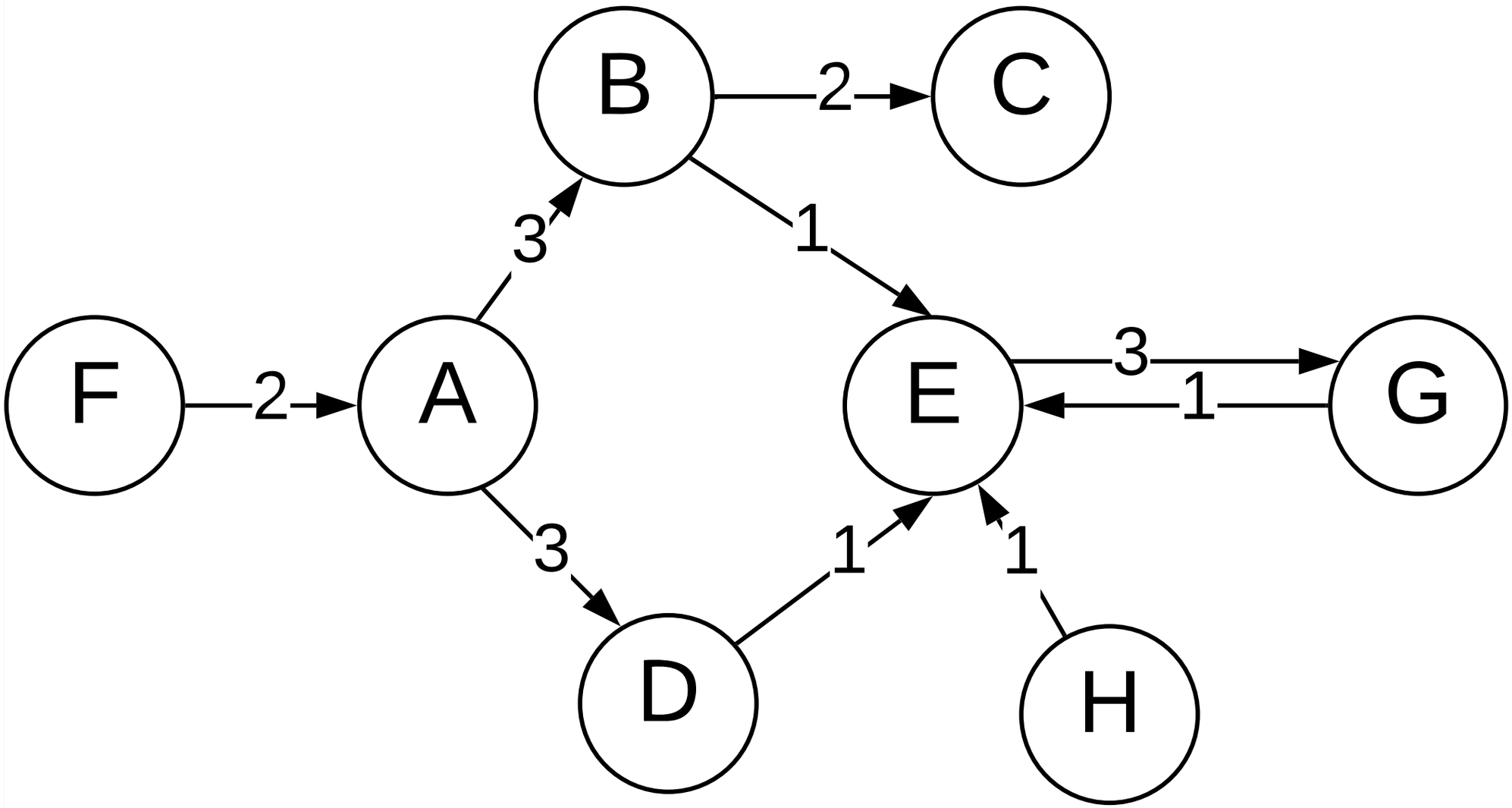
Almost 4.57 billion people were active internet users as of April 2020.

— *Statista*

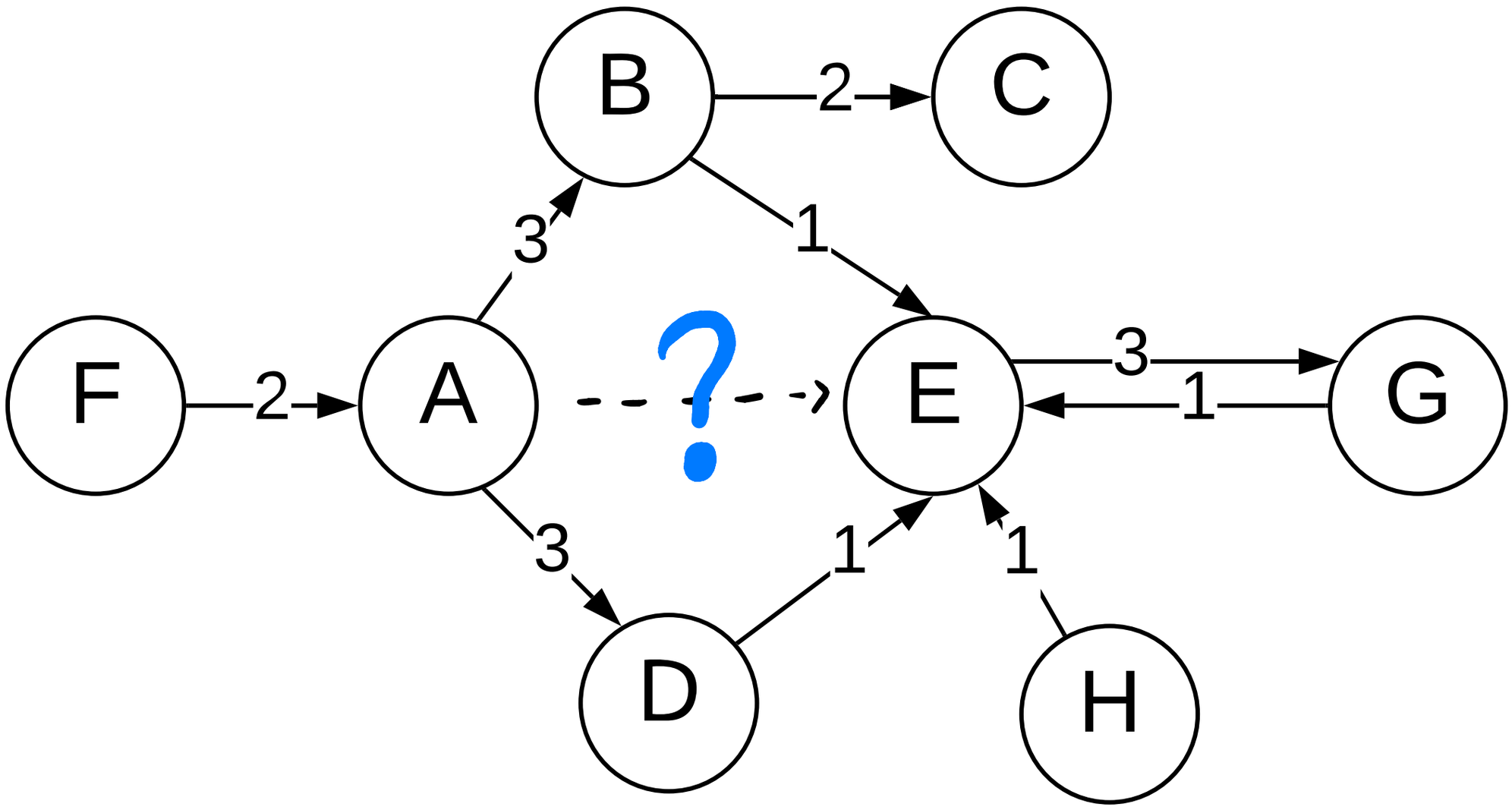
Social trust is the basis of online social networks.

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.



