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On the Social Influence in Human Behavior

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Outline

> Social Influence and Human Behavior Prediction

> Case of Study
  - EBSN

> Communities as sources of influence

> Social Influence (Deep) Learning

> Conclusion and Future Works

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Outline

> **Social Influence and Human Behavior Prediction**

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> Conclusion and Future Works

- ***Social influence***: change in individual's thoughts, feelings, attitudes, or behaviors that results from interaction with another individual or a group.

- ***Application***:
  - Human Behavior Prediction (actions, decisions, mobility)
  - Recommendation (LBSN, EBSN, products)
  - Viral Marketing
  - Targeted Advertising

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Event Based Social Network (EBSN)

- “Plancast is a service for sharing your upcoming plans with friends”.
  - Events attended by the users
  - Location of the events
  - User subscriptions (following/follower)

- Dataset:
  - 93041 users
  - 401634 events
  - 1702058 user subscriptions
  - 869200 user-event participations

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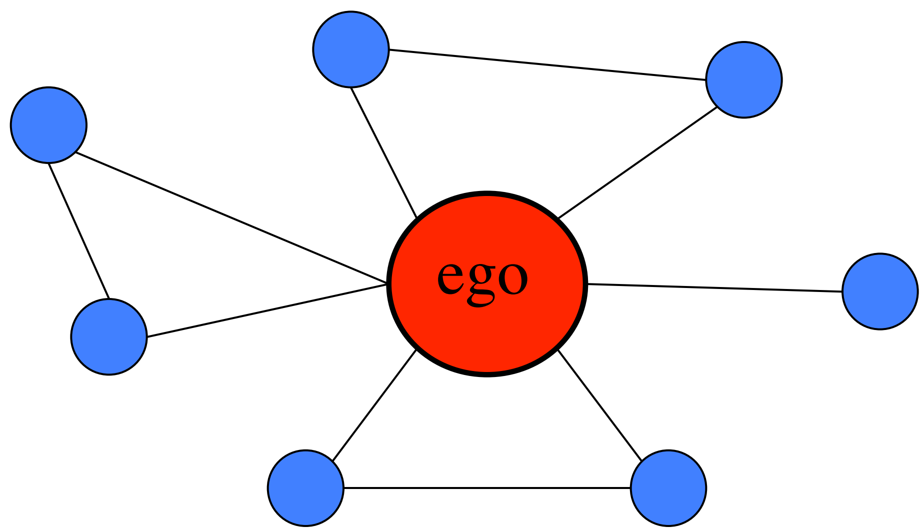
Communities as sources of influence

> The ***ego network*** is typically utilized to represent subject's community and to analyze social influence.



Communities as sources of influence

> *Hypothesis*: individuals are differently influenced by distinct communities related to interlaced factors that affects human behavior, such as physical location, interests, social ties.

Communities as sources of influence

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  - Physical Community

Communities as sources of influence

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  - Physical Community,
  - Homophily Community

Communities as sources of influence

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- *Hypothesis*: individuals are differently influenced by distinct communities related to interlaced factors that affects human behavior, such as physical location, interests, social ties.
  - Physical Community,
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  - Social Community

Communities as sources of influence

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> *Hypothesis*: individuals are differently influenced by distinct communities related to interlaced factors that affects human behavior, such as physical location, interests, social ties.
>
> > Physical Community,
> > Homophily Community,
> > Social Community,
> > and the ego network.

On the Social Influence in Human Behavior: Physical, Homophily, and Social Communities
Luca Luceri, Alberto Vancheri, Torsten Braun, Silvia Giordano

Event Based Social Network (EBSN)

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↓

  - Physical, Homophily, and Social Community
  - Ego network

Event Based Social Network (EBSN)

- Physical, Homophily, and Social Community
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Groups

$\{ego, SC, PC, HC\}$

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Features Creation

> For each user *u*, group *g*, and event *e* we evaluate the feature:

$$p_e^g = \frac{|\{i \in g | e \in A_i\}|}{|g|}$$

where

- A_i are the events attended by user i
- $g = \{ego, SC, PC, HC\}$

Features Creation

u_1	ego	SC	PC	HC
e_1	0.3	0.2	0.7	0.8
e_2	0.6	0.7	0.1	0.3
e_3	…			
…		…		
…			…	
e_N				…

Participation Prediction

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Performances

TABLE I: Prediction performances comparison.

