The Trust Propensity Prediction Problem

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Outline

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- Related Work
- Trust Prediction Family of Problems
  - Trust Formation, Trust Breakage, Change in Trust
- Trustingness and Trustworthiness
- Data Description
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- Conclusion

Introduction

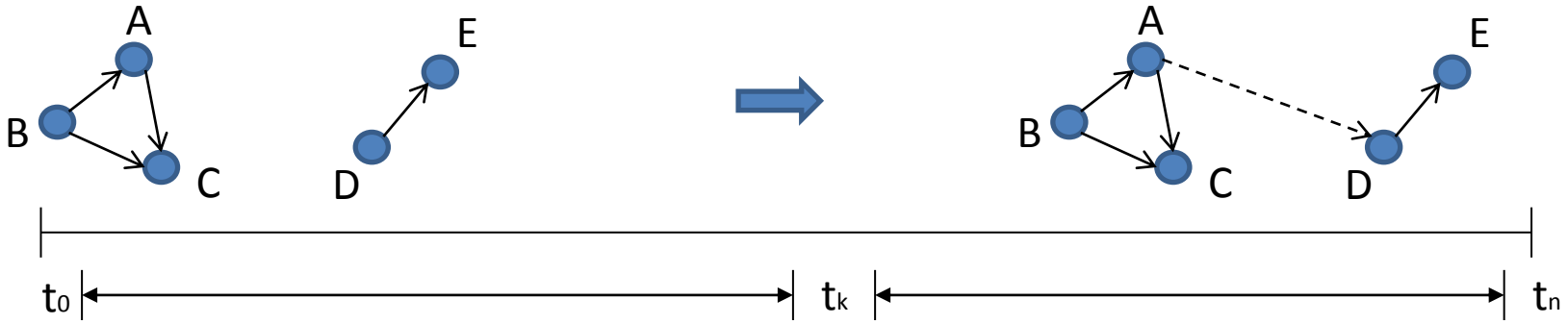
- Trust is a ubiquitous phenomenon in social settings
- Trust has been studied in the context of problems related to trust inference, propagation etc
- The study of problems related to trust is limited because of limitations in the datasets which are available

Related Work

- Computational Trust Formalized by Marsh [Marsh 1994]
- Applications: Recommendations [Massa 2005], access control [Ali 2007], spam filtering [Golbeck 2004], inferring trust in social networks [Golbeck 2006] etc
- Propagating trust in cases where no direct information is available [Guha et al 2004]
- A large body of work exists on trust propagation techniques [Golbeck 2009], [Kamvar 2003], [Kim 2009], [Quercia 2007]
- Additional work in P2P Networks [Jøsang 2007] and trust in multi-actor systems [Wang 2006]
- Trust networks which are generated by similar social processes have similar structures [Ahmad 2010]

Trust Prediction Family of Problems

Trust Prediction: Given a trust network *G* predict which nodes are going to trust one another in the future



Problem	Description	Explanation
Trust Formation	$f(a,b) \rightarrow \lambda, \quad \lambda \in \{0,1\}$	Will *A* trust *B*?
Trust Formation Duration Prediction	$f(a,b,\lambda) \rightarrow (1,\ldots,n), \quad \lambda \in \{1\}$	After how much time will *A* trust *B*?

Trust Prediction Family of Problems

Problem	Description	Explanation
Trust Change Prediction	$f(a,b,\lambda_i) \rightarrow \lambda_j, i,j \in \{1,2,\dots,N\}$	Will trust between *A* and *B* change?
Trust Change Duration Prediction	$f(a,b,\lambda_i \rightarrow \lambda_i) \rightarrow (1,\dots,n),\ \lambda \in \{1\}$	After how much time will trust between *A* and *B* change?
Trust Intensity Prediction	$f(a,b,\lambda) \rightarrow \{1,\dots,n\},\quad \lambda \in \{1\}$	What is the strength of the trust relationship between A and B?
Inter-Network Trust Prediction	$f(a,b,\lambda_T) \rightarrow \lambda_O,\quad \lambda_O \in \{0,1\}$	Will A and B who trust one another interact in another context or vice versa?
Trust Propensity Prediction	$f(a,I(S)) \rightarrow \tau_a,\ \tau_a \in \{0,1,\dots,N\}$	What is A's propensity to trust?