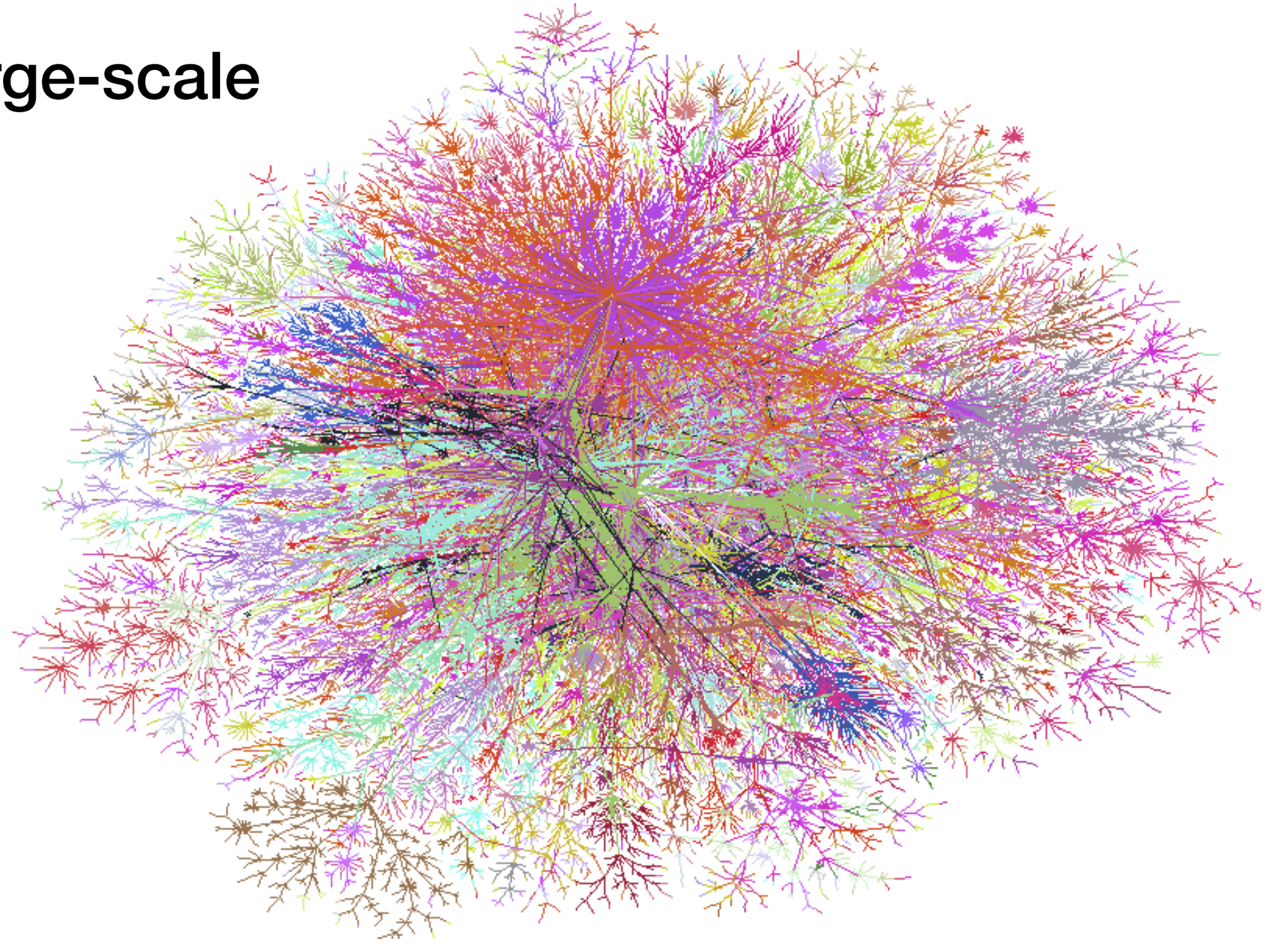
Network graph

an example



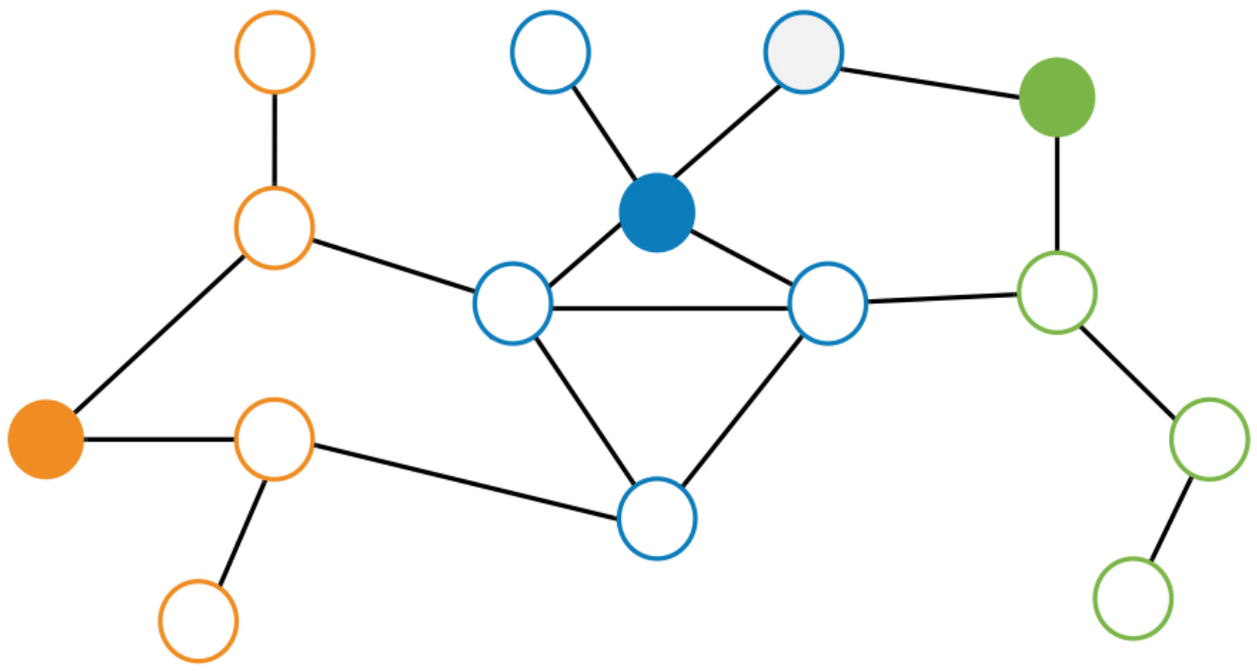
Can A trust E? And, to what extent?

Large-scale

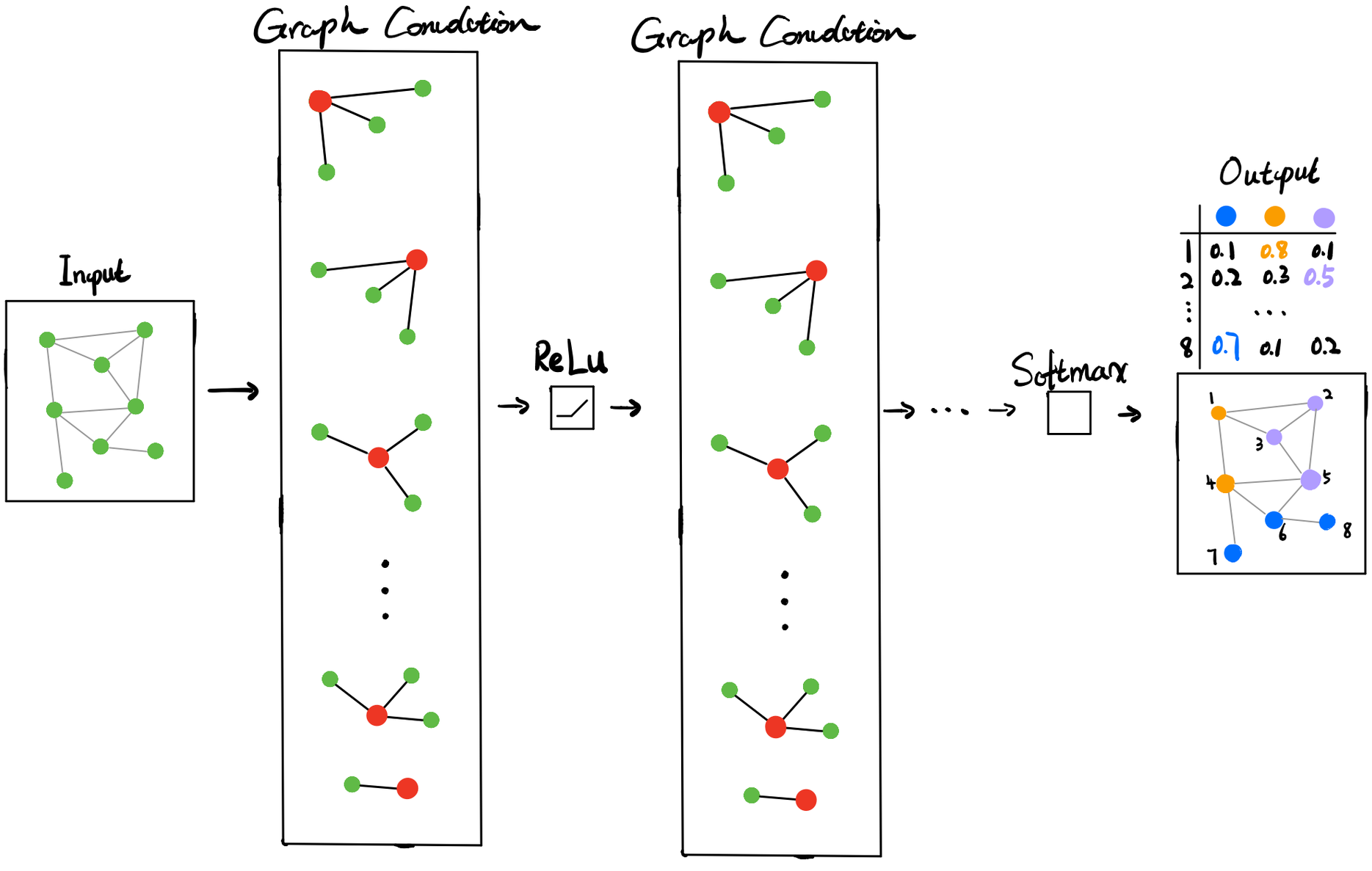


Wait a second …

Graph convolutional neural networks — an efficient variant of convolutional neural networks on graphs.

