

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

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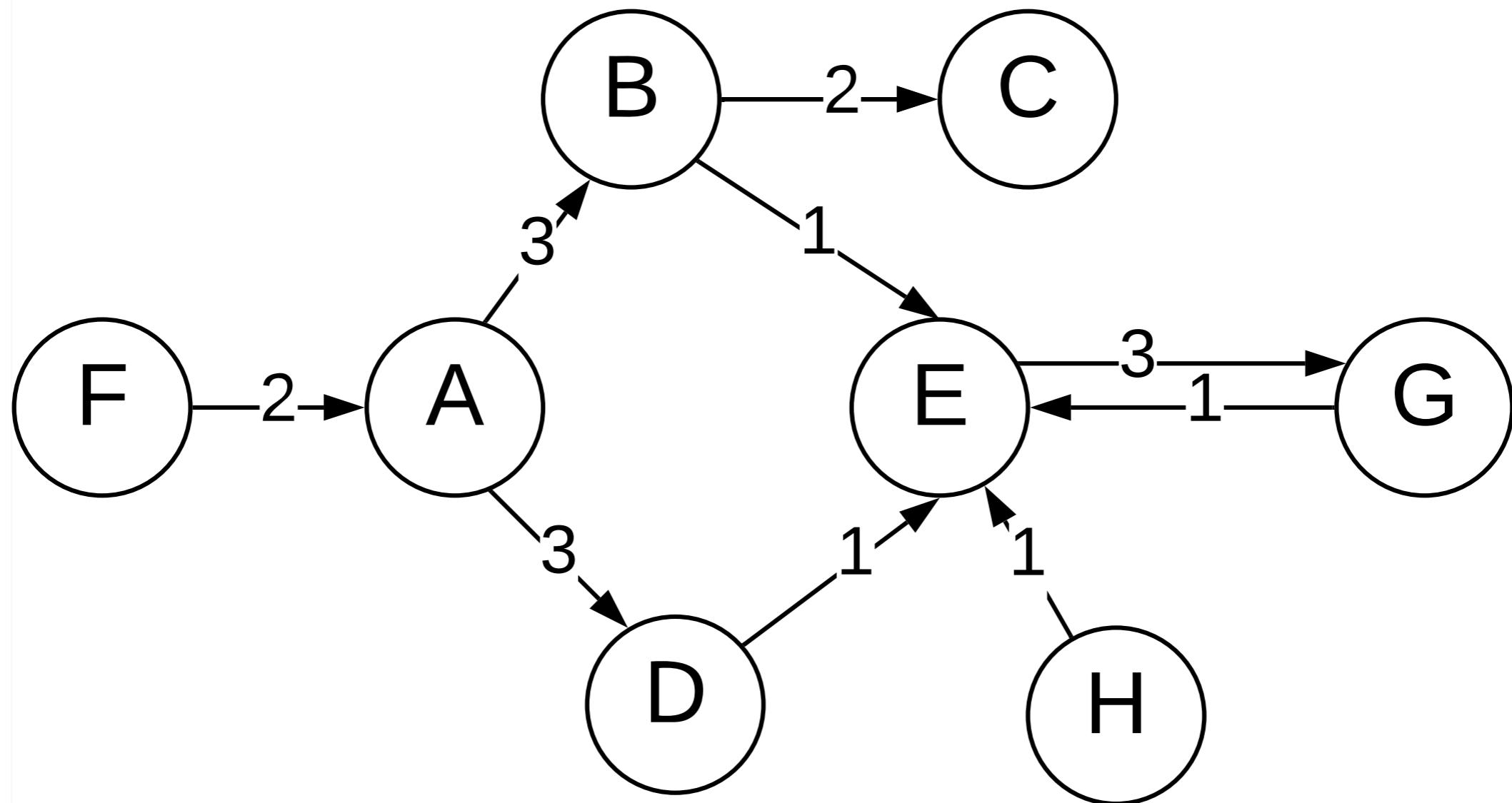


Almost 4.57 billion people were active internet users as of April 2020.

— Statista

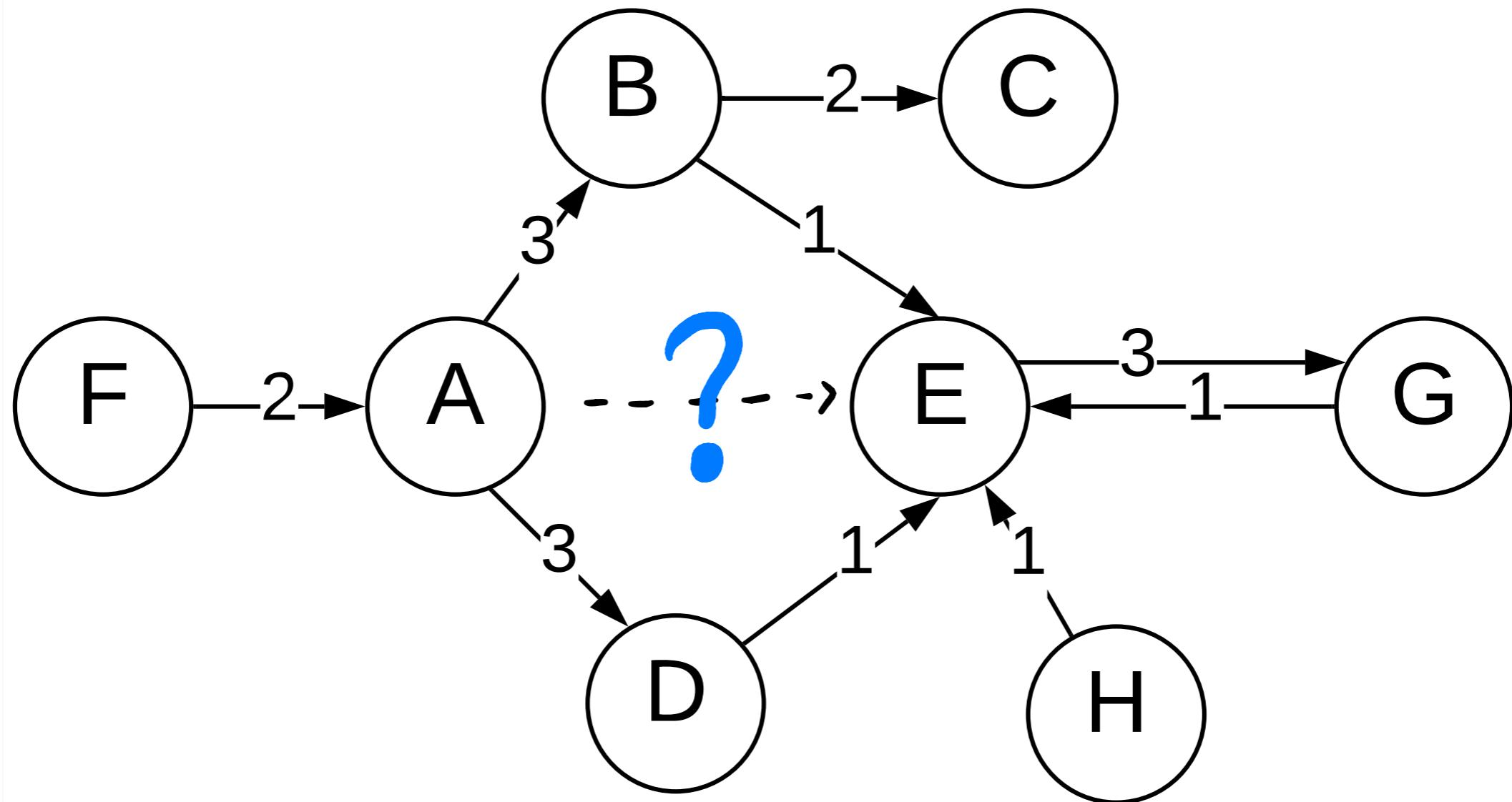
**Social trust** is the basis of  
online social networks.

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.



