国际人工智能会议
AAAI 2021 论文北京预讲会

Towards Consumer Loan Fraud Detection: Graph Neural Networks with Role-Constrained Conditional Random Field

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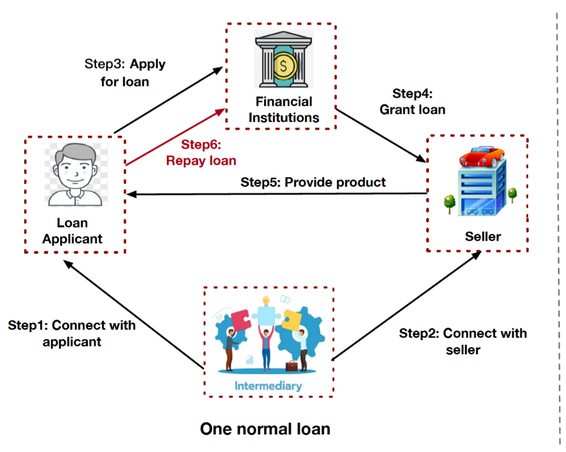
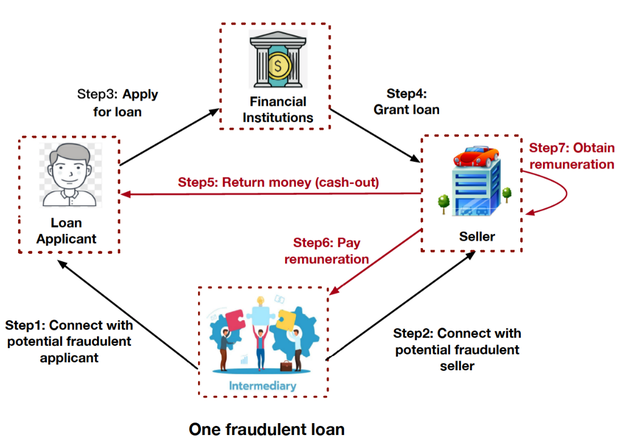
INTRODUCTION

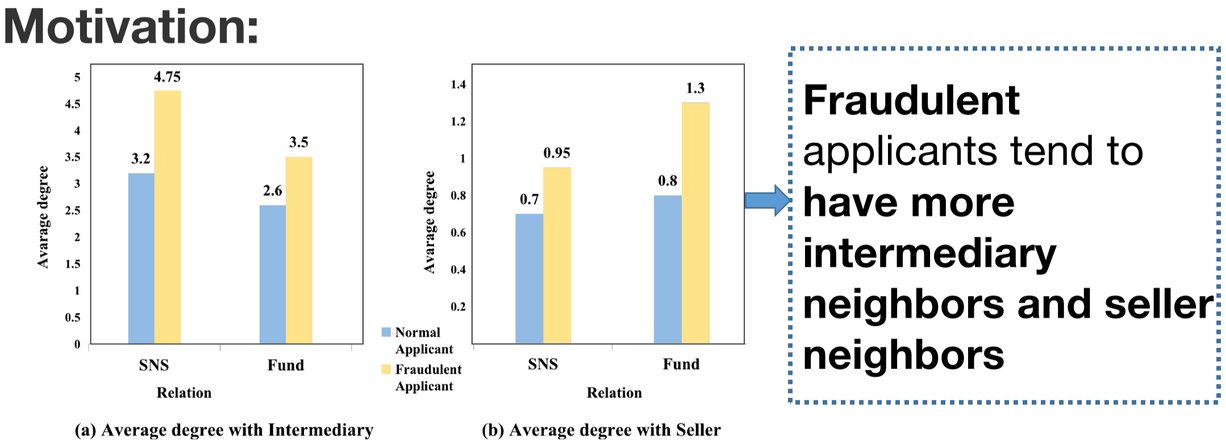
Consumer Loan Detection:

- **Consumer loans**, i.e., loans given to consumers to finance certain types of expenditures, is increasingly popular.
- Loan fraud detection is formulated as a **node classification** problem, i.e., predict whether an applicant node is fraudulent given node attribute and social relationships among nodes.
- Graph neural network with a **Role-constrained** Conditional random field, namely **GRC**, to learn the representation of applicants.