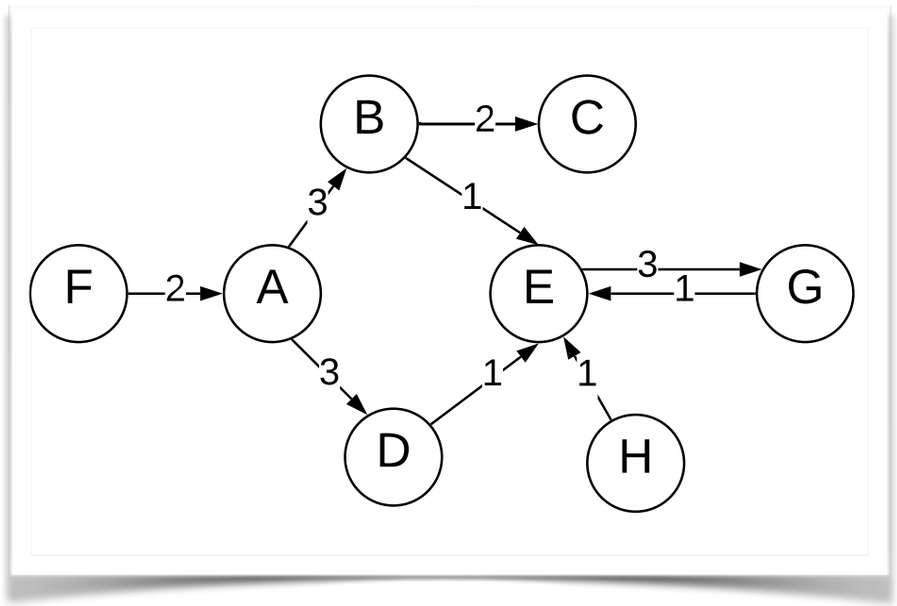


Representation learning with graph convolutional networks

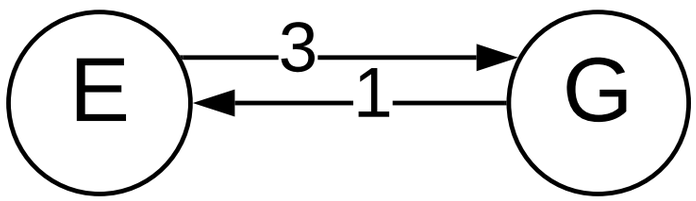


The complexity of model parameters are **independent of the input graph size.**

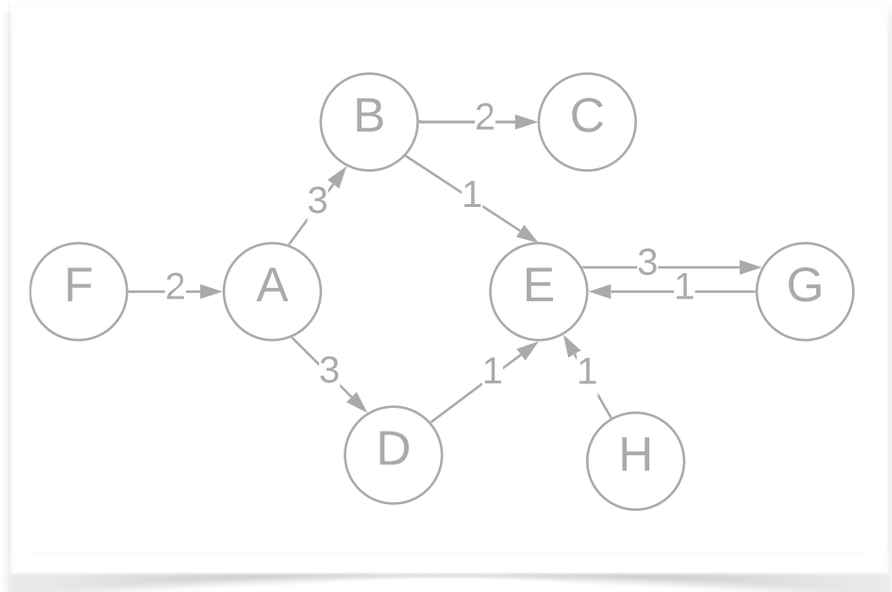
Preliminaries: trust properties



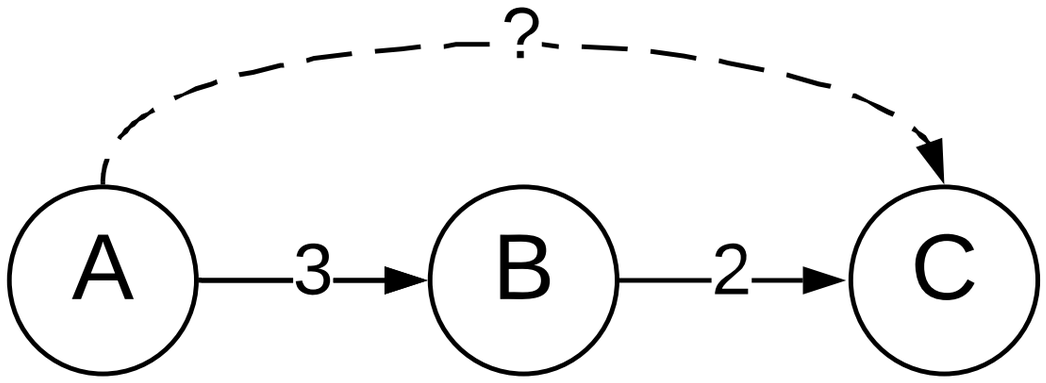
Asymmetry: one user may trust someone else more than she is trusted back.



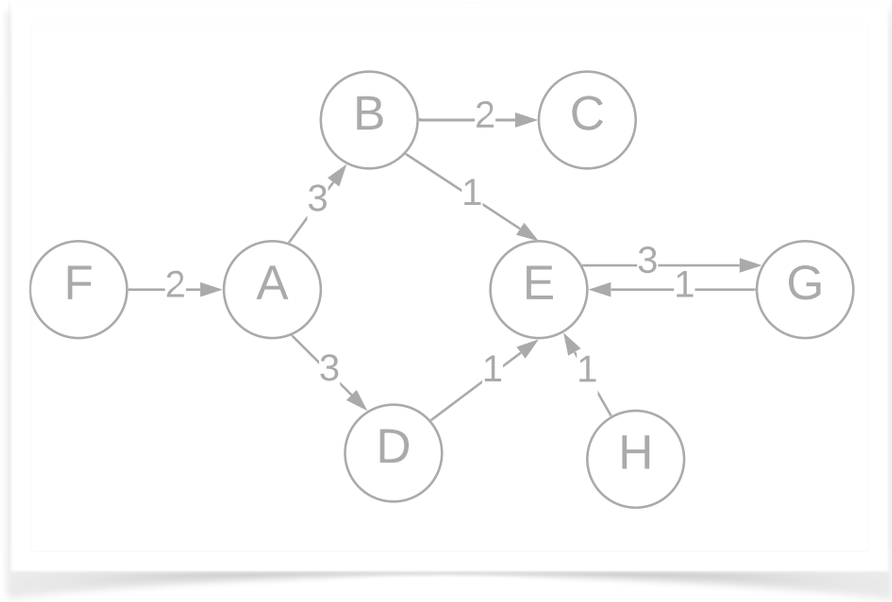
Trust properties



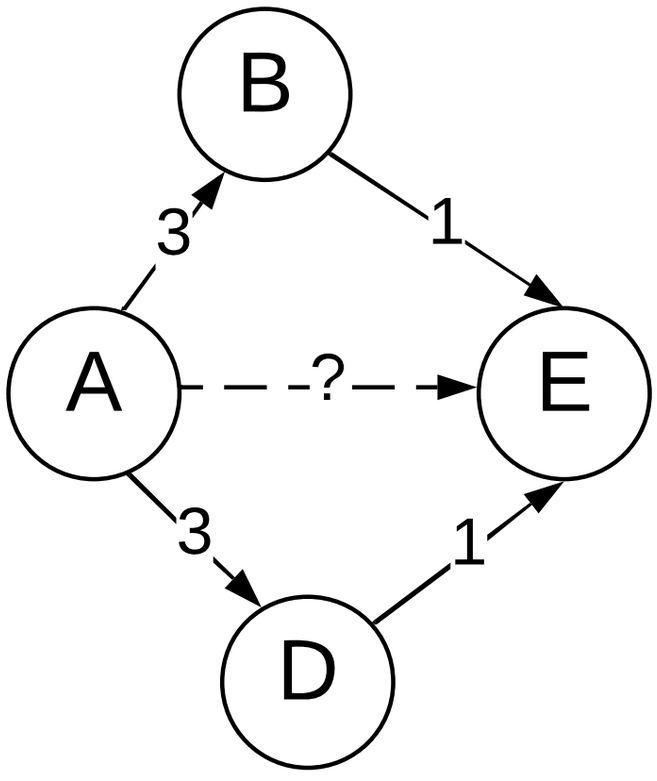
Propagative nature: trust may be passed from one user to another, creating chains of social trust that connects two users who are not connected.