	DT	SVM	DNN
Accuracy	77%	81%	81%
Precision	74%	84%	85%
Recall	72%	76%	75%

Participation Prediction

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TABLE II: Prediction performances utilizing one feature among $\{ego, SC, PC, HC\}$.

	$\boldsymbol{ego}$	$\boldsymbol{SC}$	$\boldsymbol{PC}$	$\boldsymbol{HC}$
Accuracy	77%	77%	77%	76%
Precision	81%	81%	82%	82%
Recall	72%	71%	69%	67%

Participation Prediction

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Recall	72%	71%	69%	67%

TABLE III: Prediction performances comparison: all features vs. fixed feature vs. feature selection.

	all features	fixed feature	feature selection
Accuracy	81%	77%	80%
Precision	84%	82%	84%
Recall	76%	70%	76%

Participation Prediction

Performances

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Recall	76%	70%	76%

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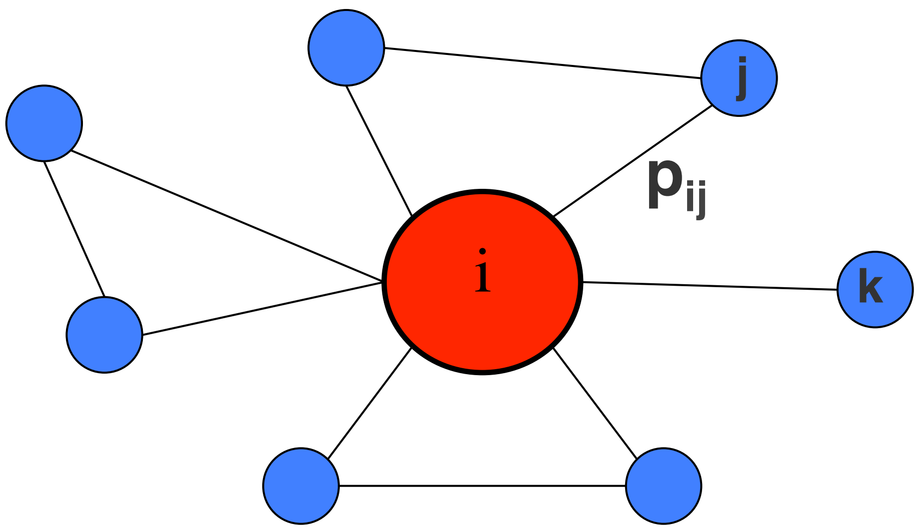
> ## Social Influence Learning: *State of the Art*