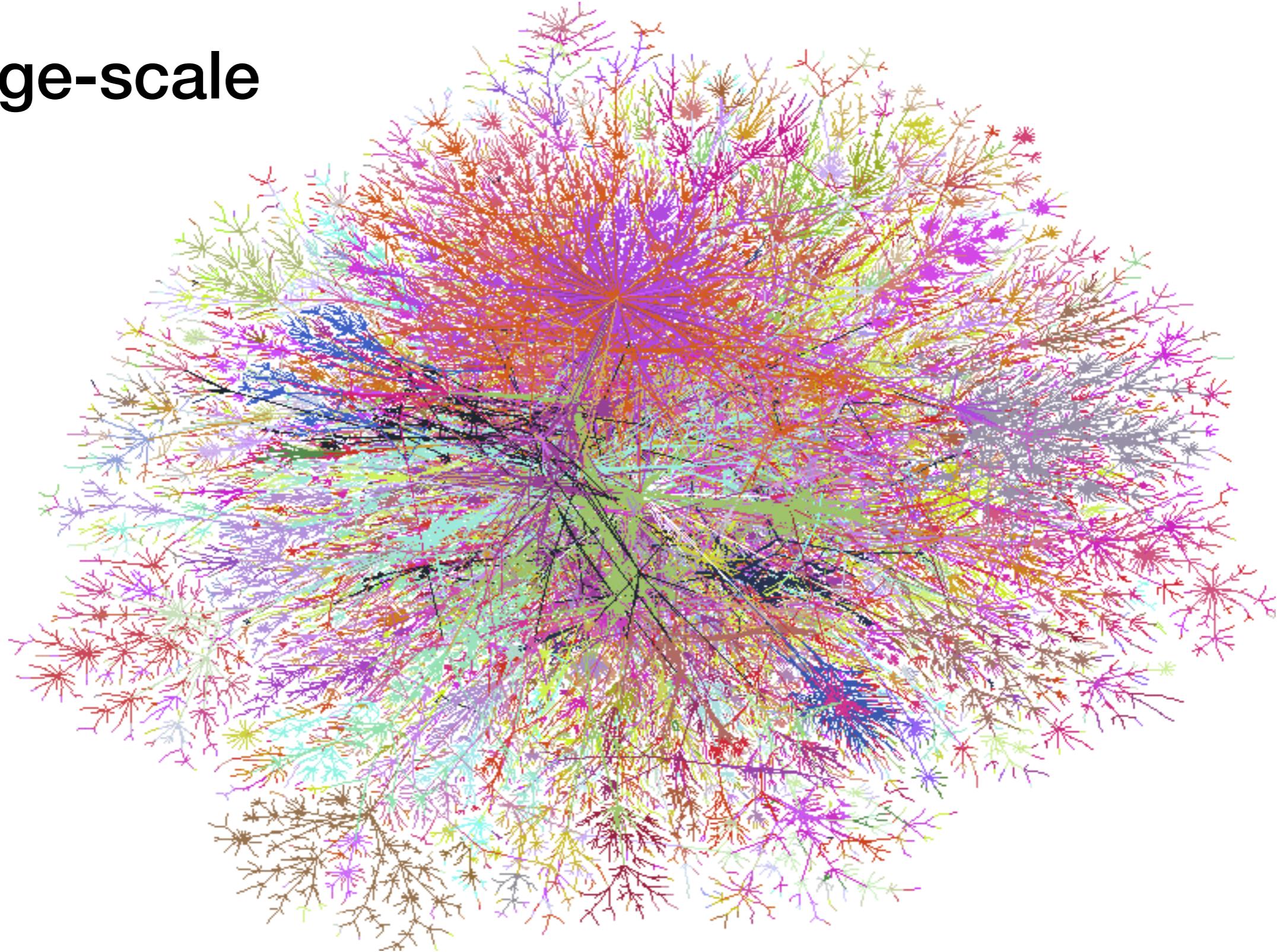
# Network graph

an example



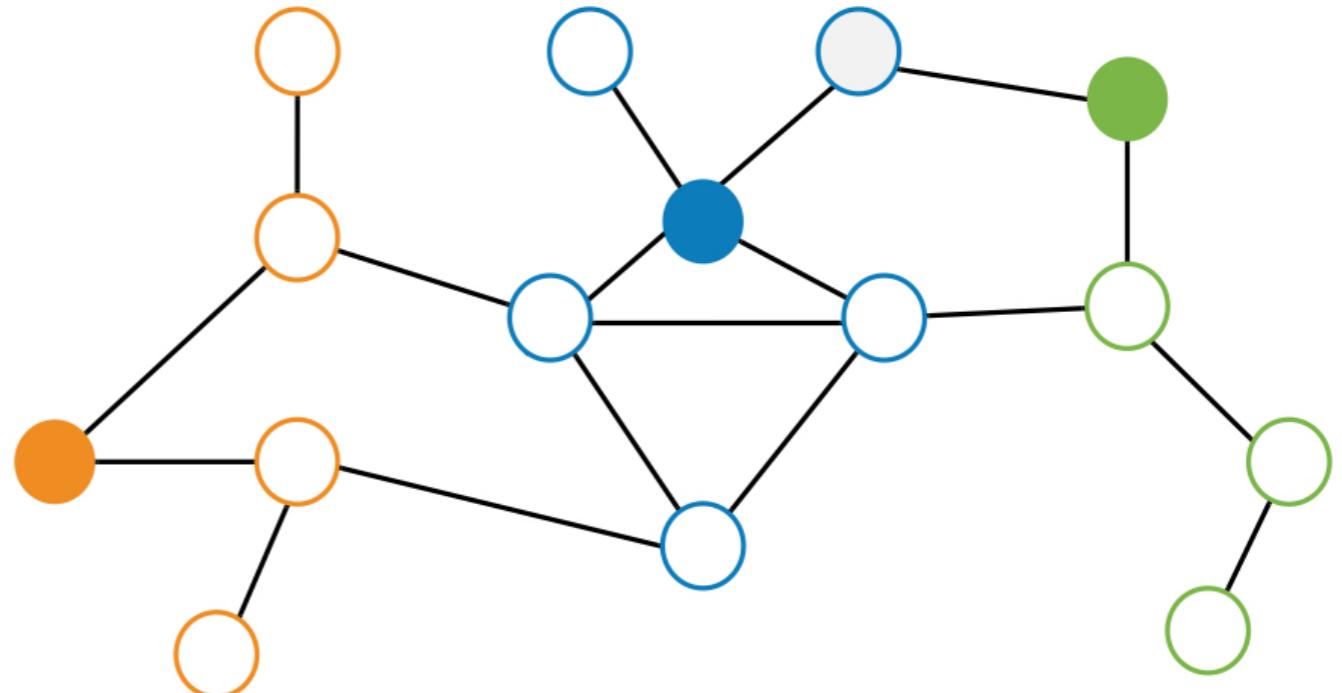
Can A trust E? And, to what extent?

# Large-scale

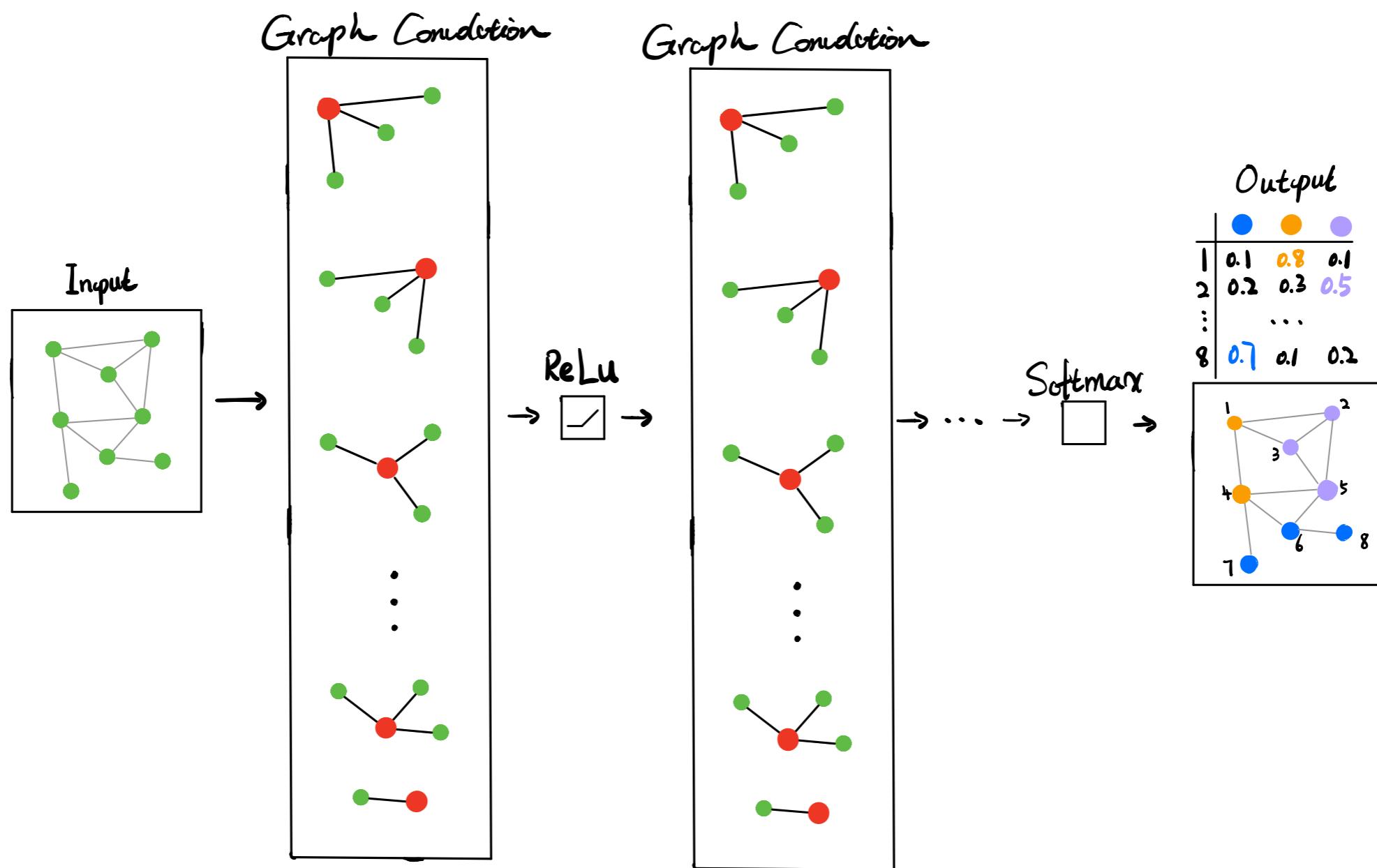


Wait a second ...