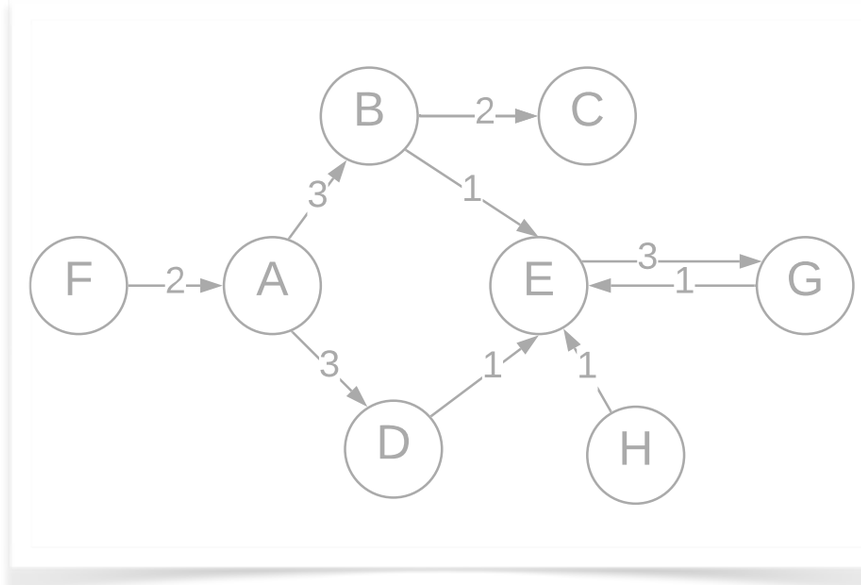
Trust properties



Composable nature: trust needs to be aggregated if several chains of social trust exit.



Trust properties

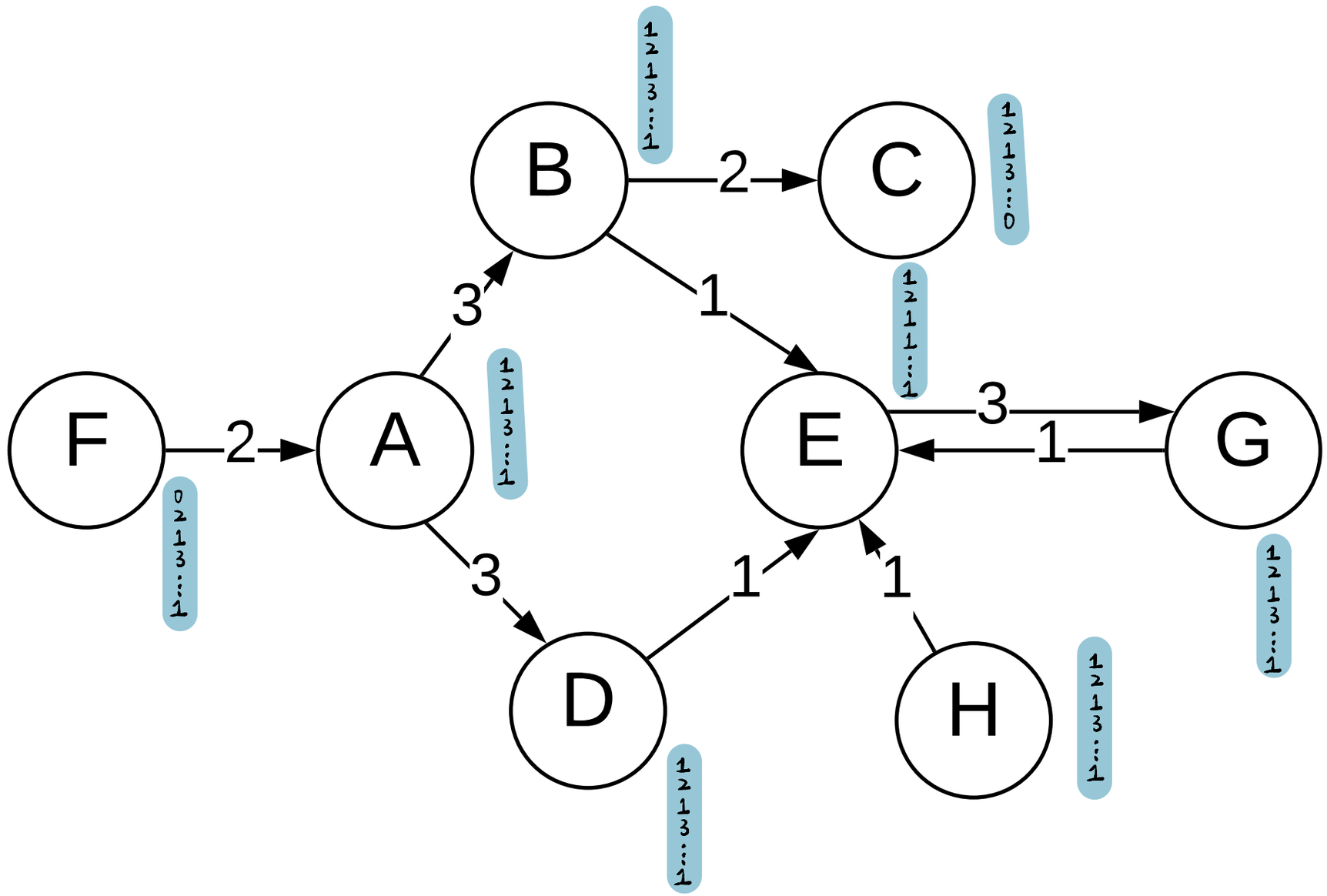


An effective way of evaluating trust should be able to capture these trust properties simultaneously.

Guardian: an end-to-end learning framework for social trust evaluation.

Embedding layer

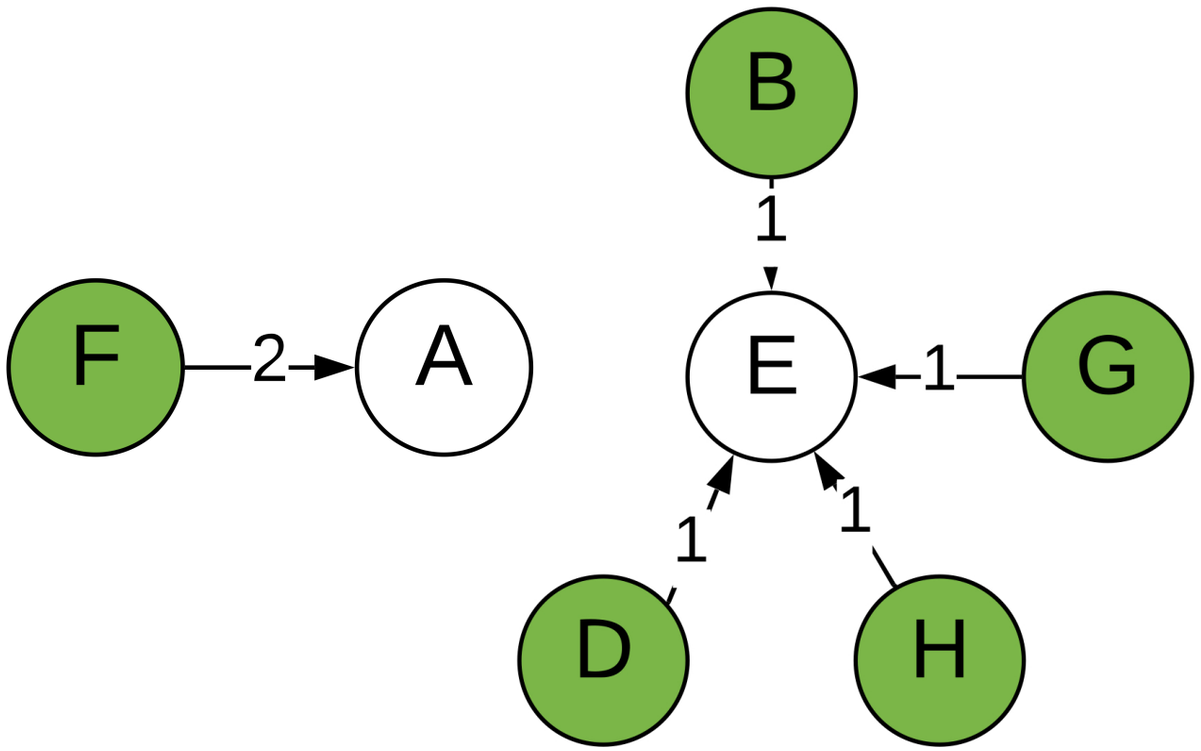
We use a pre-trained embedding layer that maps each user into a vector.

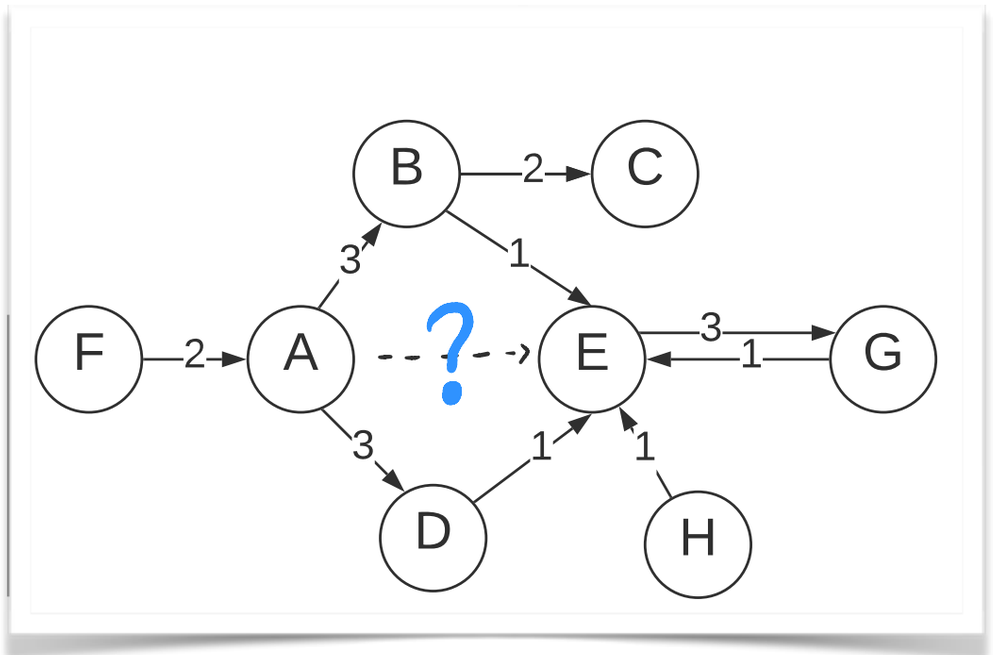


Two types of trust interactions:

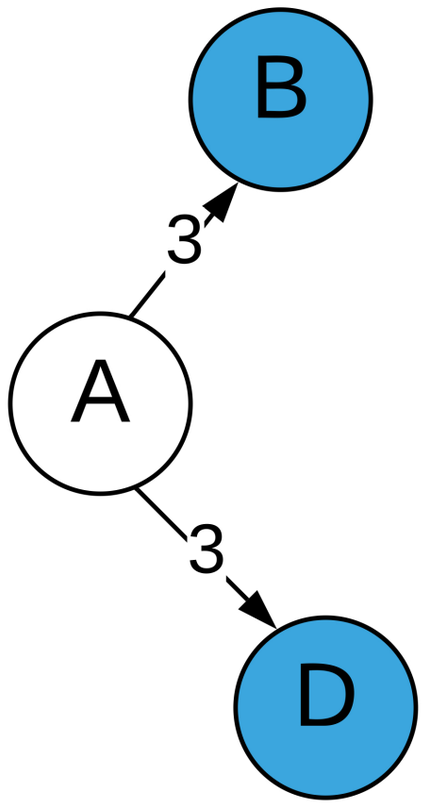
popularity trust and **engagement trust**

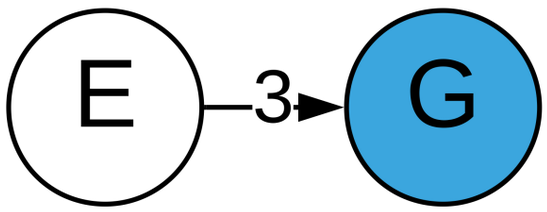
Popularity trust: the overall trust of a user endorsed by others (accumulated from the incoming links)

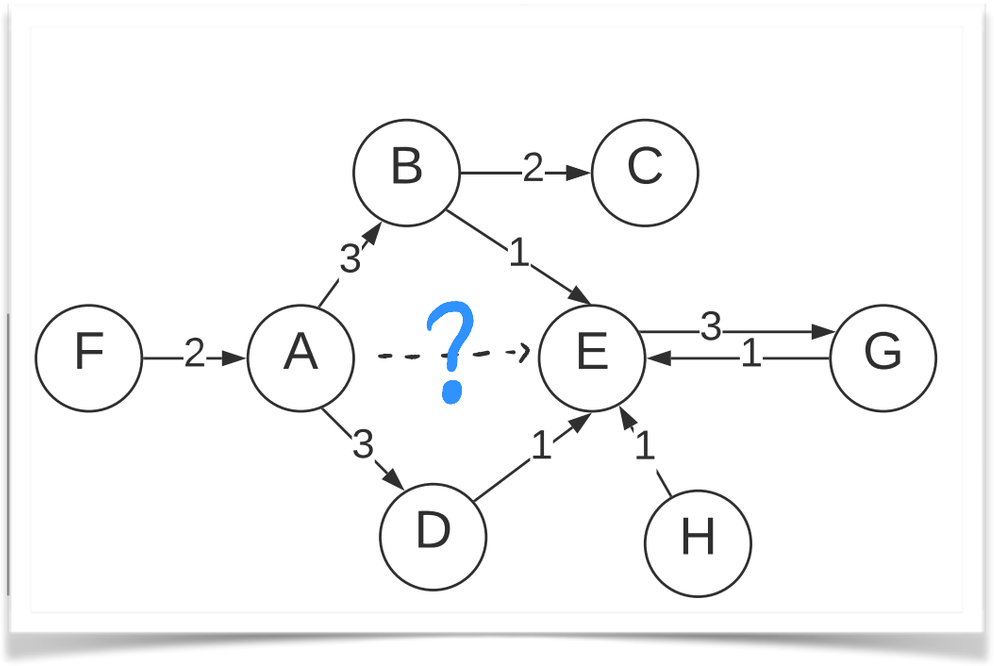


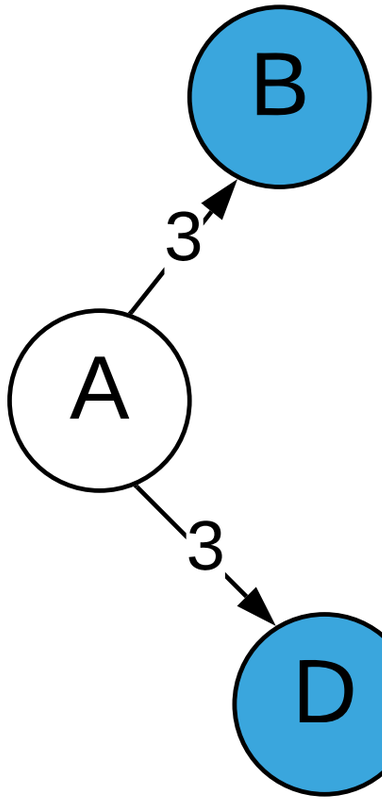


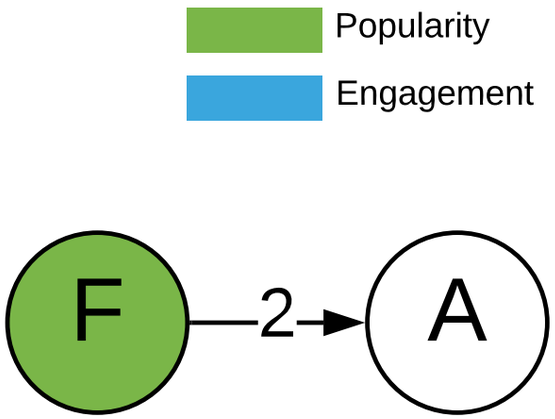
Engagement trust: the willingness of a user to trust others (accumulated from the outgoing links)