Trustingness and Trustworthiness

- People make decisions to trust or distrust based on their previous interactions
- Decision to trust is relative to an individual
  - A person who is trustworthy for one person may not be trustworthy for another person
- A trustworthy person is one who is trusted by many people, especially the ones who do not trust many people
- A trusting person is one who trusts a lot of people regardless of their trustworthiness

Hubs and Authorities Analogy

- **Hub:** Highly valued pages for a given query who link to many authority pages (Kleinber 1998)
- **Authorities:** Highly endorsed pages for a given query and are linked to by many authority pages
- **Trustingness** (μ)**:** Propensity of an individual to trust others is called trustingness
- **Trustworthiness** (ω)**:** Trustworthiness refers to the property of an individual that he or she should be trusted by others

Hubs and Authorities Analogy

- An Authority is analogous to a Trustworthy node
- A Hub is not really analogous to a trusting person since a trusting person trusts everyone regardless of them being trustworthy
- **Cautiousness:** The propensity of an individual to trust people who are trustworthy

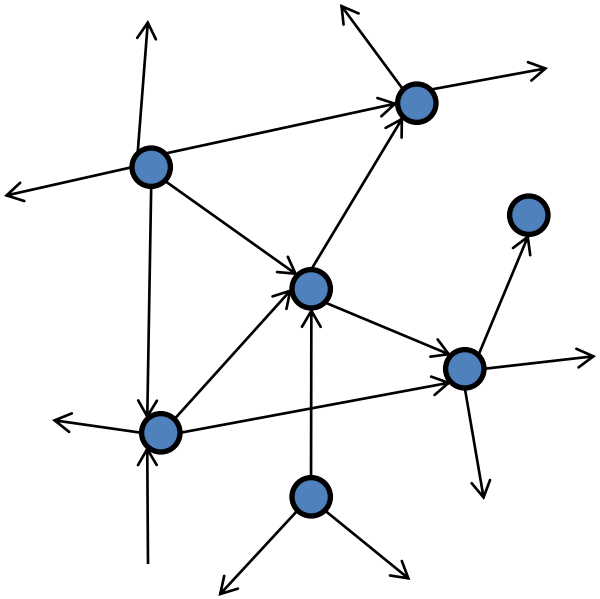
$$\xi(a) = 1 - \mu(a)$$

- Hubs are analogous to Cautious Nodes

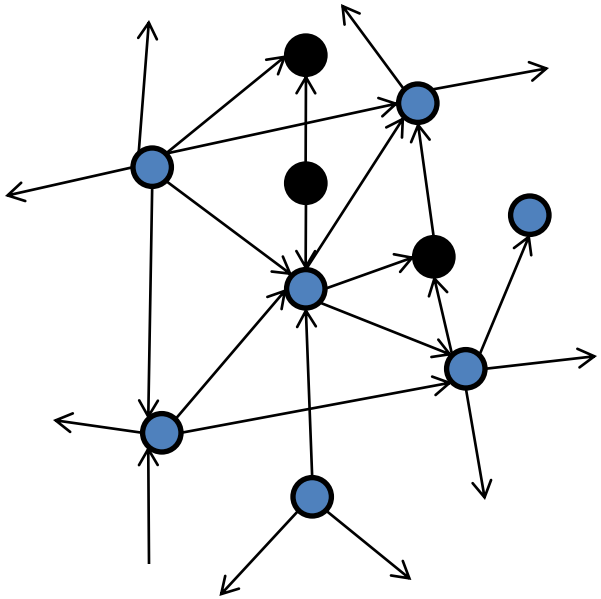
TrustHITS Algorithm

- Modified HITS Algorithm for Trust Based Environments
- Instead of considering one network, take into account participation of nodes in multiple networks
- Being Trustworthy and Being Cautious are defined recursively in terms of one another
- Values should be normalized based on how many people does one trust vs. all the people that one has interacted with

