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From Ratings to Trust: An Empirical Study of Implicit Trust in Recommender Systems

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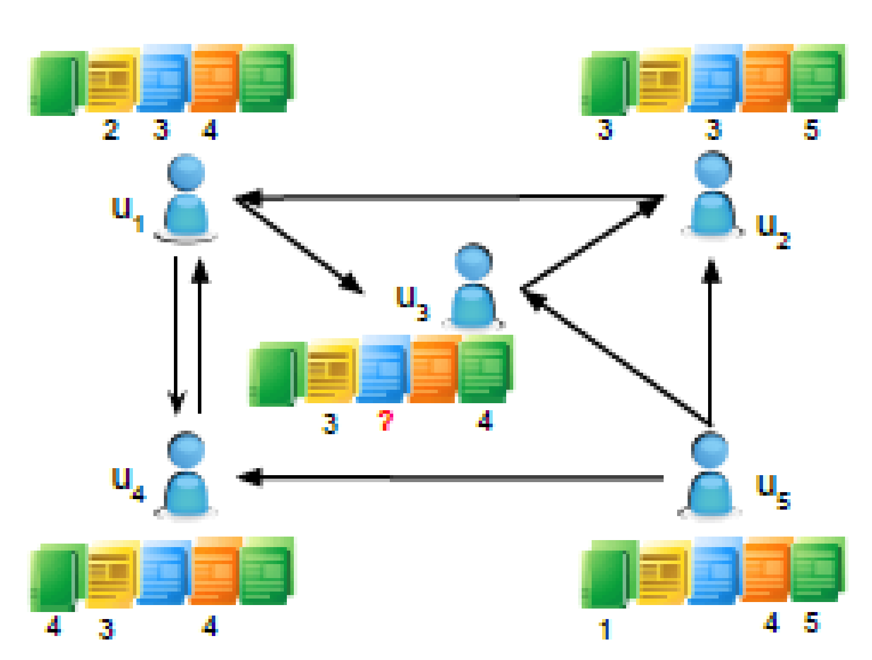
Introduction

- Trust-based RSs
  - User-item ratings
  - User-user trust
  - Alleviating data sparsity, cold start, etc.



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Introduction

- Trust types
  - Explicit
    - Binary trust only
    - Noisy trust: trusted users, different preferences
    - Sparse trust
  - Implicit
    - Inferred from user behaviors
    - Revealing implicit trust ties
    - Real values, richer information

Introduction

- Trust Metrics
  - Rating prediction of items only
  - No comparison with explicit trust
- Our proposal
  - Recover explicit relationships accurately
  - Reveal as much explicit trust as possible

Outline

Content

1. Introduction
2. Trust Definition & Metrics
3. Evaluation
4. Conclusion

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Trust Definition

- Trust in RSs
  - one's belief towards the ability of others in providing valuable ratings
- Trust properties
  - Asymmetry
  - Transitivity
  - Dynamicity
  - Context dependency

Trust Metrics

- TM1 (Lathia et al., 2008)

$$t_{u,v} = \frac{1}{|I_{u,v}|} \sum_{i \in I_{u,v}} (1 - \frac{|r_{u,i} - r_{v,i}|}{r_{max}})$$

- TM2 (Yuan et al., 2010, Papagelis et al., 2005)

$$t_{u,v} = \begin{cases} s_{u,v}, & if\ s_{u,v} > \theta, |I_{u,v}| > \theta_I \\ 0, & otherwise \end{cases}$$

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Trust Metrics

- TM3 (Hwang and Chen, 2007)

$$p_{u,i} = \bar{r}_u + \left(r_{v,i} - \bar{r}_v\right)$$

  - TM3a

$$t_{u,v} = \frac{1}{|I_{u,v}|} \sum_{i \in I_{u,v}} (1 - \frac{|p_{u,i} - r_{u,i}|}{r_{max}})$$

  - TM3b

$$t_{u,v} = \frac{|I_{u,v}|}{|I_u \cup I_v|} (1 - \frac{1}{|I_{u,v}|} \sum_{i \in I_{u,v}} \left(1 - \frac{|p_{u,i} - r_{u,i}|}{r_{max}}\right)^2)$$

Trust Metrics

- TM4 (O'Donovan and Smyth, 2005)