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

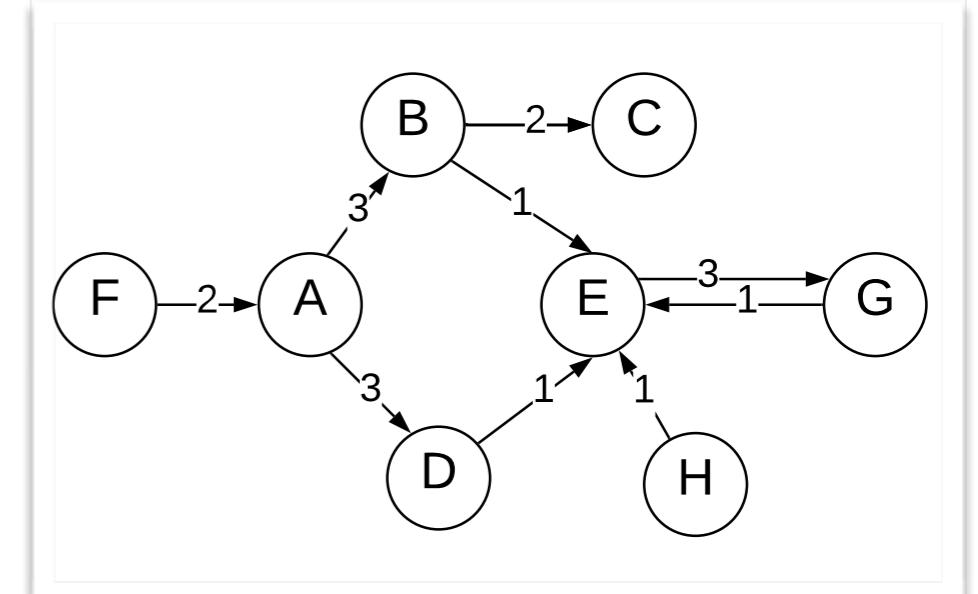


# Representation learning with graph convolutional networks

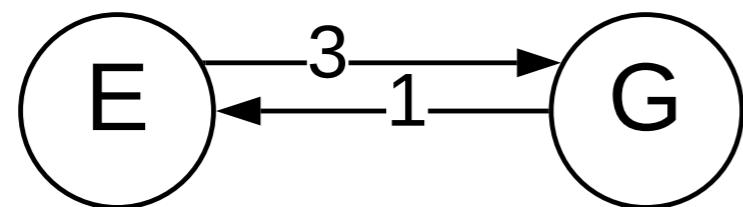


The complexity of model parameters  
are **independent** of the input  
graph size.

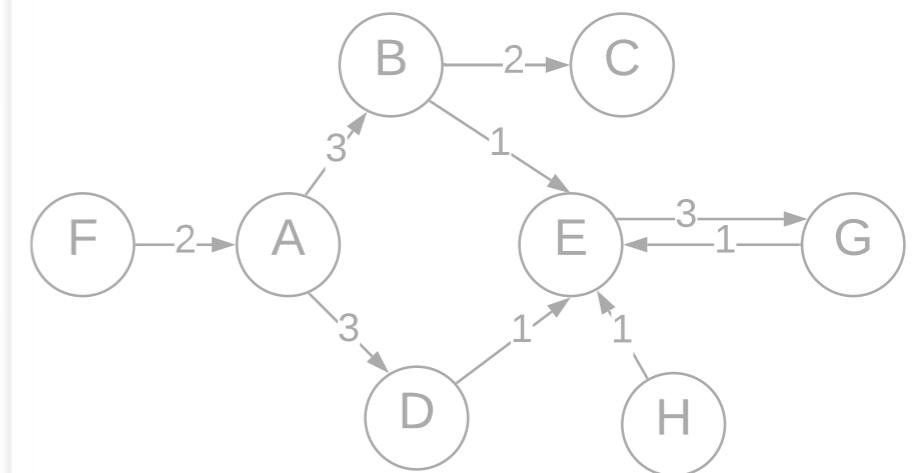
# Preliminaries: trust properties



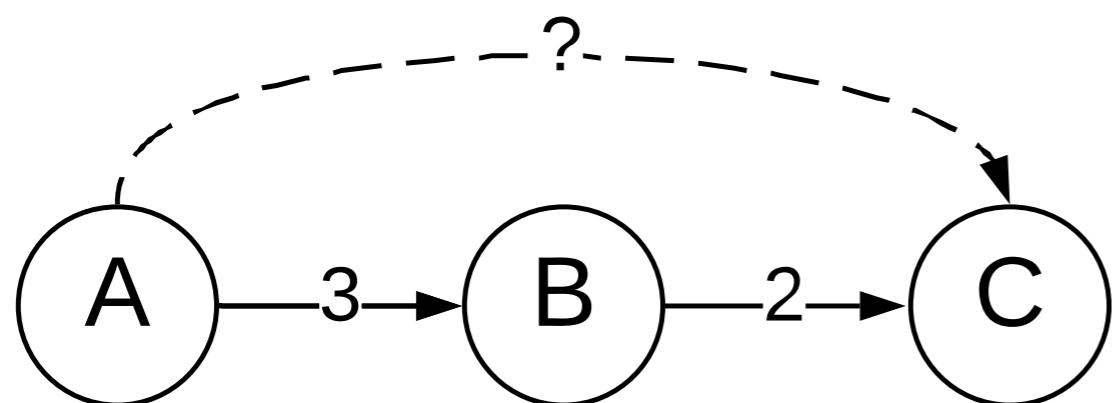
**Asymmetry:** one user may trust someone else more than she is trusted back.



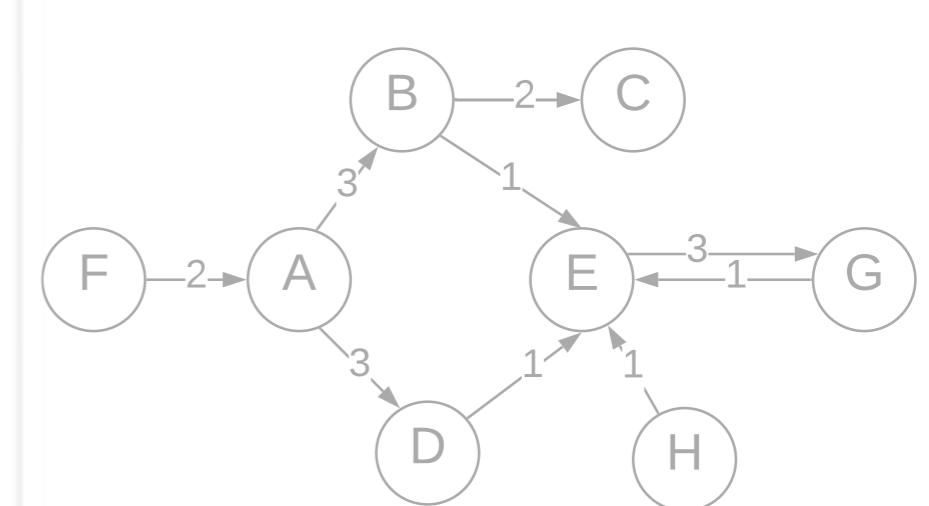
Trust properties



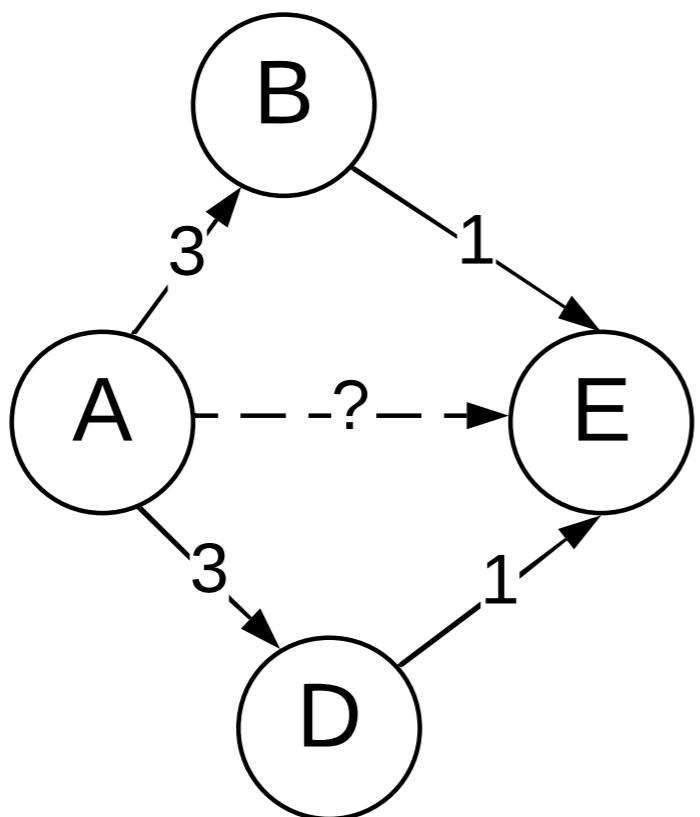
**Propagative nature:** trust may be passed from one user to another, creating chains of social trust that connects two users who are not connected.