TrustHITS Algorithm



HITS Setting

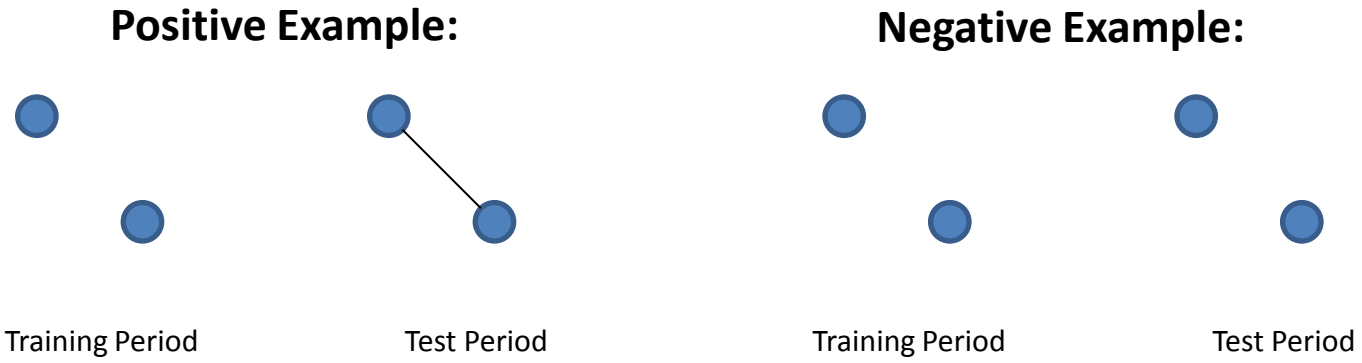


TrustHITS Setting

Nodes in Trust Network Nodes in Other Networks

Data Description

- Trust Prediction as a classification problem
- 60,000 examples for each prediction task
- 10 Fold Cross-validation
- Data from Guk Server
- Total Characters: 95,733
- Six Standard Classifiers for Comparison: J48, JRip, AdaBoost, Bayes Network, Naive Bayes and k-nearest neighbor



Experimental Evaluation of Trust Proxies

Prediction tasks (Training Period: FEB-JUN, Test Period: JUL-AUG)

Networks: **H**=Housing-trust, **M**=mentoring, **T**=Trade, **G**=Group, **P**=PvP