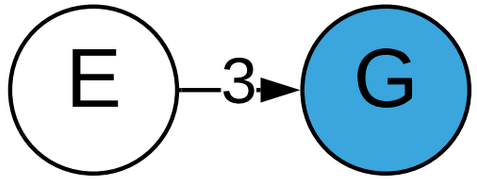


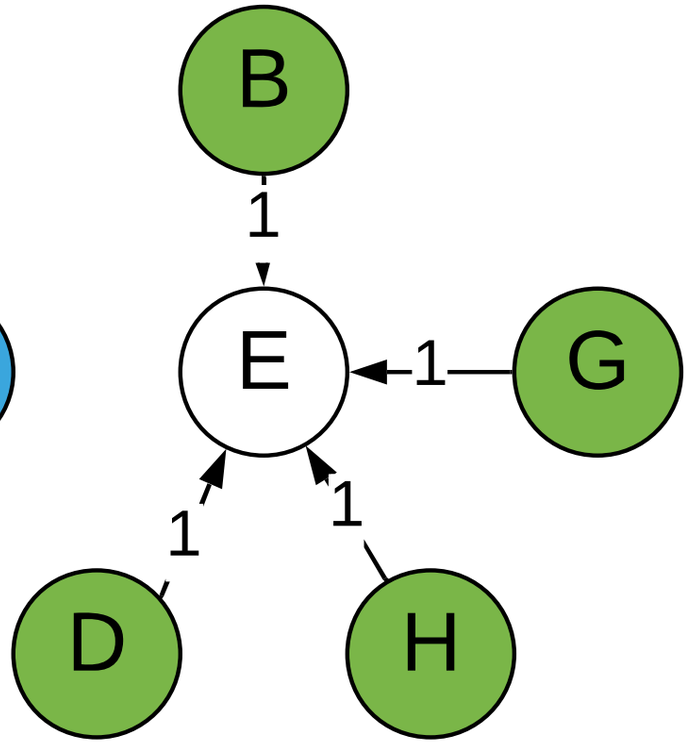




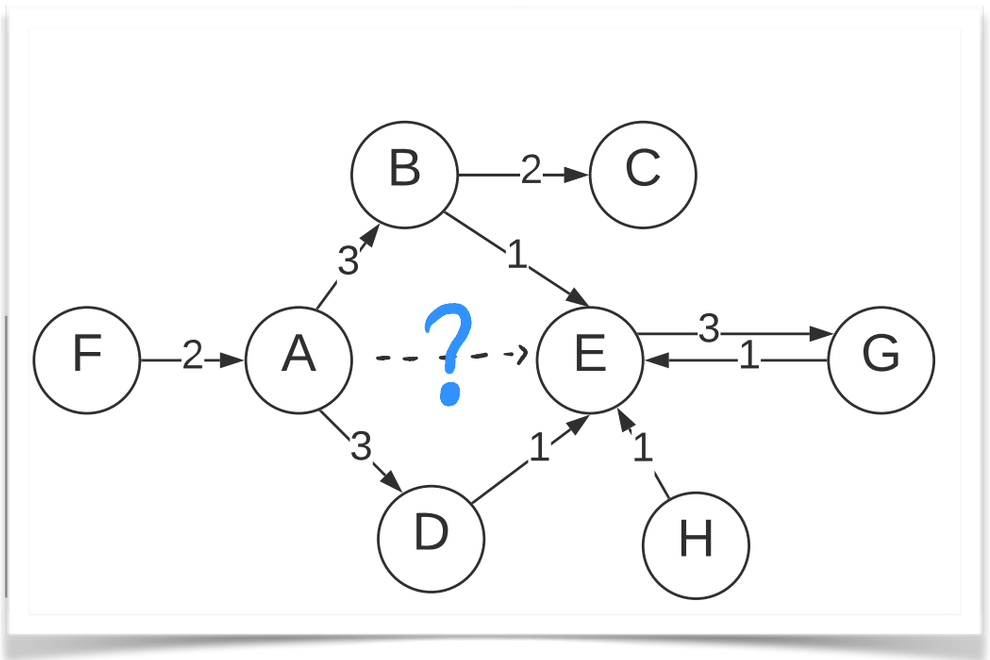




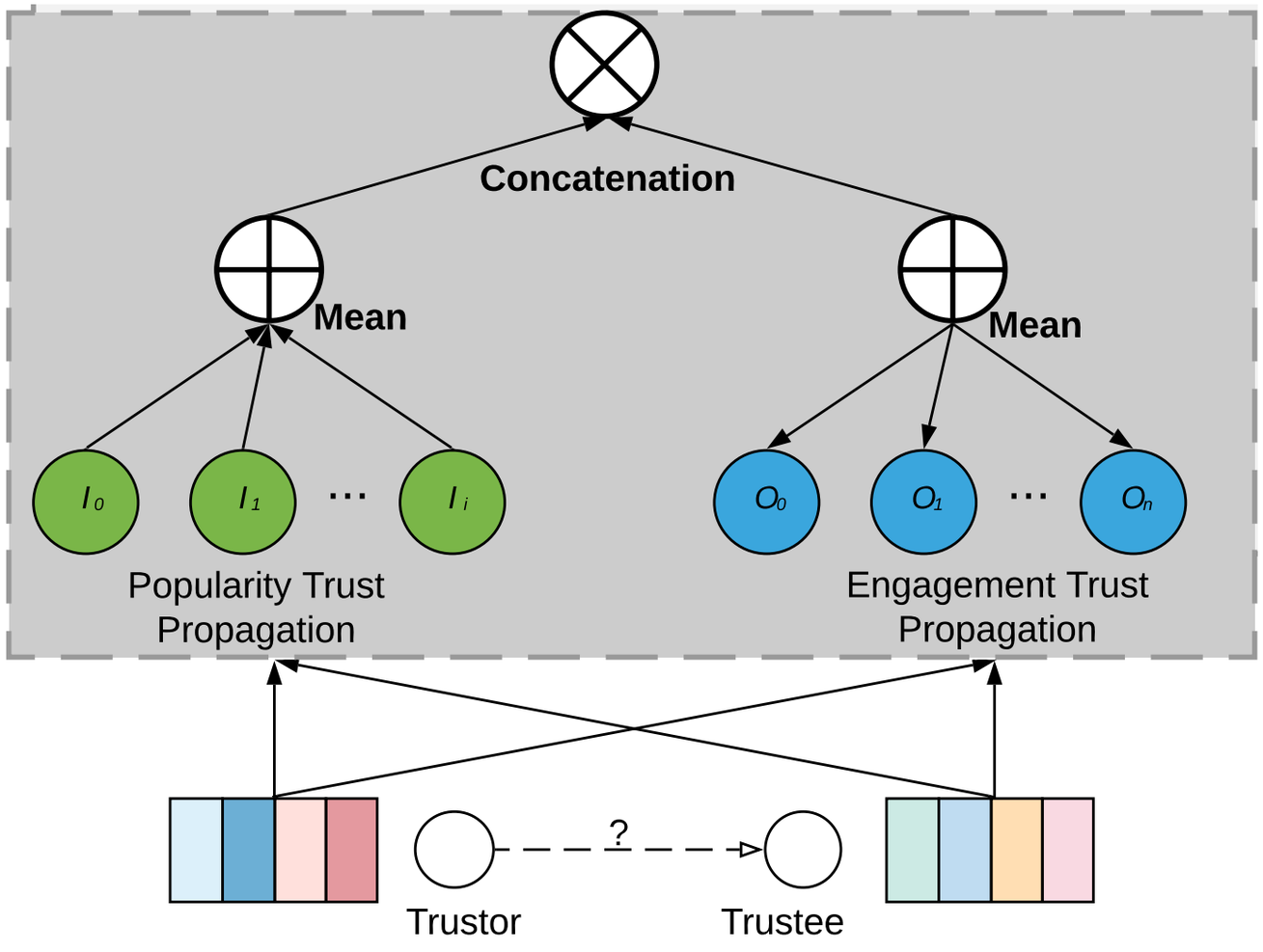




Two types of trust aggregation

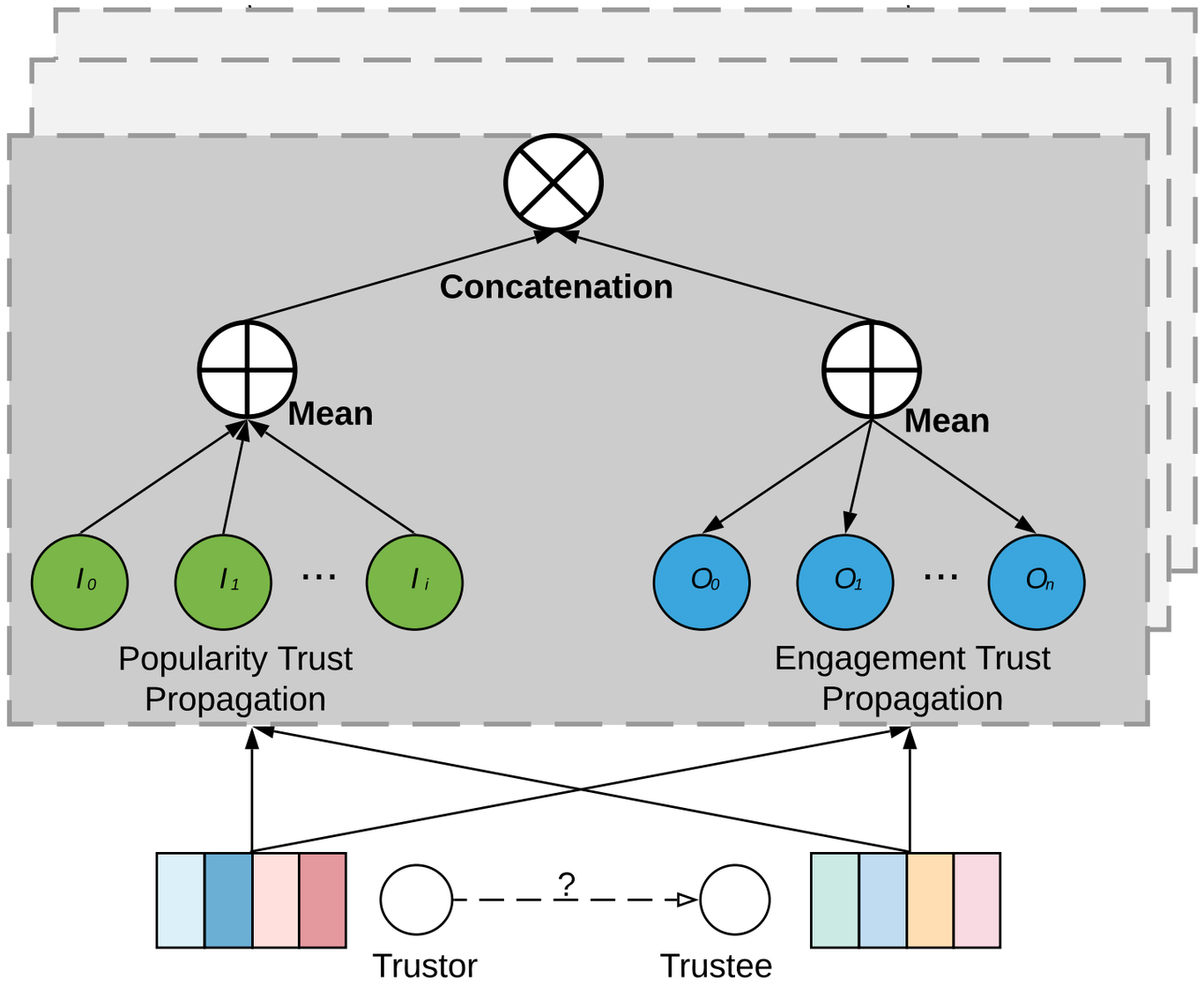


Trust convolutional layer



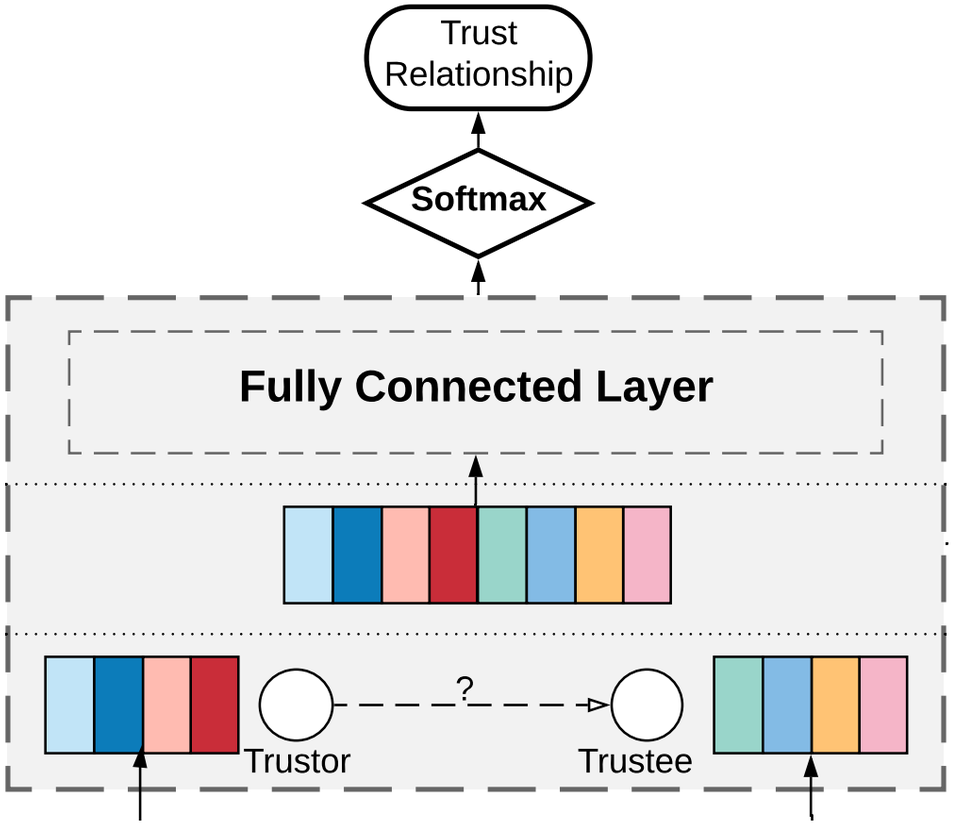
To capture the **composable and asymmetric nature** of trust

Stack multiple trust convolutional layers

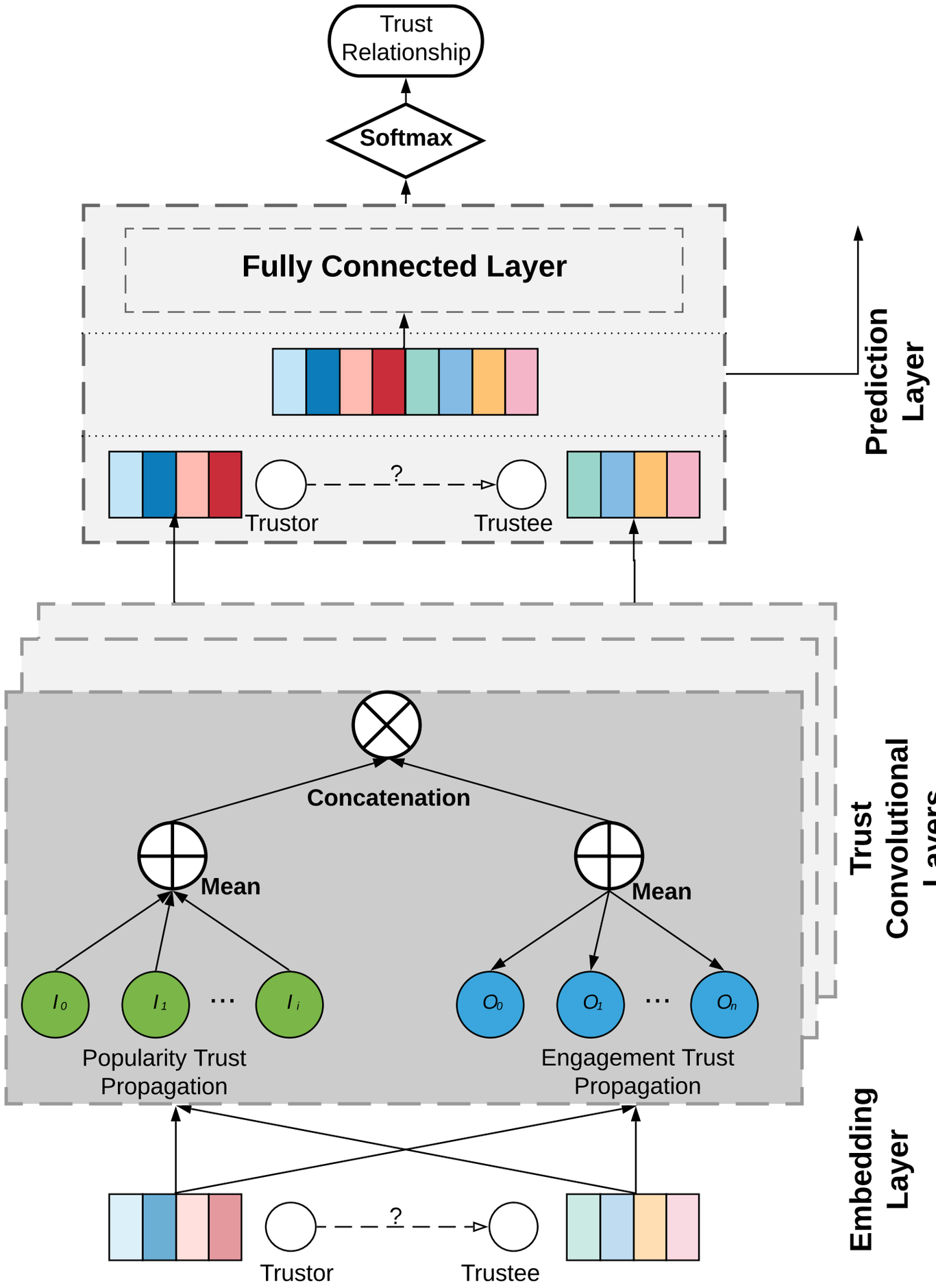


To capture the **propagative nature** of trust

Prediction layer



Guardian


Trust Relationship
Softmax
Fully Connected Layer
Prediction Layer
Trustor
?
Trustee
Concatenation