$$P_i(e) = 1 - \prod_{j \in pf(i)} (1 - p_{ij})$$

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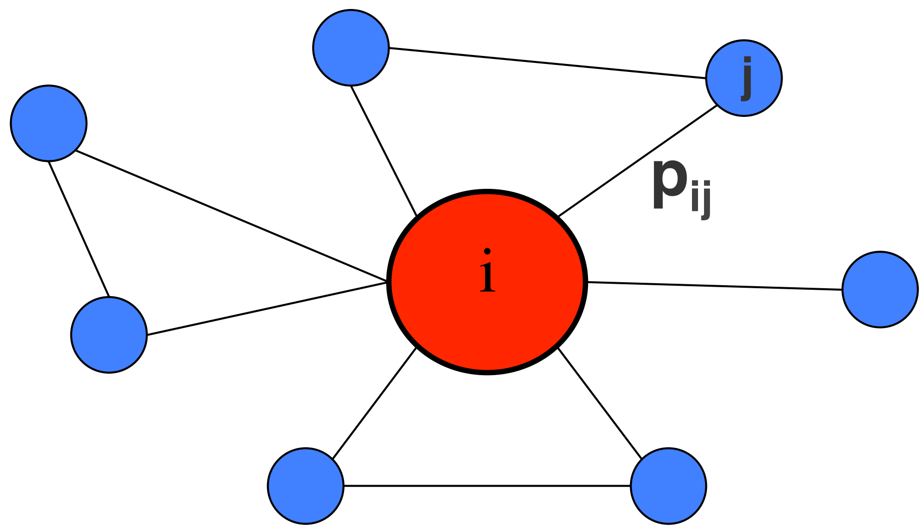
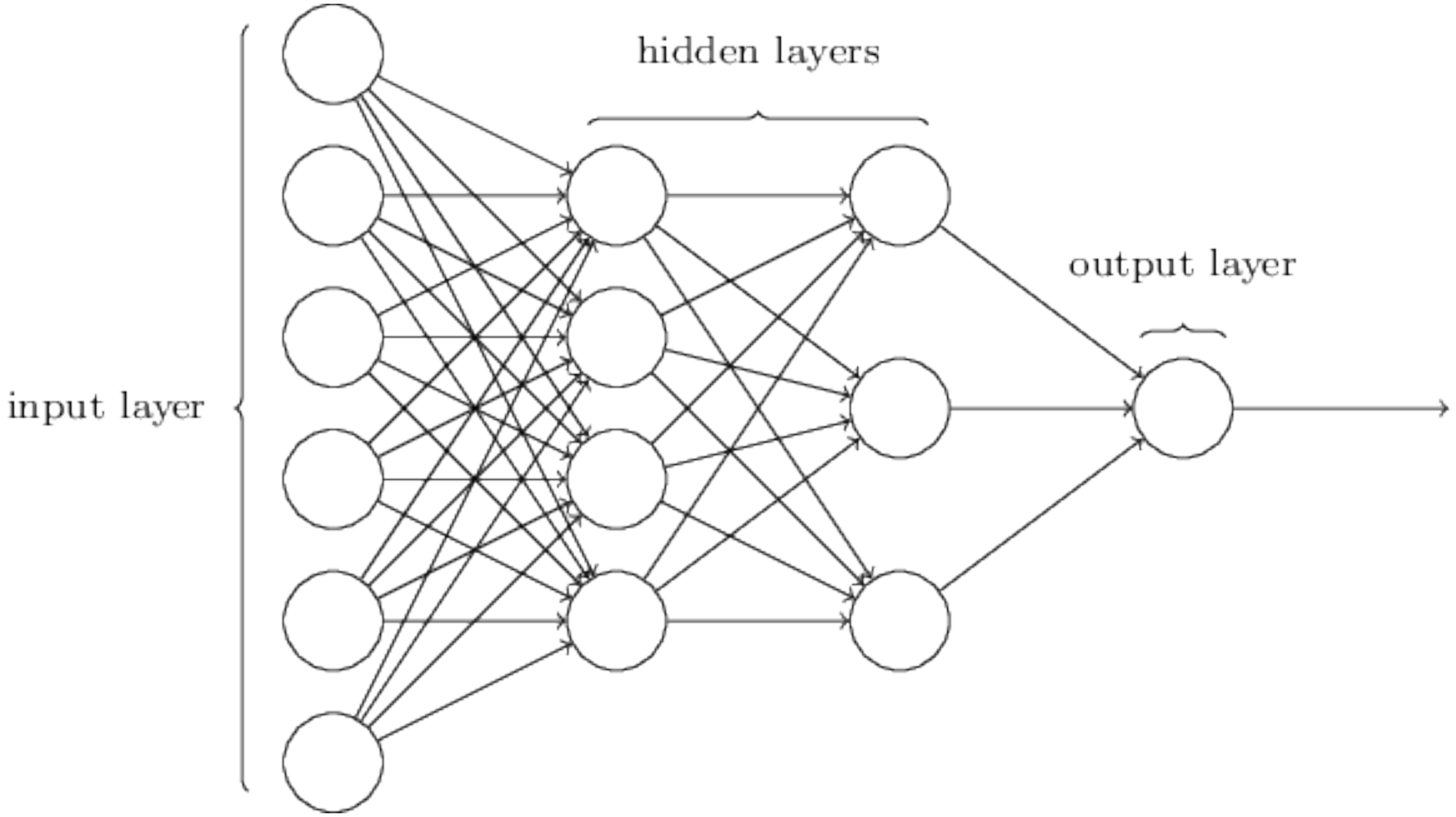
> Social Influence Learning: *State of the Art*



$$P_i(e) = 1 - \prod_{j \in pf(i)} (1 - p_{ij}) \Longrightarrow P_i(e) = \begin{cases} 1 & if\ P_i(e) > \theta \\ 0 & otherwise \end{cases}$$