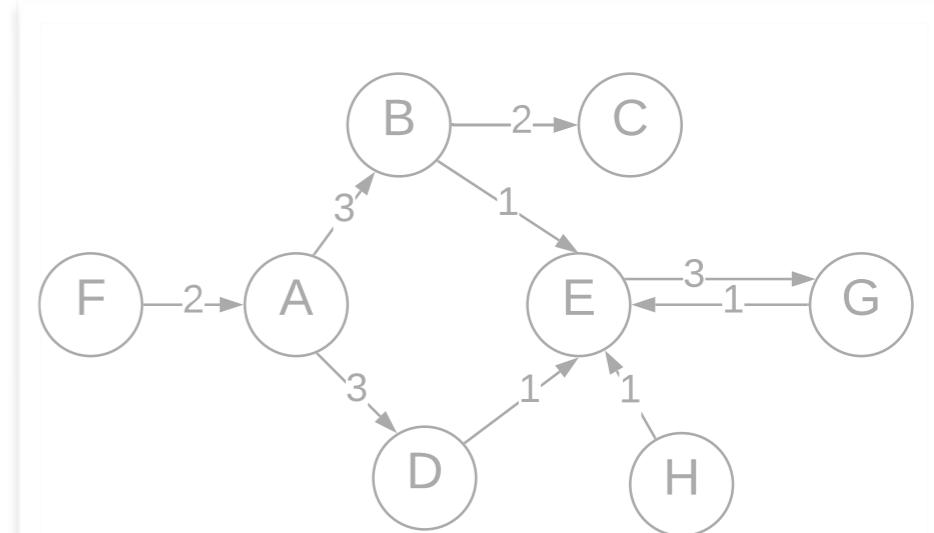
Trust properties



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



Trust properties

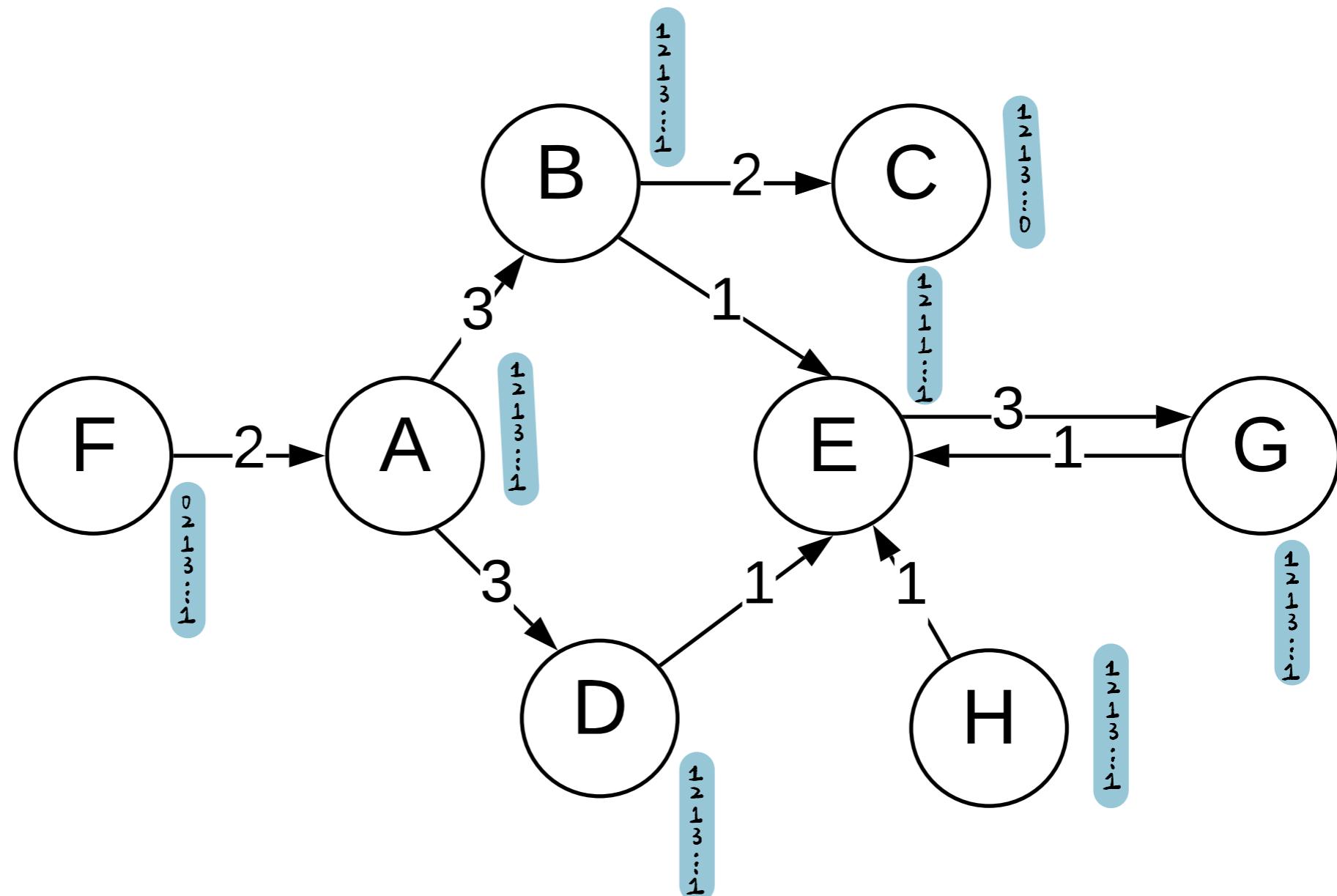


An effective way of evaluating trust should be able to capture these trust properties simultaneously.

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

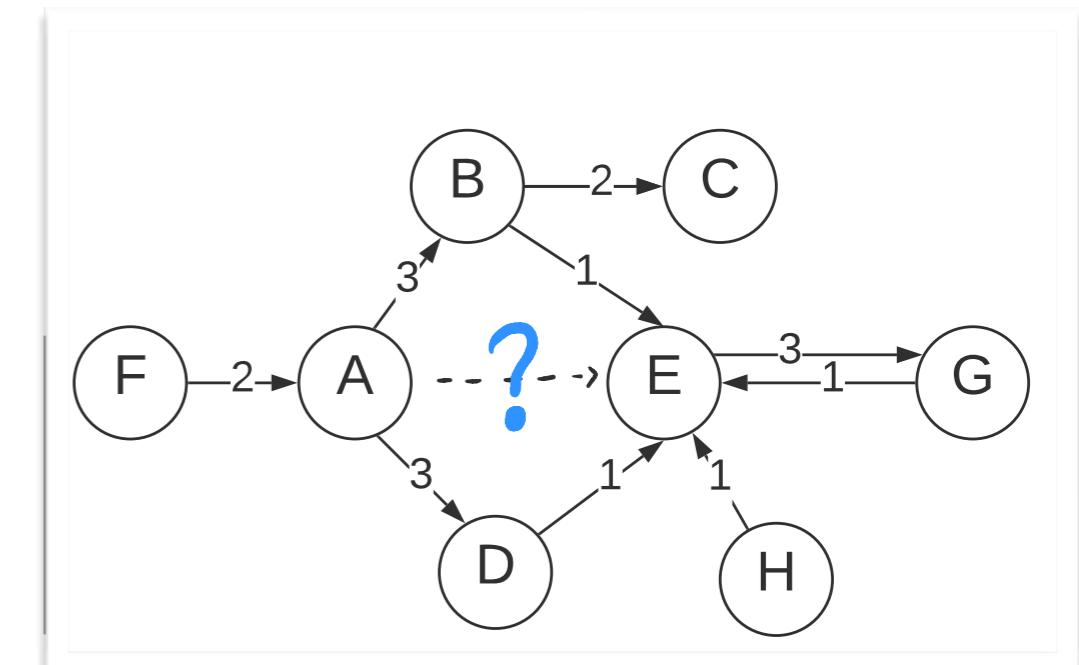
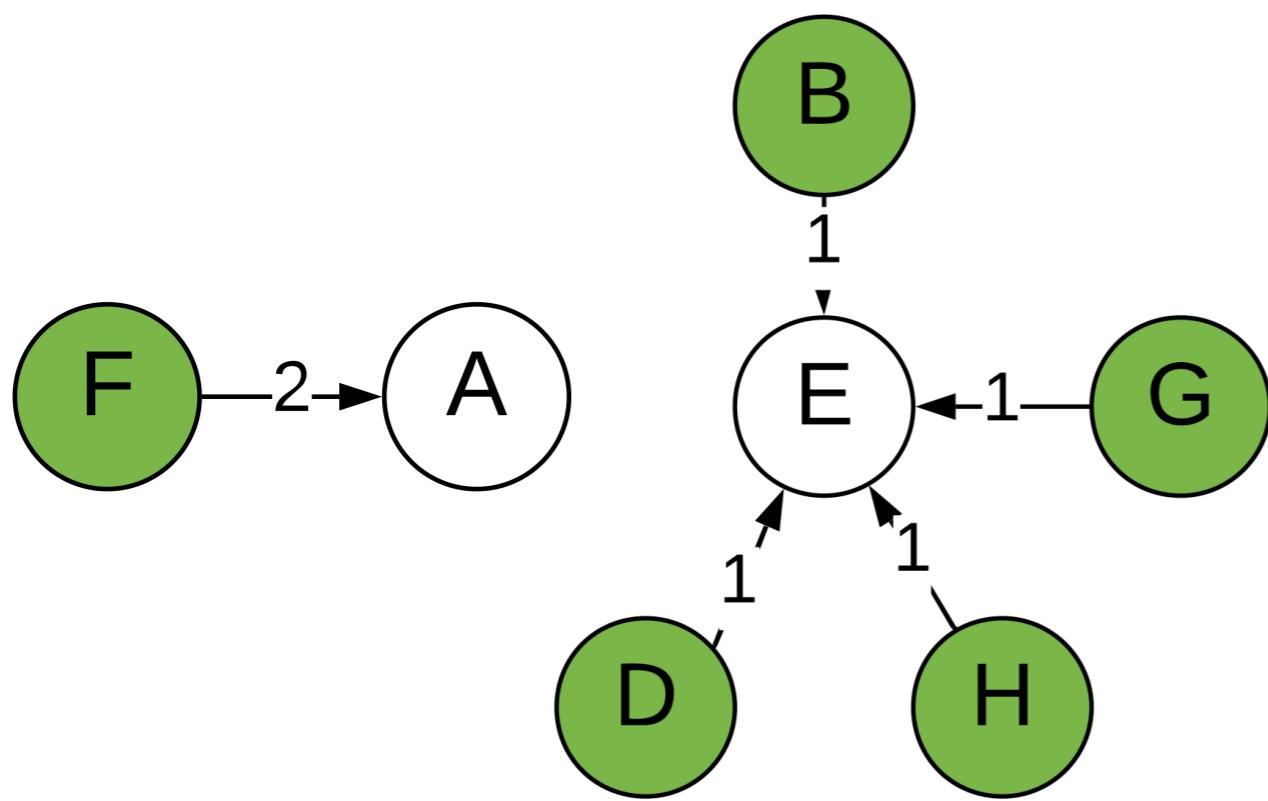
# Embedding layer