Mean
Mean
I_0
I_1
...
I_i
O_0
O_1
...
O_n
Popularity Trust Propagation
Engagement Trust Propagation
Trust Convolutional Layers
Trustor
?
Trustee
Embedding Layer

Our experimental results…

Datasets Used

Advogato and Pretty-Good-Privacy (PGP) adopt the concept of the “web of trust”, and both contain four different levels of trust.

Dataset	# of Nodes	# of Edges	Avg. Degree	Diameter
Advogato	6,541	51,127	19.2	4.82
PGP	38,546	317,979	16.5	7.7

Accuracy

Evaluation Accuracy on Advogato

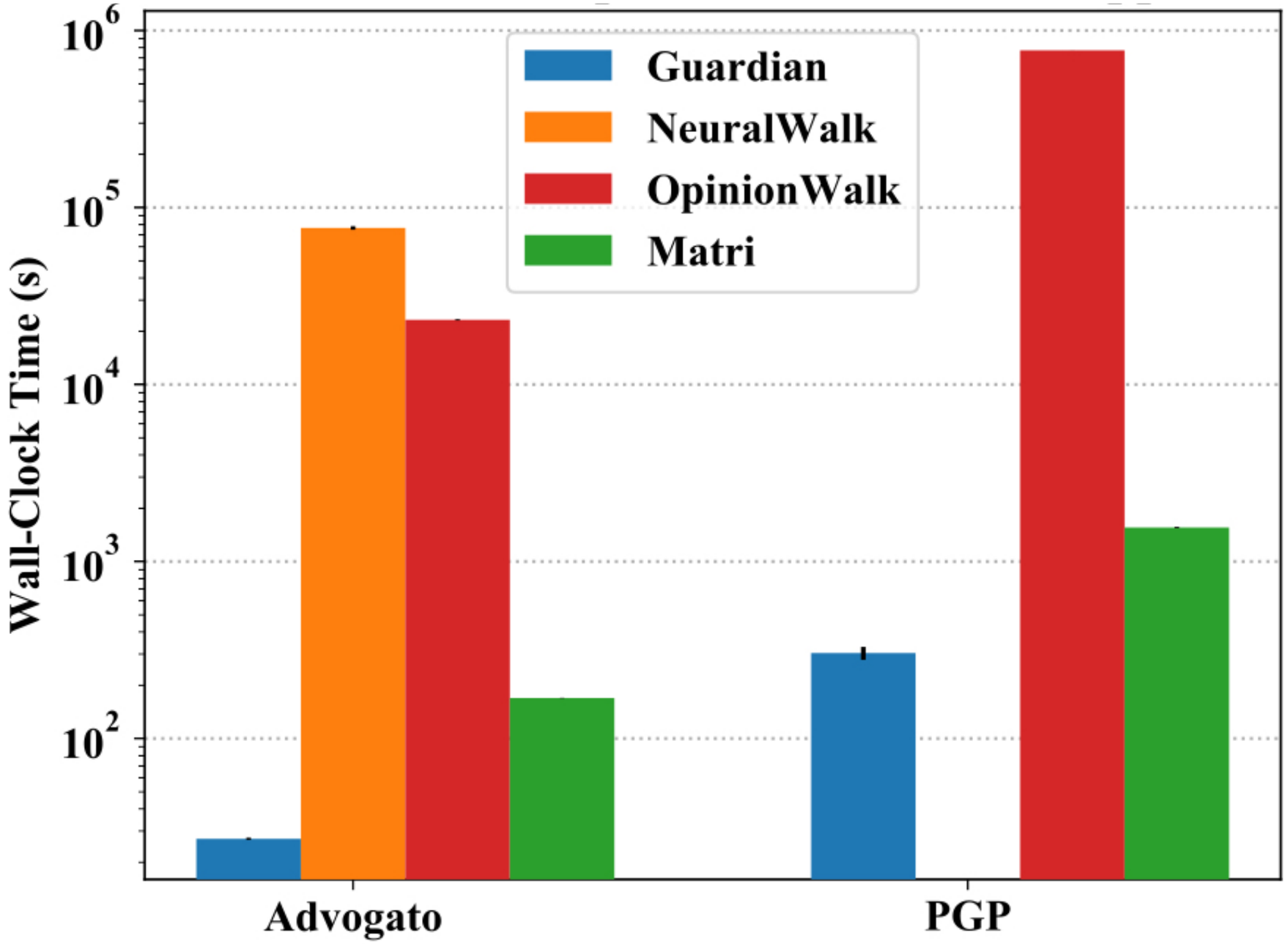
Approaches	F1-Score	MAE
Guardian	**74.3%**	0.082
NeuralWalk	74.0%	0.081
OpinionWalk	64.3%	0.228
Matri	65.6%	0.127