Feature Name	HH	MM	TT	GG	HM	HT	HG	MH	MT	MG	TH	TM	TG	GH	GM	GT	Average	Rank
Human gender	0	0	7E-04	3E-04	0	0	0.002	0	6E-04	6E-04	0	1E-04	7E-04	5E-05	7E-05	8E-04	0.00037	31
Avatar gender	0	0	0	3E-04	6E-05	0	4E-04	0	0	2E-04	0	8E-05	5E-04	2E-04	0	8E-05	0.00011	32
Avatar race	4E-04	0	0.002	9E-05	6E-05	0.002	0	8E-04	0.001	1E-04	0.001	2E-04	2E-04	5E-04	0	0.001	0.00058	30
Country	0.002	0.004	2E-04	8E-04	0.003	0.001	0.001	0.004	9E-05	0.001	0.007	0.006	0.001	0.004	0.002	0	0.00233	26
Human Age Sum	0.003	0.001	0.002	6E-04	0.001	0.002	0.007	0.005	0.004	7E-04	0.005	0.001	0.003	0.004	0.003	0.013	0.00355	25
Avatar Age Sum	0.006	0.026	0.175	0.291	0.022	0.217	0.326	0.01	0.191	0.203	0.019	0.06	0.24	0.009	0.049	0.309	0.13445	2
Human Age Differe	0.013	5E-04	2E-04	1E-03	7E-04	0	0.001	0.032	2E-04	8E-04	0.047	0.003	0.001	0.036	7E-04	4E-04	0.00856	22
Avatar Age Differer	0	0.005	0.05	0.04	0.004	0.038	0.025	0.001	0.035	0.014	0.003	0.01	0.029	0.002	0.01	0.073	0.02122	16
Event age sum	0.003	0.002	0.003	0.002	0.001	0.003	0.003	0.005	0.006	0	0.005	0.002	0.001	0.006	0.004	0.016	0.00389	24
Event age differenc	0.009	3E-04	2E-04	8E-04	3E-04	0	0.001	0.026	2E-04	8E-04	0.037	0.001	0.001	0.032	0	4E-04	0.007	23
Avatar character cla	0	0	0.002	4E-04	8E-05	0.002	7E-04	0	0.002	4E-04	0	1E-04	7E-04	0	0	0.002	0.0006	29
Seniority Sum	0.006	0.02	0.144	0.398	0.025	0.21	0.443	0.015	0.175	0.275	0.023	0.051	0.321	0.011	0.055	0.328	0.15635	1
Seniority Difference	0.004	0.025	0.01	0.298	0.024	0.042	0.356	0.005	0.025	0.255	0.007	0.039	0.267	0.002	0.03	0.056	0.09032	4
Guild	0.033	0.042	0.014	**0.01**	0.031	0.01	0.065	0.052	0.01	0.046	0.067	0.053	0.038	0.029	0.019	0.029	0.03422	14
Guild Rank Sum	1E-03	0.007	0.017	0.062	0.003	0.017	0.032	0.002	0.018	0.029	0.002	0.013	0.042	0.002	0.013	0.036	0.01851	17
Guild Rank Differer	0.002	0.005	0.02	0.04	0.003	0.015	0.024	0.003	0.019	0.024	0.005	0.01	0.027	0.002	0.009	0.036	0.0153	18
Degree centrality (d	0.003	0.035	0.14	0.096	0.001	0.047	0.027	0.002	0.032	0.037	0.008	0.007	0.039	0.002	0.026	0.085	0.0366	13
Betweenness centr	0.004	0.048	0.195	0.086	0.003	0.072	0.083	0.003	0.045	0.061	0.011	0.015	0.069	0.001	0.027	0.045	0.04808	11
Sum degree	0.009	0.082	0.287	0.263	0.003	0.089	0.06	0.007	0.085	0.116	0.022	0.025	0.149	0.004	0.04	0.157	0.08745	5
Difference in degre	0.003	0.035	0.14	0.096	0.001	0.047	0.027	0.002	0.032	0.037	0.008	0.007	0.039	0.002	0.026	0.085	0.03663	12
distance	0.039	0.082	0.238	0.367	0.041	0.012	0.061	0.034	0.066	0.144	0.024	0.033	0.17	0.021	0.054	0.169	0.09734	3
Sum clustering ind	0.004	0.03	0.277	0.113	0.005	0.048	0.037	0.002	0.035	0.041	0.023	0.023	0.174	0.002	0.034	0.063	0.05702	10
Common neighbors	0.055	0.037	0.313	0.31	0.027	2E-04	0.017	0.03	0.004	0.027	0.037	0.033	0.218	0.019	0.035	0.099	0.079	6
Salton Index	0.055	0.036	0.277	0.298	0.027	6E-04	0.018	0.03	0.005	0.026	0.038	0.031	0.194	0.023	0.034	0.094	0.07417	9
Jaccard Index	0.009	3E-04	0	5E-05	0.005	0	0.001	9E-04	1E-04	1E-04	4E-04	0	0	5E-04	0	0	0.00109	27
Sorensen Index	0.009	3E-04	0	5E-05	0.005	0	0.001	9E-04	1E-04	1E-04	4E-04	0	0	5E-04	0	0	0.00109	27
Adar-Adamic inde	0.056	0.038	0.315	0.303	0.027	4E-04	0.017	0.033	0.004	0.027	0.037	0.034	0.217	0.021	0.037	0.097	0.07898	7
Resource Allocatior	0.056	0.038	0.316	0.3	0.027	4E-04	0.017	0.033	0.004	0.027	0.037	0.036	0.21	0.024	0.035	0.094	0.07833	8
Has link in housing	0	0.004	2E-04	7E-04	0	0	0	**0.04**	0	0.003	**0.06**	0.012	0.004	0.031	0.003	8E-05	0.01006	21
Has link in mentorir	0.012	0	3E-04	0.002	**0.03**	5E-04	0.014	0	0	0	0.031	**0.05**	0.013	0.002	0.012	4E-04	0.01077	20
Has link in trade ne	8E-04	5E-04	0	0.011	4E-04	0.058	0.016	0.002	0.046	0.01	0	0	0	0.001	9E-04	0.057	0.01278	19
Has link in group n	0.017	0.012	0.003	0	0.024	0.005	0.107	0.023	0.003	0.064	**0.05**	**0.05**	0.077	0	0	0	0.02676	15