> *Our Approach: Deep Neural Network (DNN)*



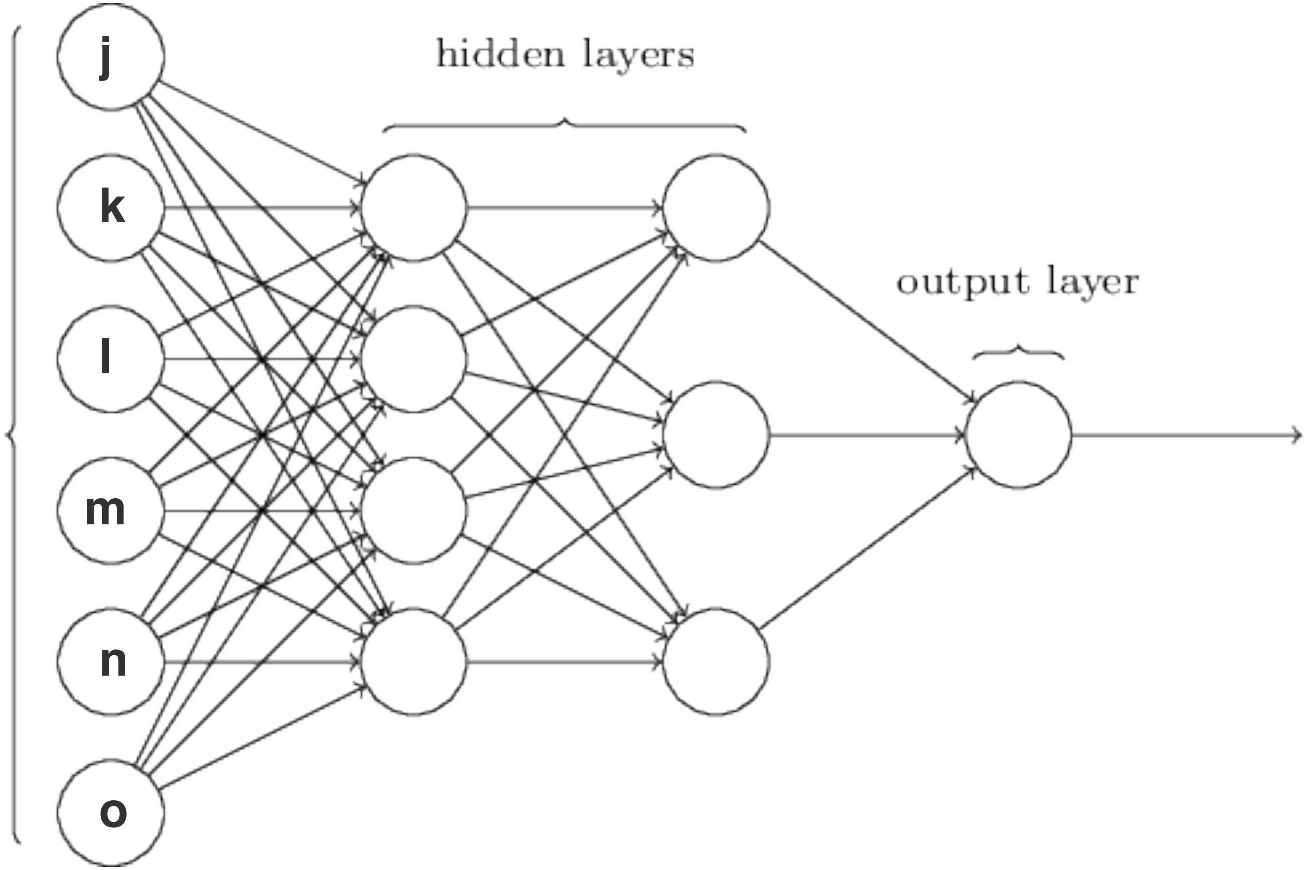
Social Influence (Deep) Learning

Our Approach: Deep Neural Network (DNN)