Accuracy

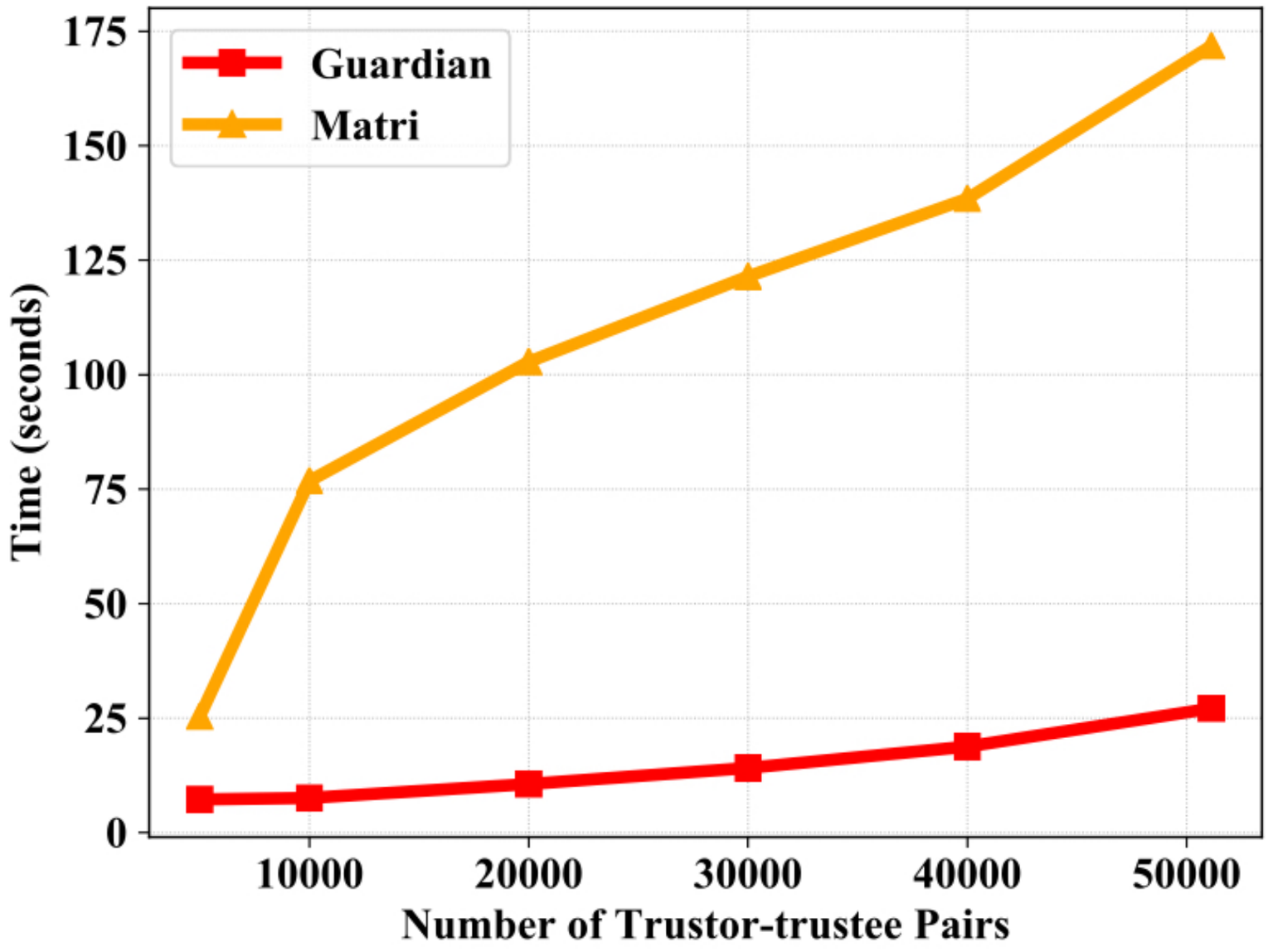
Evaluation Accuracy on PGP

Approaches	F1-Score	MAE
Guardian	**87.1%**	**0.083**
NeuralWalk	–	–
OpinionWalk	67.3%	0.249
Matri	68.3%	0.122

Efficiency

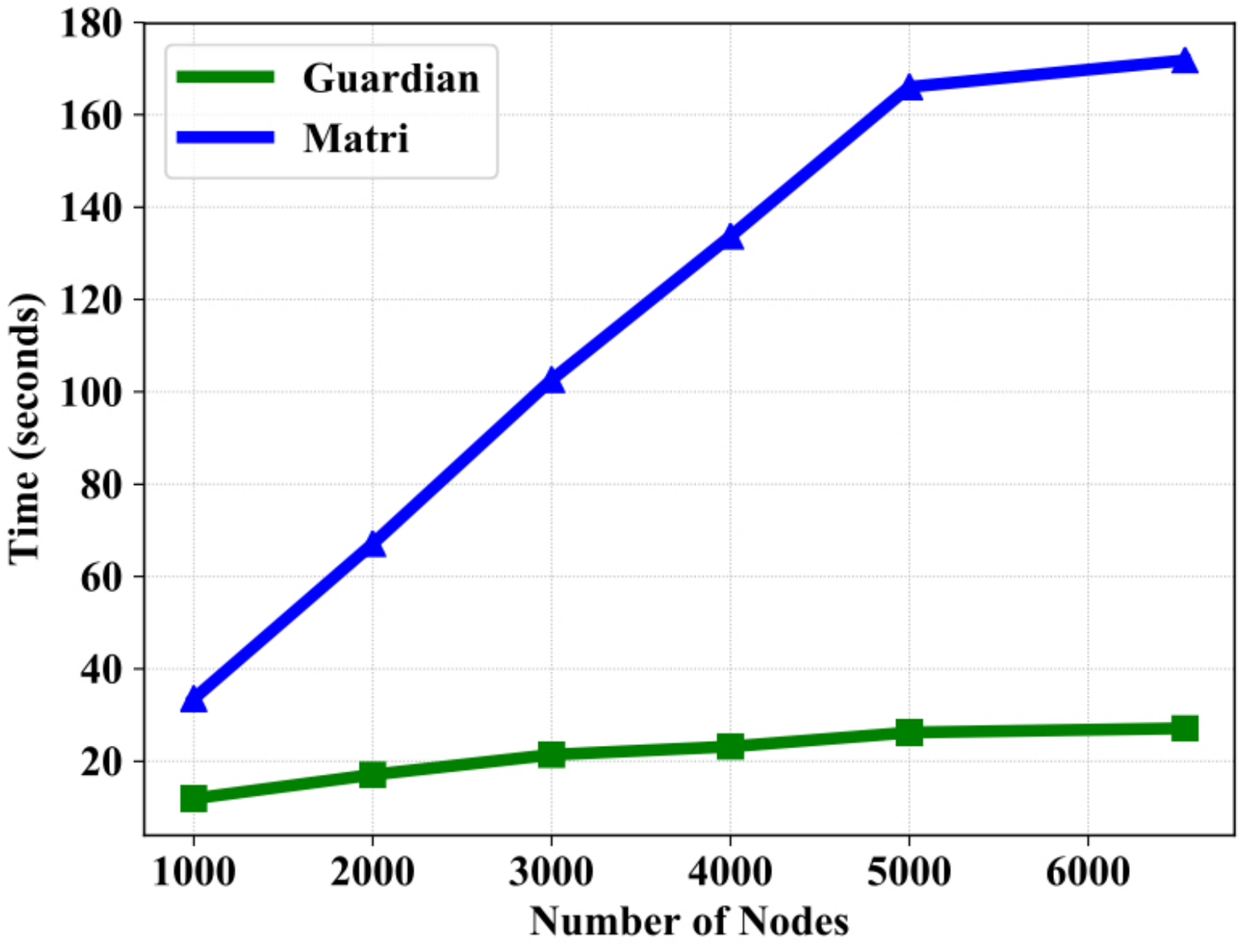

Guardian
NeuralWalk
OpinionWalk
Matri
Wall-Clock Time (s)
10^6
10^5
10^4
10^3
10^2
Advogato
PGP

Scalability



Time vs. # of pairs

Scalability



Time vs. # of users

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

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iQua
The *interflow* of *Quality*.