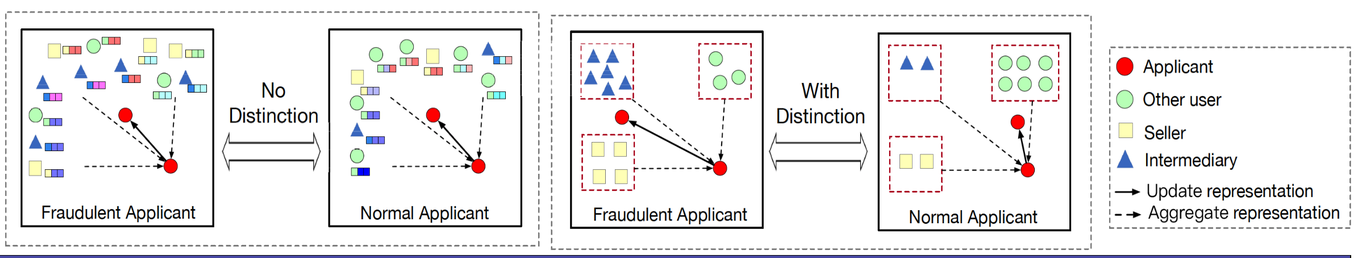


Motivation:



Fraudulent applicants tend to **have more intermediary neighbors and seller neighbors**

- GRC is equiped with a conditional random field component to learn **role-aware node represenations**,thus distinguishing the fraudulent applicants from normal applicants and enhancing the classification.



METHOD

GRC: Graph neural network with a Role-constrained Conditional random field

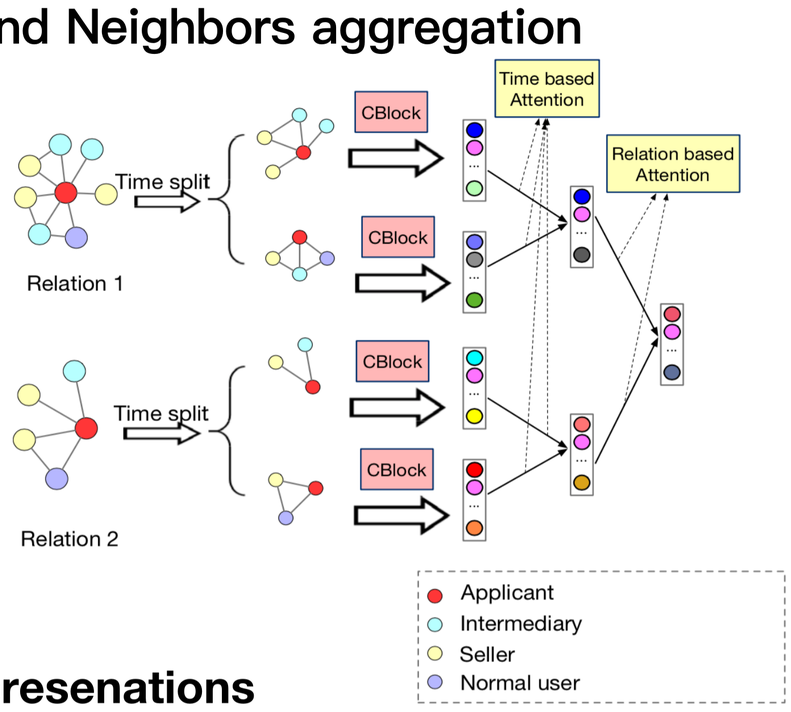
➢ Feature transformation and Neighbors aggregation

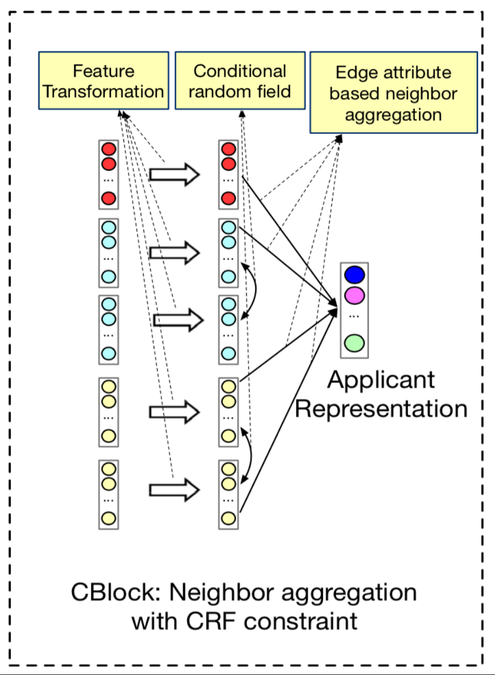
$$X^{'} = XW,$$
$$e_{uv} = a^{i} X^{i}_{uv},$$
$$h_v = \sum_{u \in N(v)} e_{uv} H^K_u + H^K_v$$