DNN of user i

x: input layer

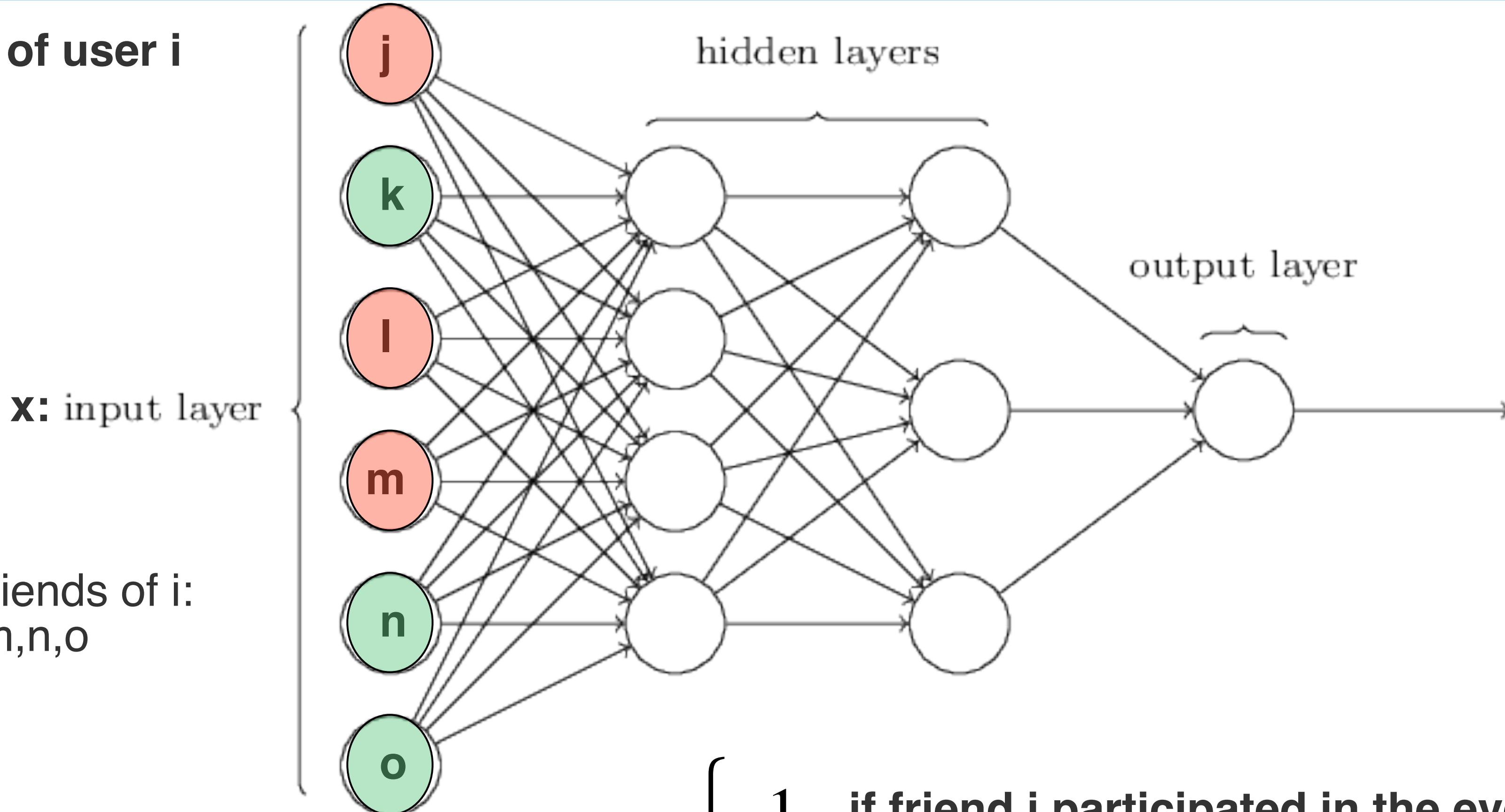
x = friends of i:
j,k,l,m,n,o



Social Influence (Deep) Learning

Our Approach: Deep Neural Network (DNN)