Results from Prediction Tasks

Table 2: Results for Trust Formation Prediction

Technique	Precision	Recall	F-Score
Random	0.23	0.27	0.25
In-Game	0.85	0.66	0.75
Offline	0.29	0.22	0.25
TRUCE	0.78	0.68	0.73

Table 3: Results for Trust Change Prediction

Technique	Precision	Recall	F-Score
Random	0.09	0.27	0.14
In-Game	0.19	0.25	0.22
Offline	0.26	0.34	0.29
TRUCE	0.39	0.42	0.40

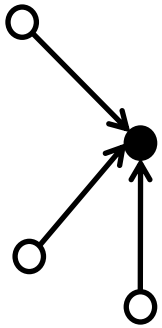
Table 4: Results for Trust Breakage Prediction

Technique	Precision	Recall	F-Score
Random	0.02	0.50	0.04
In-Game	0.10	0.26	0.15
Offline	0.02	0.11	0.04
TRUCE	0.06	0.09	0.08

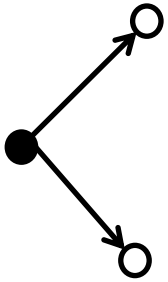
Trust Propensity Prediction

- Dataset: 7,129 nodes
  - Trust Network and Explicit Propensity to Trust info
- Expressed Trust vs. Inferred Trust?
- Trust Scale: 1-4
- Approach:
  - In-game feature similarity
  - Network Topology based approaches

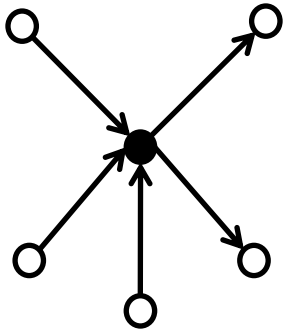
Network Based Approaches for Trust Propensity Prediction