➢ CRF constraint

$$\psi_u(H_u, X^{'}_u) = ||H_u - X^{'}_u||^2_2 \to 0,$$
$$\psi_p(H_u, H_v) = f_{uv}||H_u - H_v||^2_2 \to 0$$
$$H^{k+1}_u = \frac{\alpha X^{'}_u + \beta \sum_{v \in R(u)} f_{uv} H^k_v}{\alpha + \beta \sum_{v \in R(u)} f_{uv}}$$

- **Learn role-aware node represenations**





➢ Time slot aggregation

$$w_{r,ti} = \frac{\exp(w_{r,ti})}{\sum_{i \in 1,2} \exp(w_{r,ti})}$$
$$h^r_v = w_{r,t1} h^r_{v,t1} + w_{r,t2} h^r_{v,t2}.$$

➢ Relation aggregation

$$w_r = \frac{\exp(w_r)}{\sum_{r \in R} \exp(w_r)},$$
$$h_v = \sum_{r \in R} w_r h^r_v.$$

EXPERIMENTS

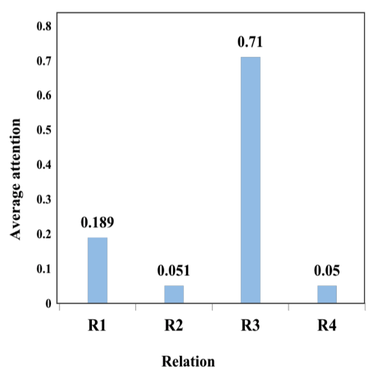
Experimental results:

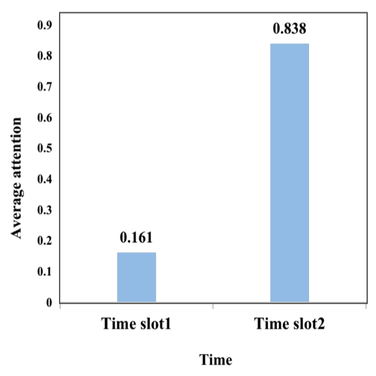
Table 1: Results of loan fraud detection

Size	Method	SVM	MLP	GCN	GRC
1,000	Precision	66.32%	72.80%	69.78%	72.28%
	Recall	51.00%	44.20%	61.20%	82.40%
	F1-Score	57.66%	55.00%	65.21%	**77.01%**
2,000	Precision	65.80%	71.25%	68.59%	74.38%
	Recall	51.60%	46.60%	69.00%	89.70%
	F1-Score	57.84%	56.35%	68.79%	**81.32%**
3,000	Precision	66.50%	69.25%	70.35%	77.09%
	Recall	47.10%	51.80%	71.60%	89.50%
	F1-Score	55.14%	59.27%	70.97%	**82.83%**
12,000	Precision	68.65%	66.82%	74.06%	77.50%
	Recall	54.10%	59.20%	84.80%	95.50%
	F1-Score	60.51%	62.78%	79.07%	**85.56%**

Attntion analysis:

- “Relation3” and “Time slot2” are of higher importance
- Modeling the impacts of relations and time slots is necessary.





Ablation study:

- Each component achieves the positive effect.
- The edge attributes are important to identify the important neighbors.

Table 2: Ablation study

Method	precision	Recall	F1 score
GRC(w/o CRF)	77.71%	91.00%	83.83%
GRC(w/o EA)	79.60%	88.20%	83.68%
GRC(w/o RA)	77.58%	92.40%	84.34%
GRC(w/o TA)	76.54%	91.70%	83.44%
GRC	77.50%	95.50%	**85.56%**

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