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

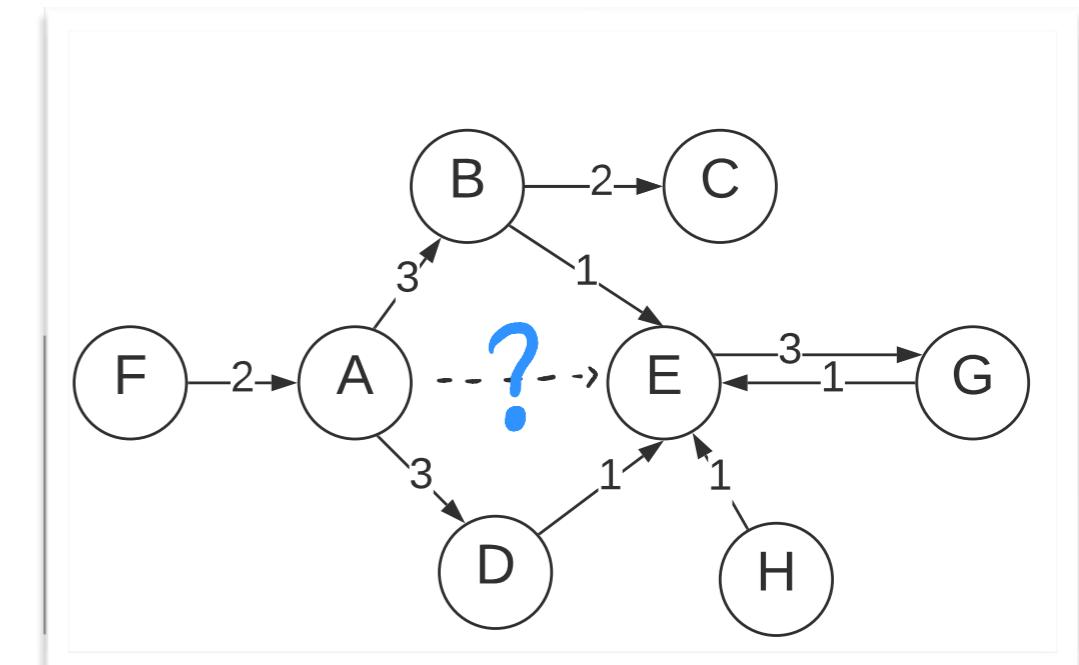
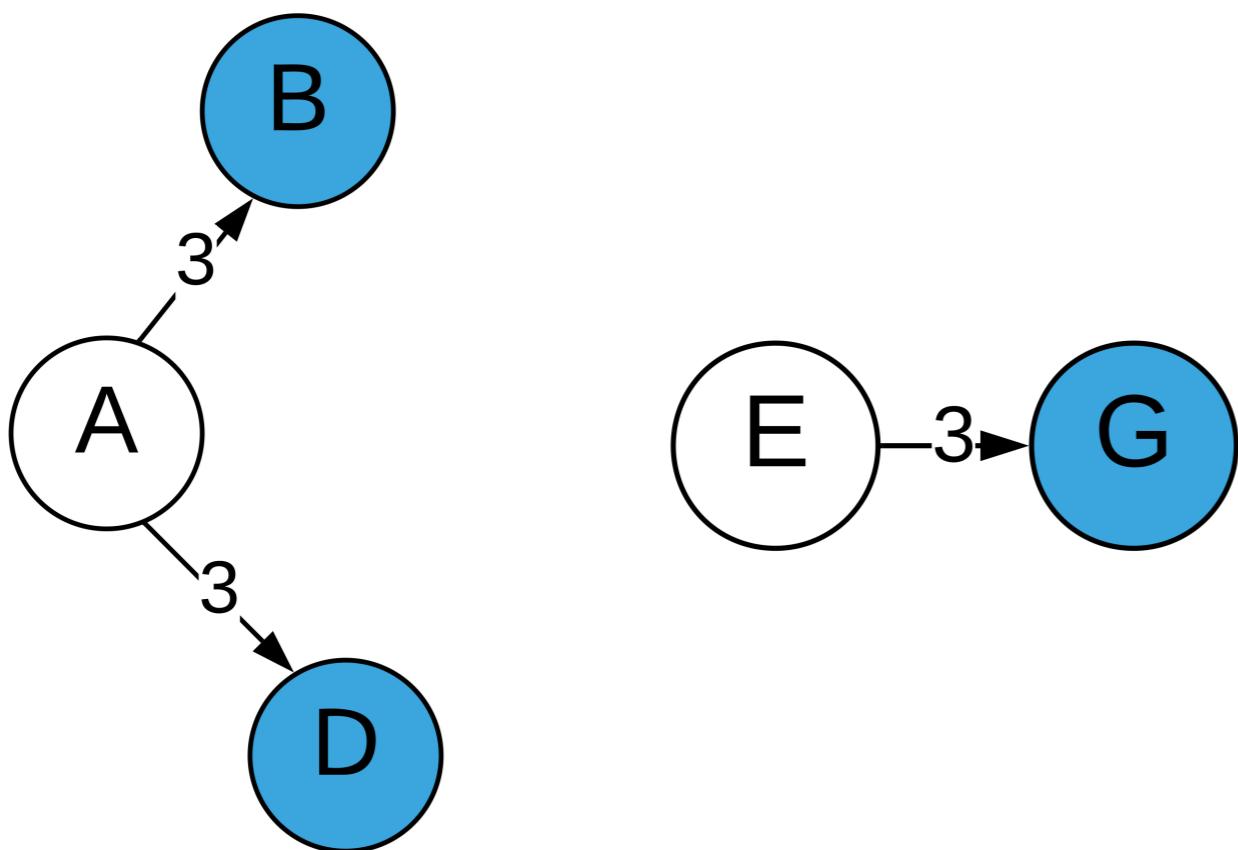


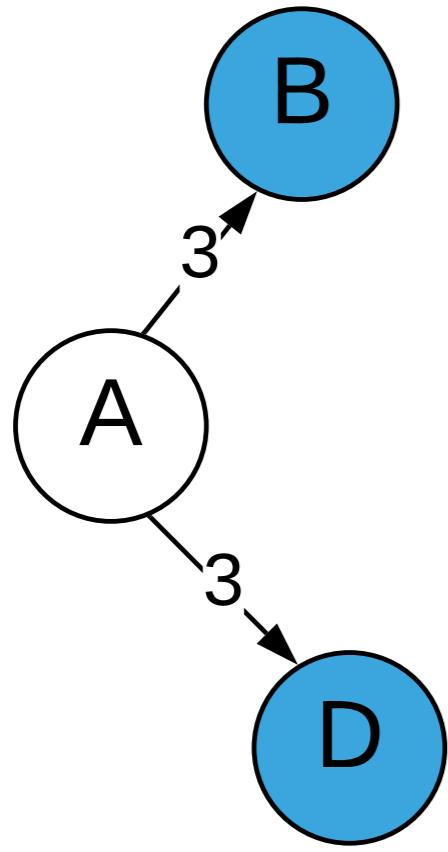
Two types of trust interactions:  
**popularity trust** and **engagement trust**

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

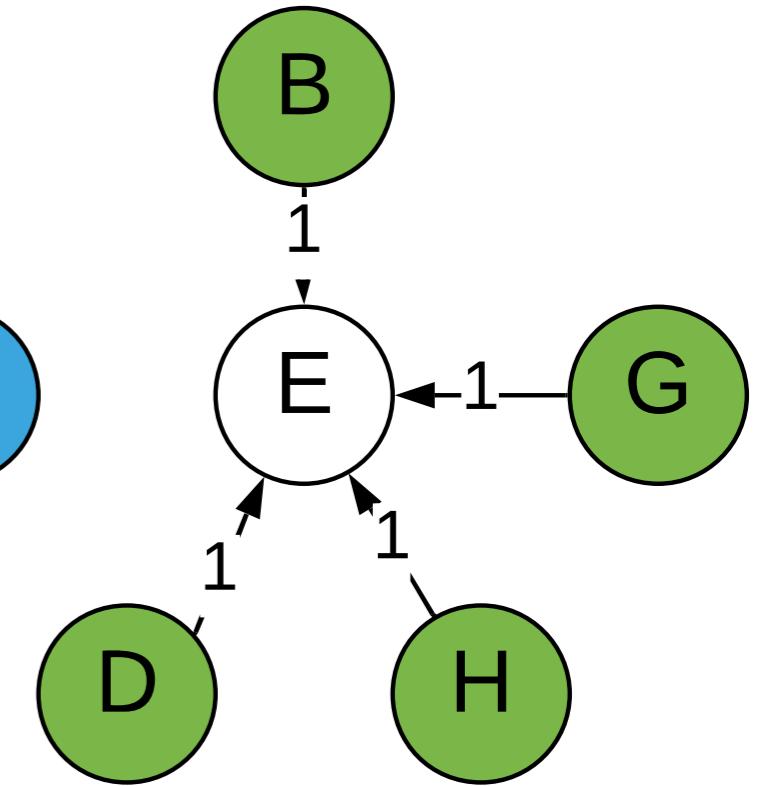
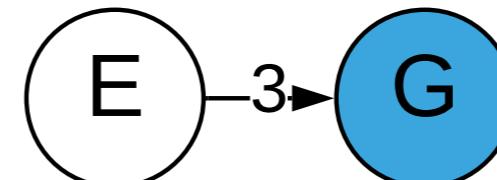
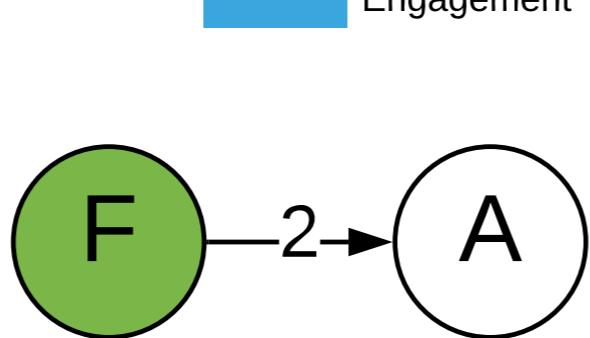