DNN of user i

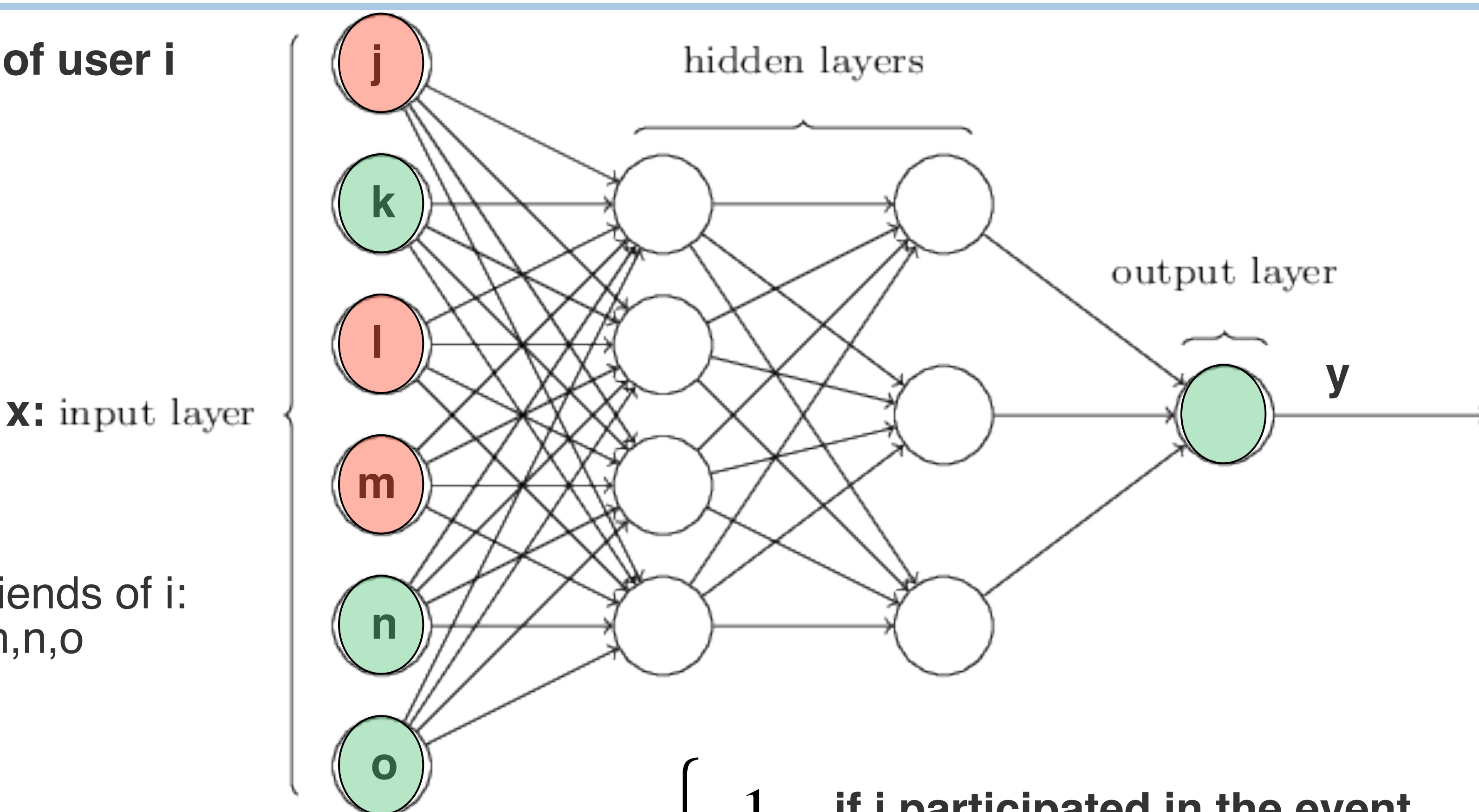


x = friends of i:
j,k,l,m,n,o

$$x_j = \begin{cases} 1 & \text{if friend j participated in the event} \\ 0 & \text{otherwise} \end{cases}$$

Our Approach: Deep Neural Network (DNN)

DNN of user i



x = friends of i: j,k,l,m,n,o

$$y = \begin{cases} 1 & \textbf{if i participated in the event} \\ 0 & \textbf{otherwise} \end{cases}$$

Social Influence (Deep) Learning

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Results

	DNN	GT(1)	IC(2)
Accuracy	85%	78%	75%
TPR	75%	74%	54%
FPR	5%	14%	4%

> (1) Goyal, Amit, Francesco Bonchi, and Laks VS Lakshmanan. "Learning influence probabilities in social networks." Proceedings of the third ACM international conference on Web search and data mining.

> (2) Saito, Kazumi, Ryohei Nakano, and Masahiro Kimura. "Prediction of information diffusion probabilities for independent cascade model." Knowledge-based intelligent information and engineering systems.