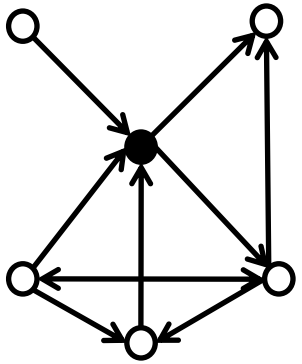
(a) In-degree Based



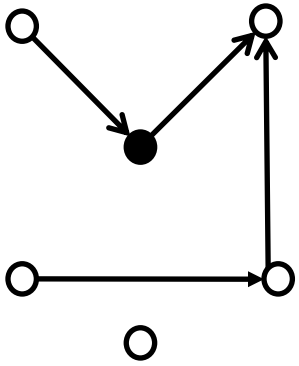
(b) Out-degree Based

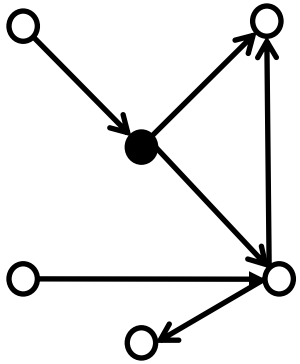


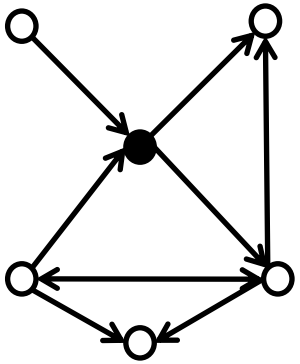
(c) Degree Based