**Engagement trust:** the willingness of a user to trust others (accumulated from the outgoing links)

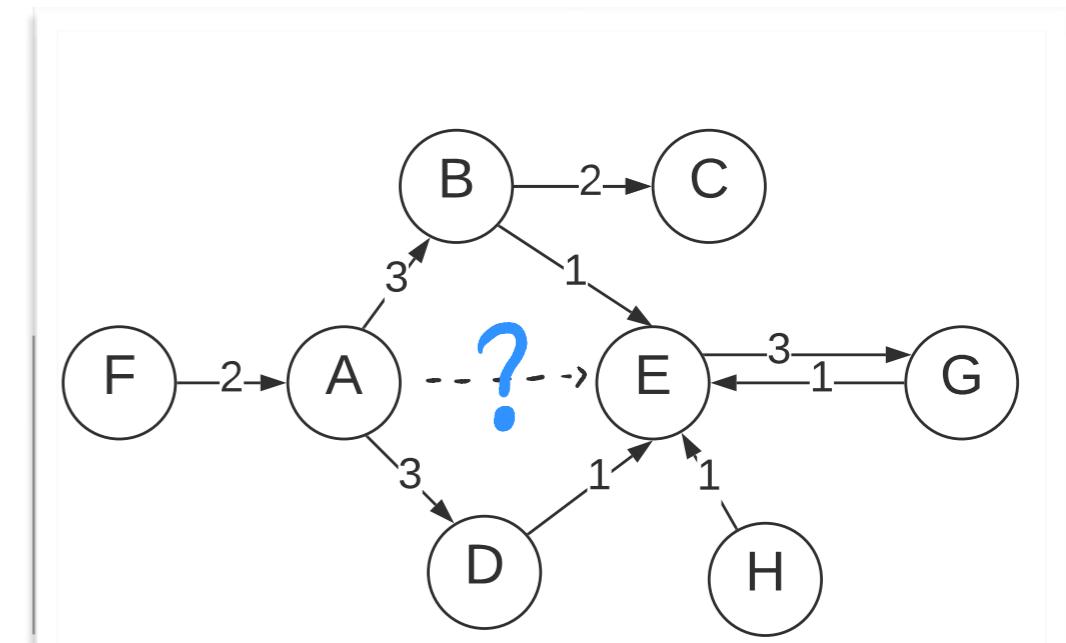




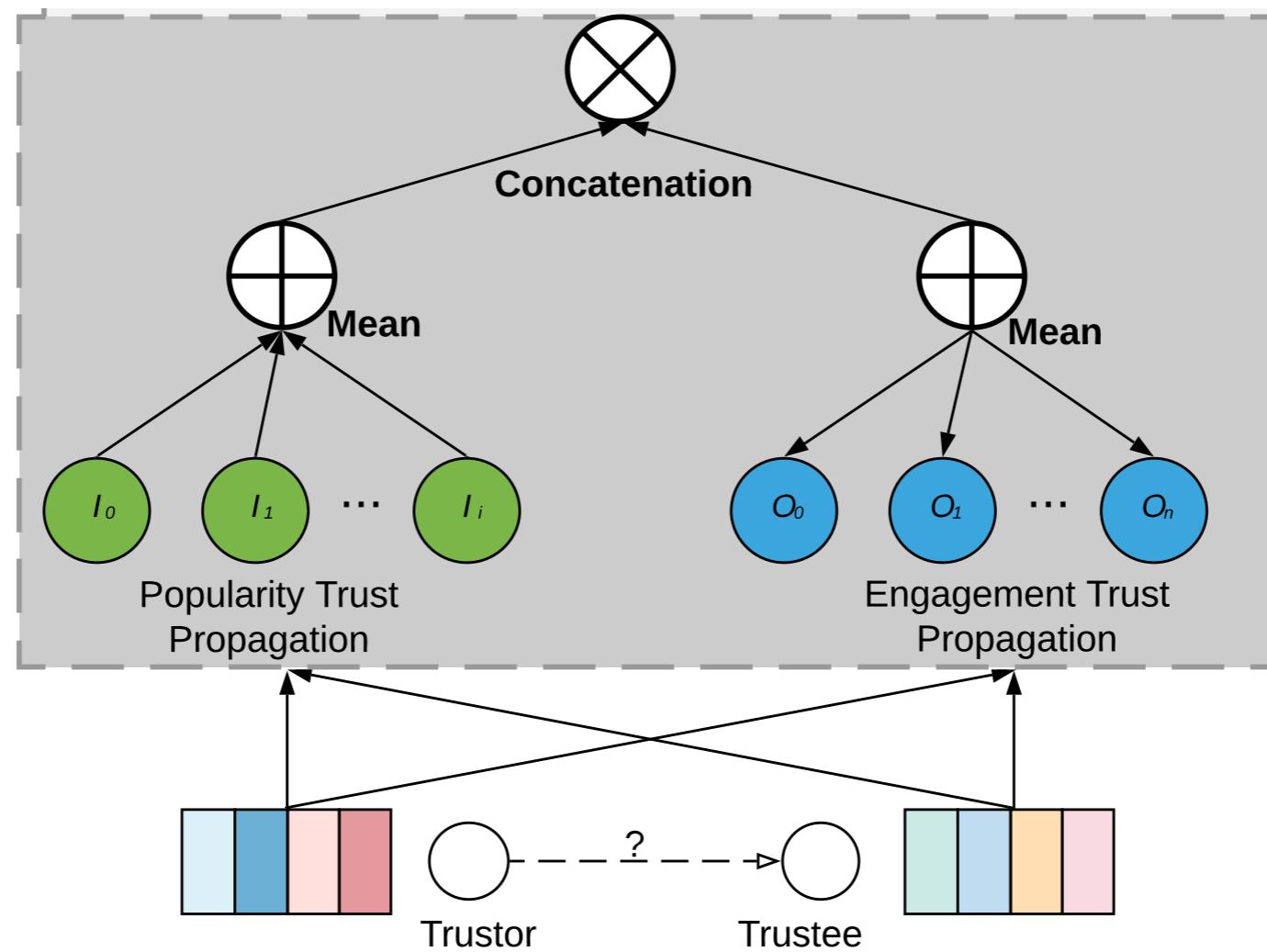
Popularity  
 Engagement



# Two types of trust aggregation

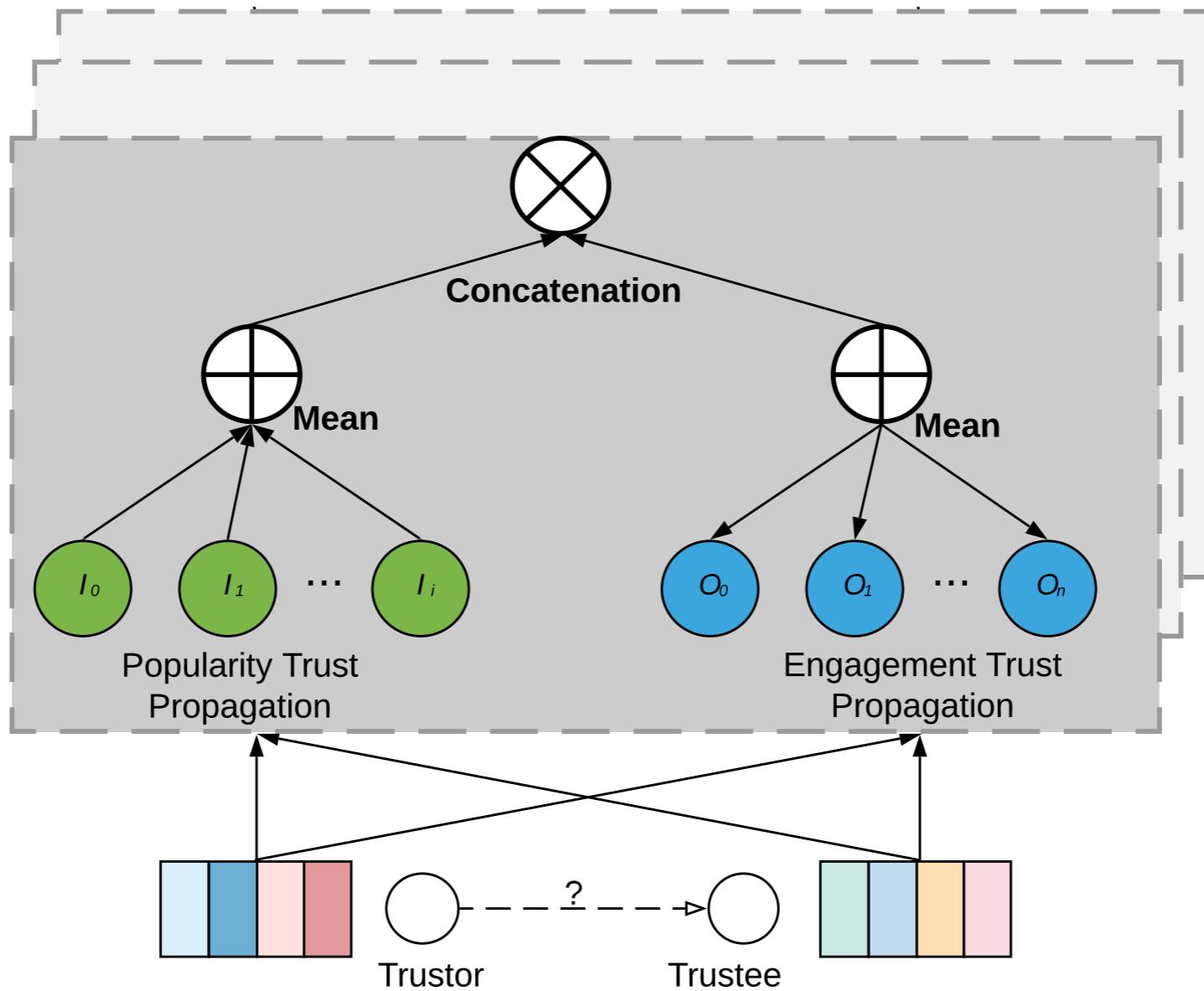


# Trust convolutional layer



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

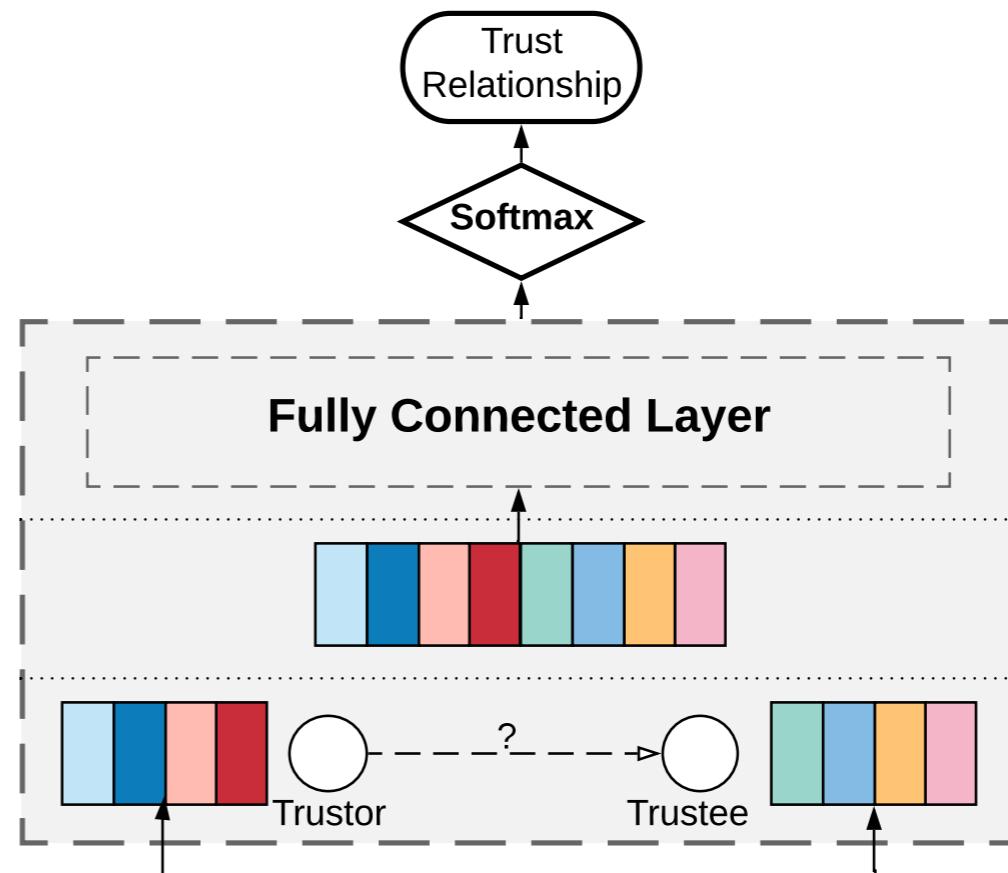
# Stack multiple trust convolutional layers



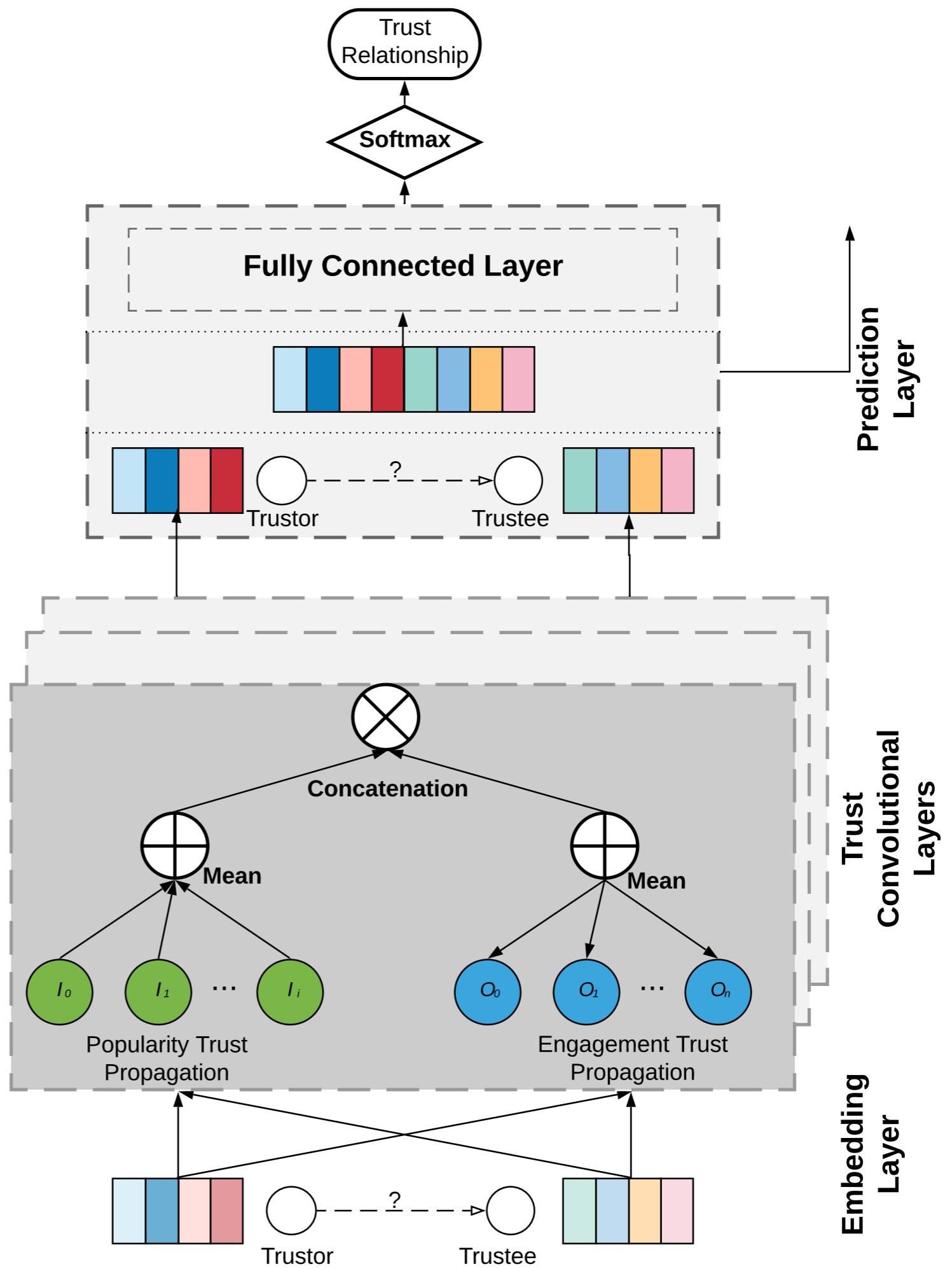
To capture the **propagative nature** of trust

# Prediction layer

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# Guardian



# Our experimental results...

# Datasets Used

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

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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

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# Accuracy

## Evaluation Accuracy on Advogato

APPROACHES	F1-SCORE	MAE
<i>Guardian</i>	<b>74.3%</b>	0.082
NEURALWALK	74.0%	0.081
OPINIONWALK	64.3%	0.228
MATRI	65.6%	0.127