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Conclusion and Future Works

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> We introduced a novel interpretation of physical, homophily, and social community, as sources of social influence

> We proved that the ego network alone is not sufficient to model social influence

> We proposed a new method to learn social influence and predict human behavior

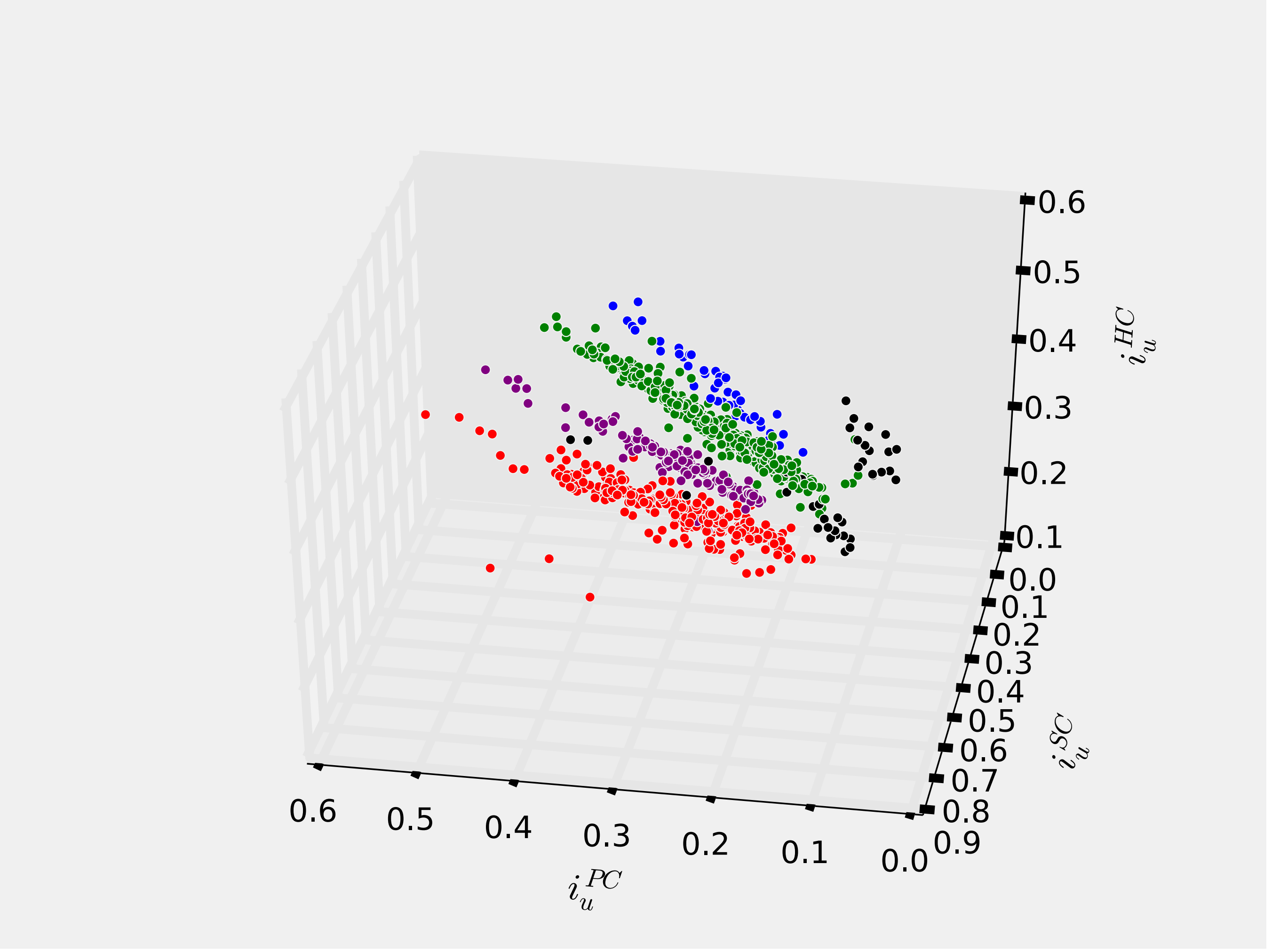
Conclusion and Future Works

- Merge the two works in a unique Social Influence framework: include SC, HC, PC in the DNN
- Validate it with different datasets
- Include Social Influence framework in an application scenario, e.g. recommendation:
  - LBSN
  - EBSN

Q & A

Community-Features Correlation

Results



Community-Features Correlation

- For each user *u*, group *g*, and event *e* we evaluate the feature:

$$p_e^g = \frac{|\{i \in g | e \in A_i\}|}{|g|}$$

  where A_i are the events attended by user *i.*

- We utilize the four features related to the groups to:
  - infer users participation to the events;
  - evaluate the relation among the communities and classify users accordingly.