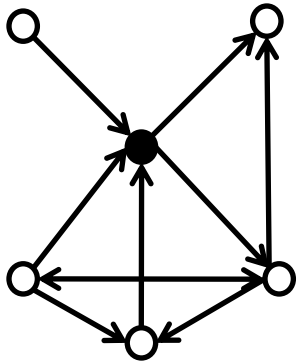


(d) Neighborhood Based



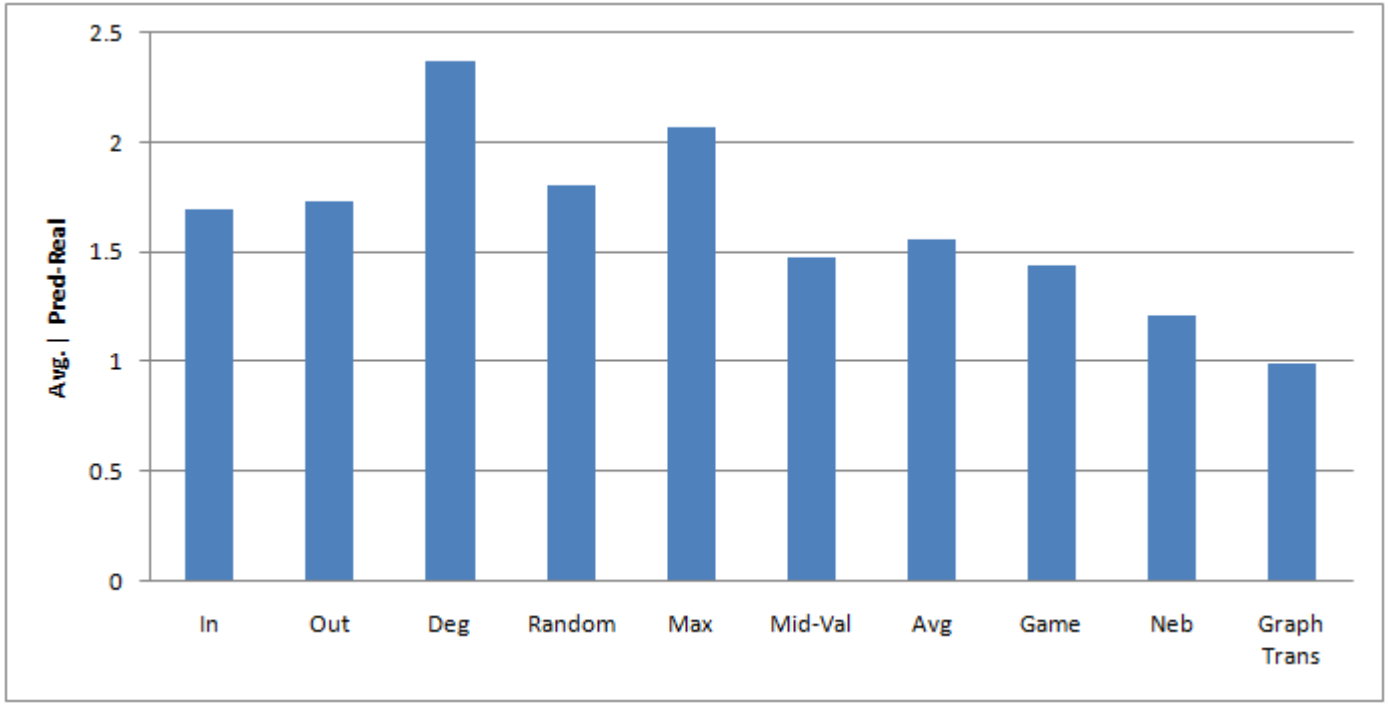




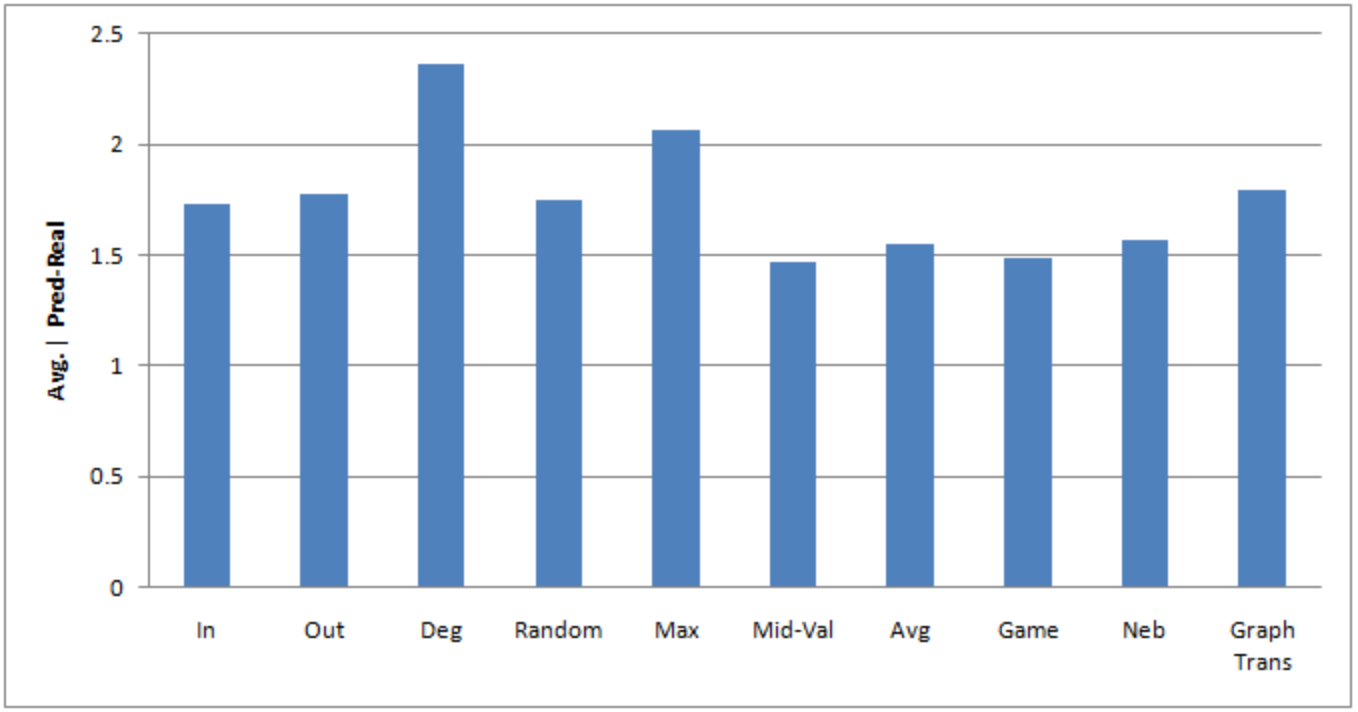


(e) Graph-Transformation Based

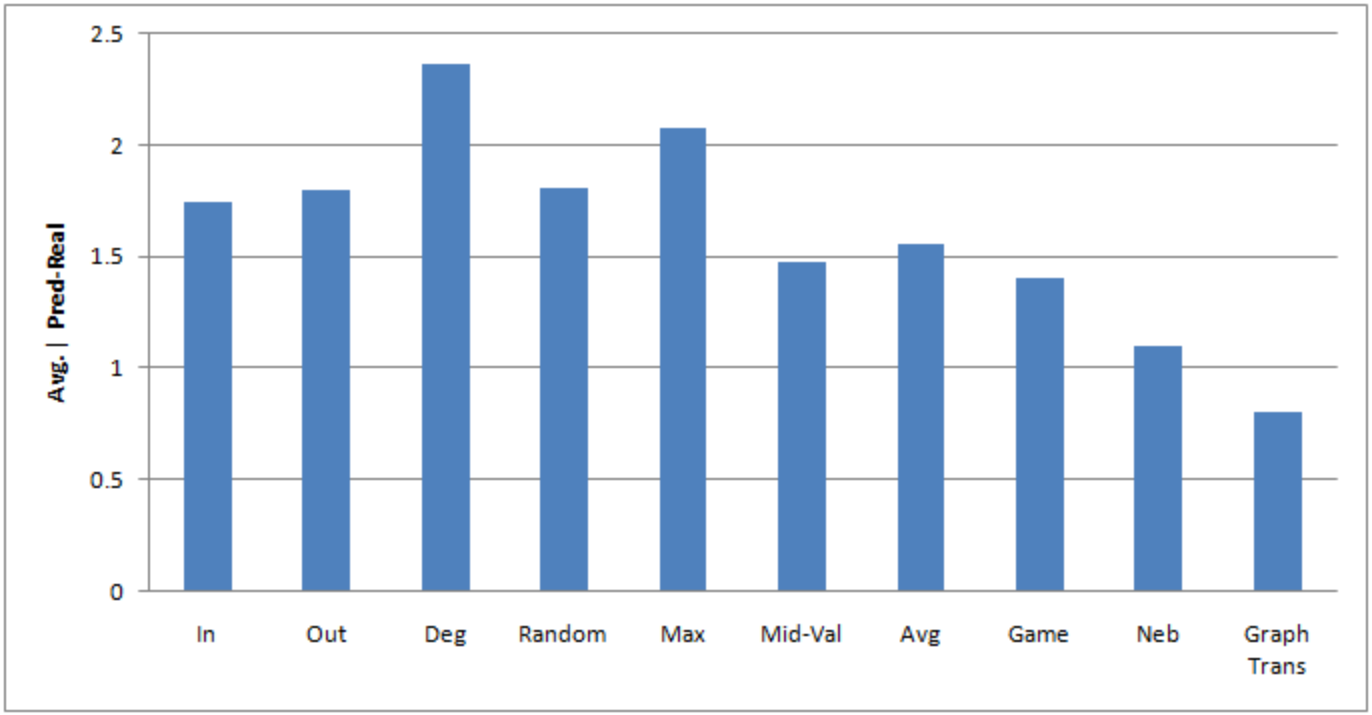
Results: Trusting Everyone?