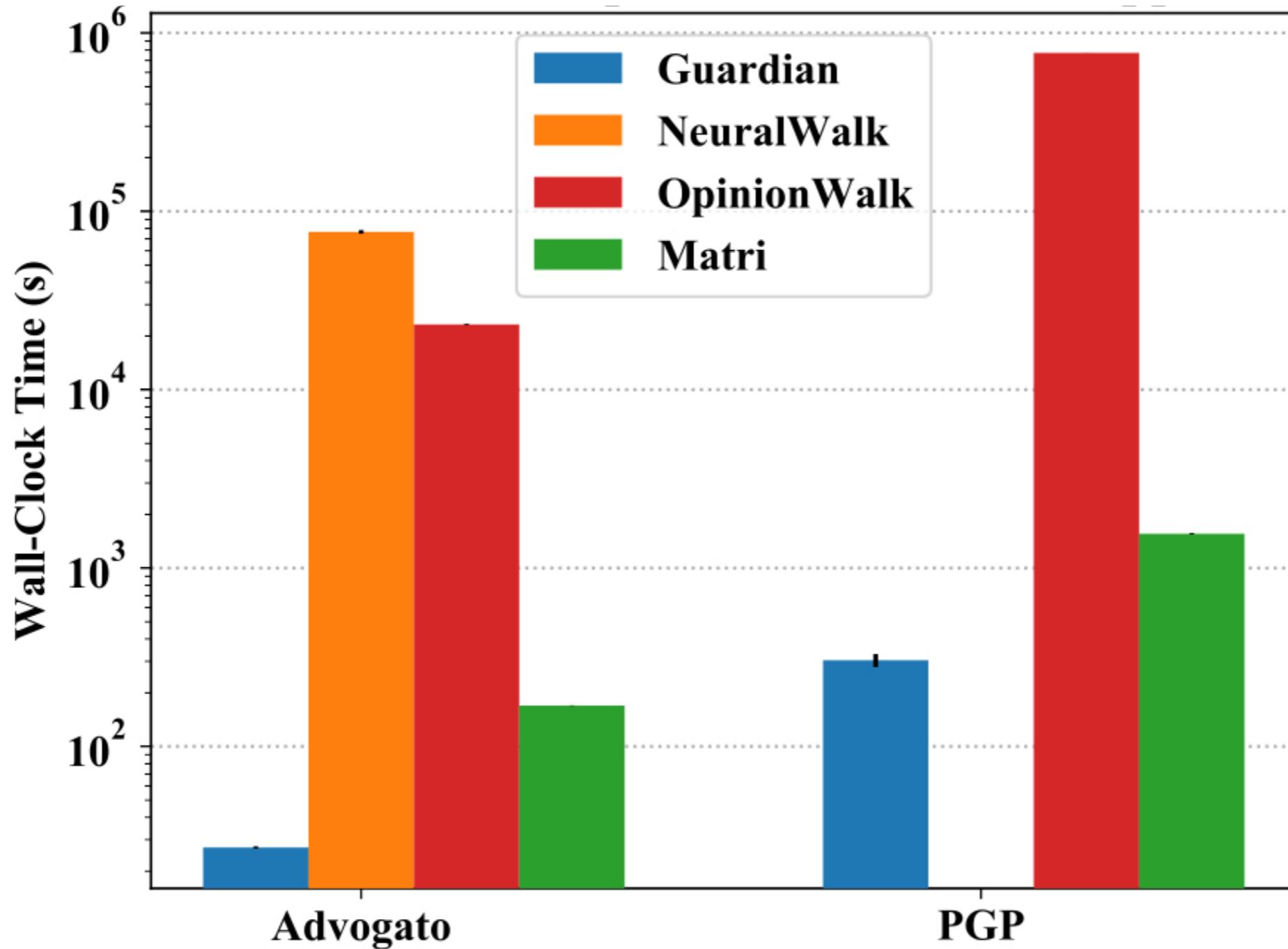
# Accuracy

## Evaluation Accuracy on PGP

APPROACHES	F1-SCORE	MAE
<i>Guardian</i>	<b>87.1%</b>	<b>0.083</b>
NEURALWALK	—	—
OPINIONWALK	67.3%	0.249
MATRI	68.3%	0.122

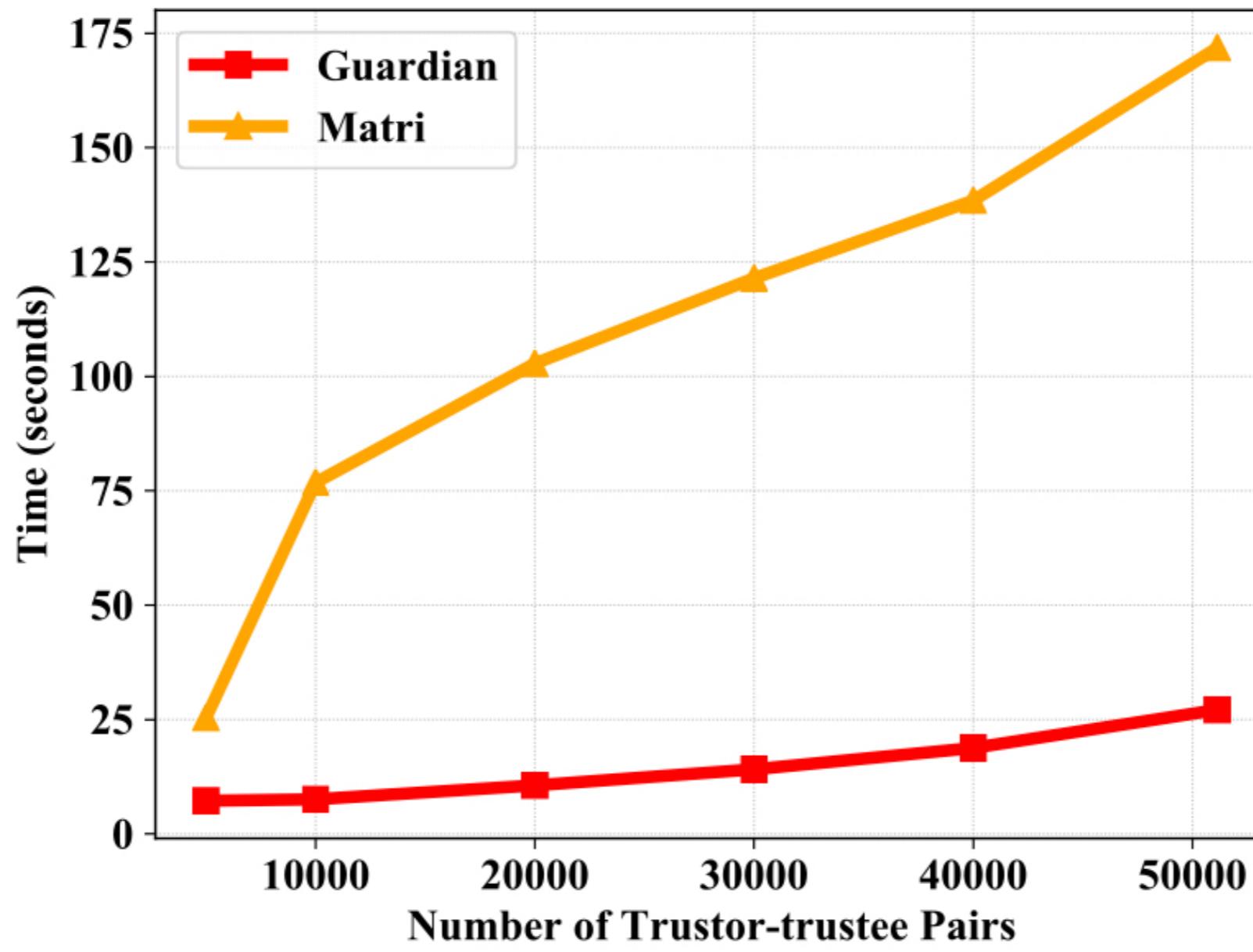
# Efficiency

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# Scalability

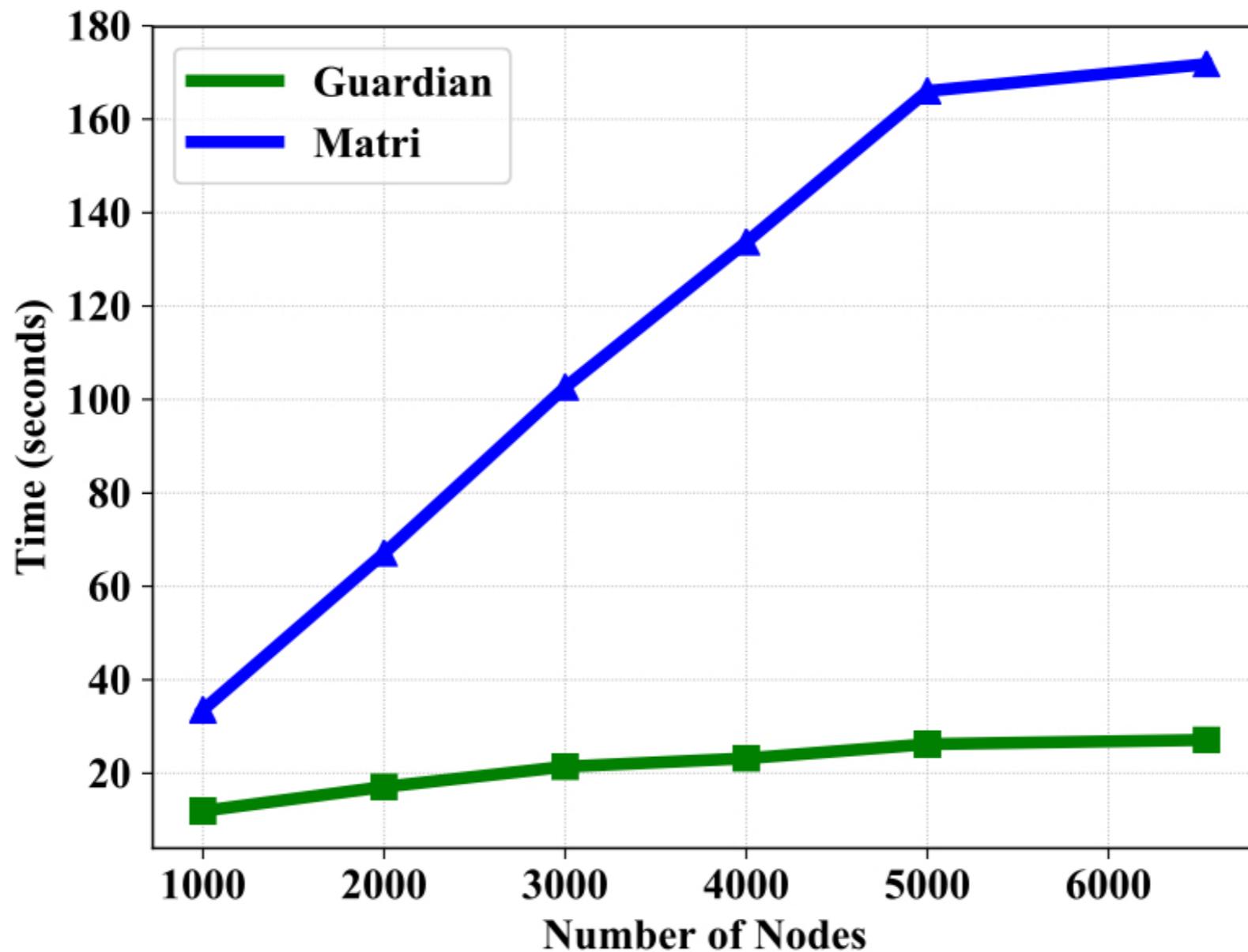
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Time vs. # of pairs

# Scalability

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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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