User Classification

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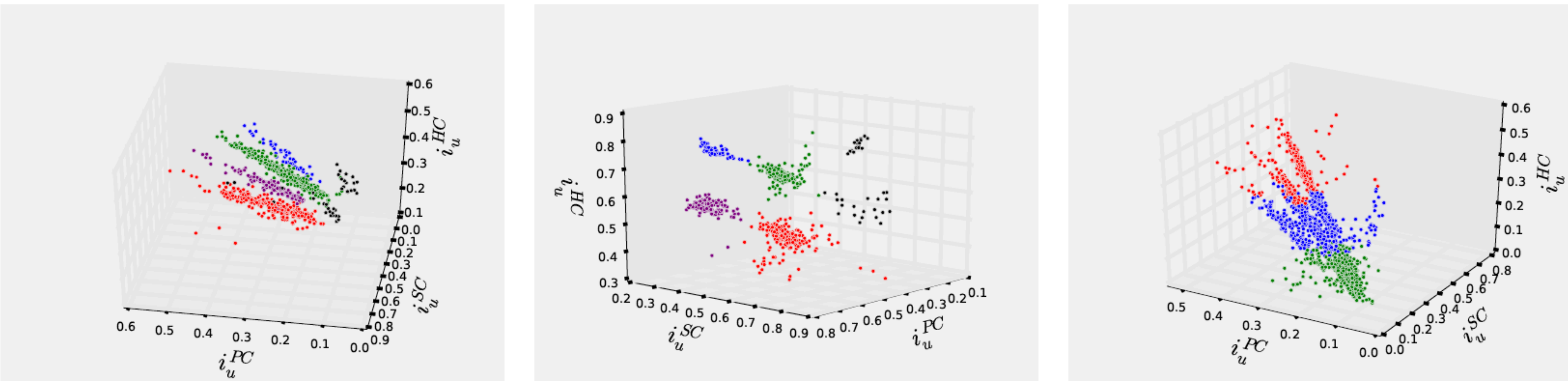

TABLE V: Performance of the prediction based on both fingers and classes of influence.

	average	low	medium	high
Accuracy	82%	74%	83%	89%
Precision	84%	75%	86%	92%
Recall	79%	73%	78%	85%

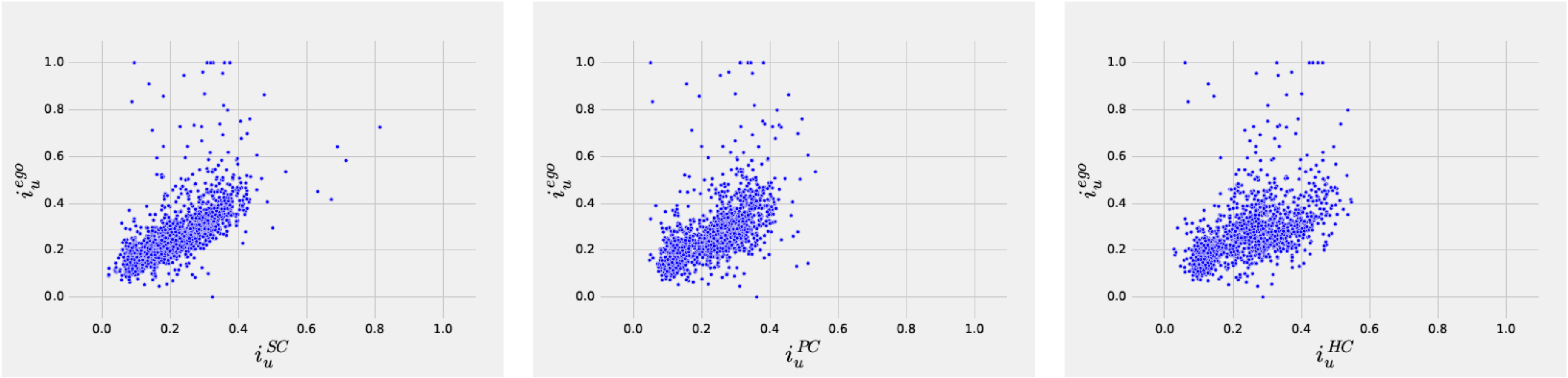

Fig. 1: Scatter plots of i_u^{ego} vs. i_u^{SC}, i_u^{PC}, and i_u^{HC}. Each point represents a user.