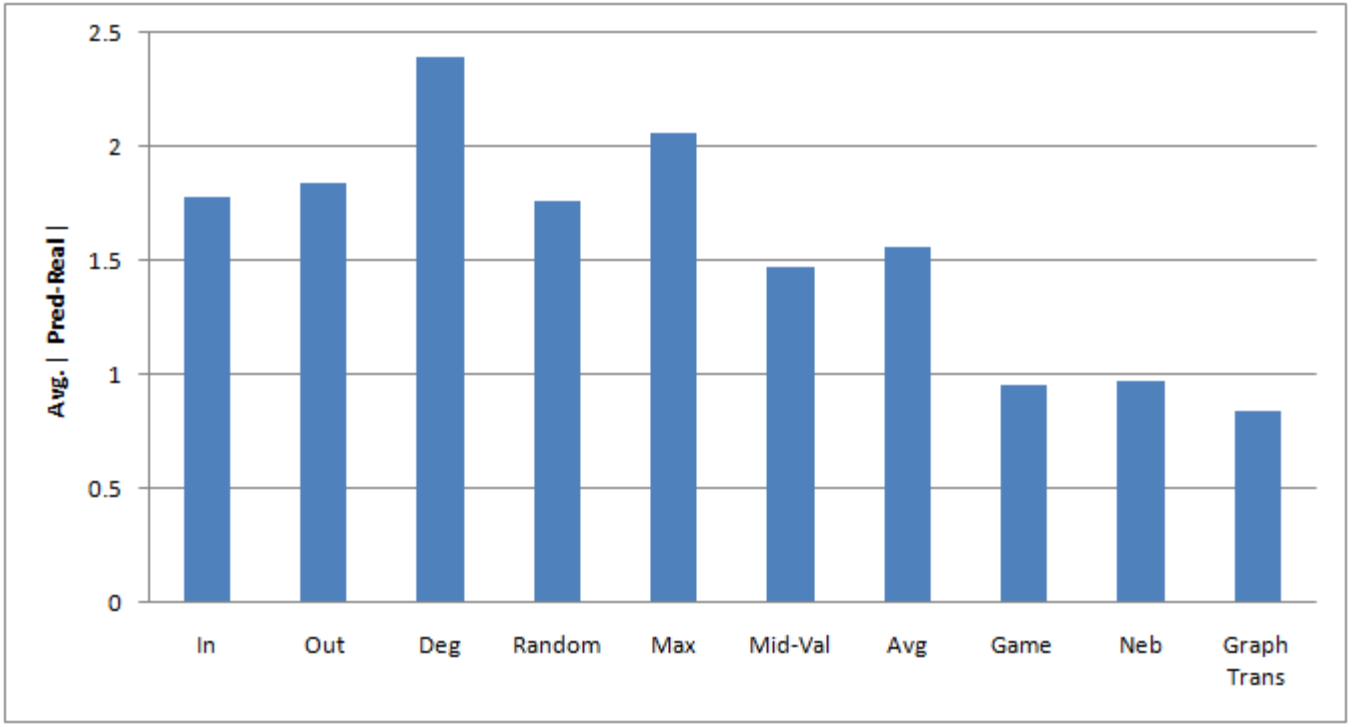
Results: Trusting Online?



Results: Trusting In-Game?



Results: Trusting In-guild?



Conclusion

- We considered the problem of various prediction tasks in trust based networks in EverQuest II
- We defined the new problem of trust propensity prediction and proposed various techniques to solve this problem
- Future work will involve replicating these results in other dataset

Questions?