Correct $(r_{v,i}, , r_{u,i})$: $|p_{u,i} - r_{u,i}| < \epsilon$

$$t_{u,v} = \frac{|CorrectSet(v)|}{|RecSet(v)|}$$

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Trust Metrics

- TM5 (O'Donovan and Smyth, 2005)

$$u_v = \frac{1}{|I_{u,v}|} \sum_{i \in I_{u,v}} \frac{|p_{u,i} - r_{u,i}|}{r_{max}}$$

$$b_v = \frac{1}{2}(1 - u_v)(1 + s_{u,v})$$

$$d_v = \frac{1}{2}(1 - u_v)(1 - s_{u,v})$$

$$t_{u,v} = b_v$$

Trust Metrics

- Comparison

Table 1: A comparison of different trust metrics in terms of trust properties

Method	Asymm.	Transitive	Dynamic	Context
TM1 [9]	No	Yes	No	No
TM2 [13, 18]	No	Yes, iff $s_{u,v} > \theta_s$	No	No
TM3a [7], TM3b [16]	No	Yes	No	No
TM4 [12]	No	Yes	No	No
TM5 [15]	No	Yes, iff $s_{u,v} > \theta_s$	No	No

Trust Metrics

- More about ratings
  - Rating time
  - Item category
  - Rating noise
    - Assumption: ratings are accurate and reflecting users' real preferences

Evaluation

- Experimental Settings
  - Two real-world datasets
  - 5-fold cross validation
  - Using suggested settings
    - TM1: $\theta_S = 0.07$, $\theta_I = 2$
    - TM3b: $\lambda = 0.15$
    - TM4: $\epsilon = 0.8, \text{or } 1.5$

Dataset	Users	Items	Ratings	Trust	Density
FilmTrust	1,508	2,071	35,497	1,853	1.14%
Epinions	40,163	139,738	664,824	487,183	0.05%

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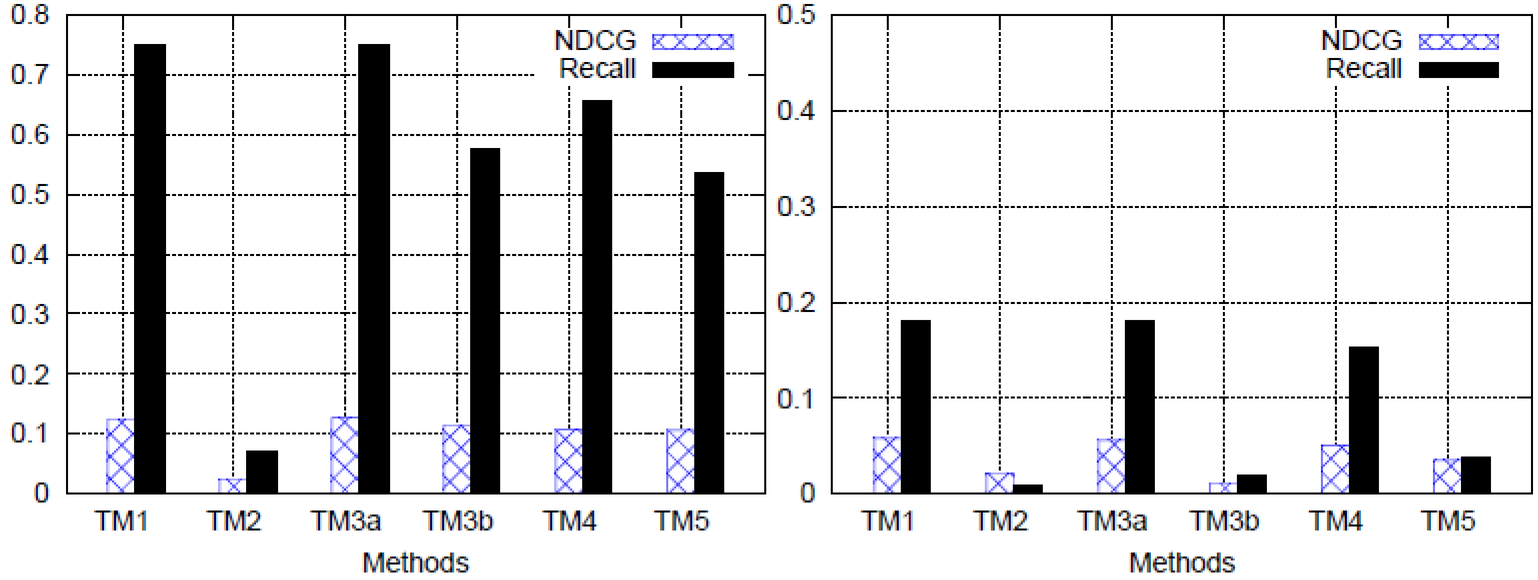
Evaluation

- Evaluation Metrics
  - Metrics for rating prediction
    - MAE = $\frac{\sum_i |\hat{r}_i - r_i|}{N}$
    - RC $= \frac{P}{M}$
  - Metrics for trust ranking
    - NDCG
    - Recall

Evaluation

- Performance of trust ranking



(a) FilmTrust (b) Epinions

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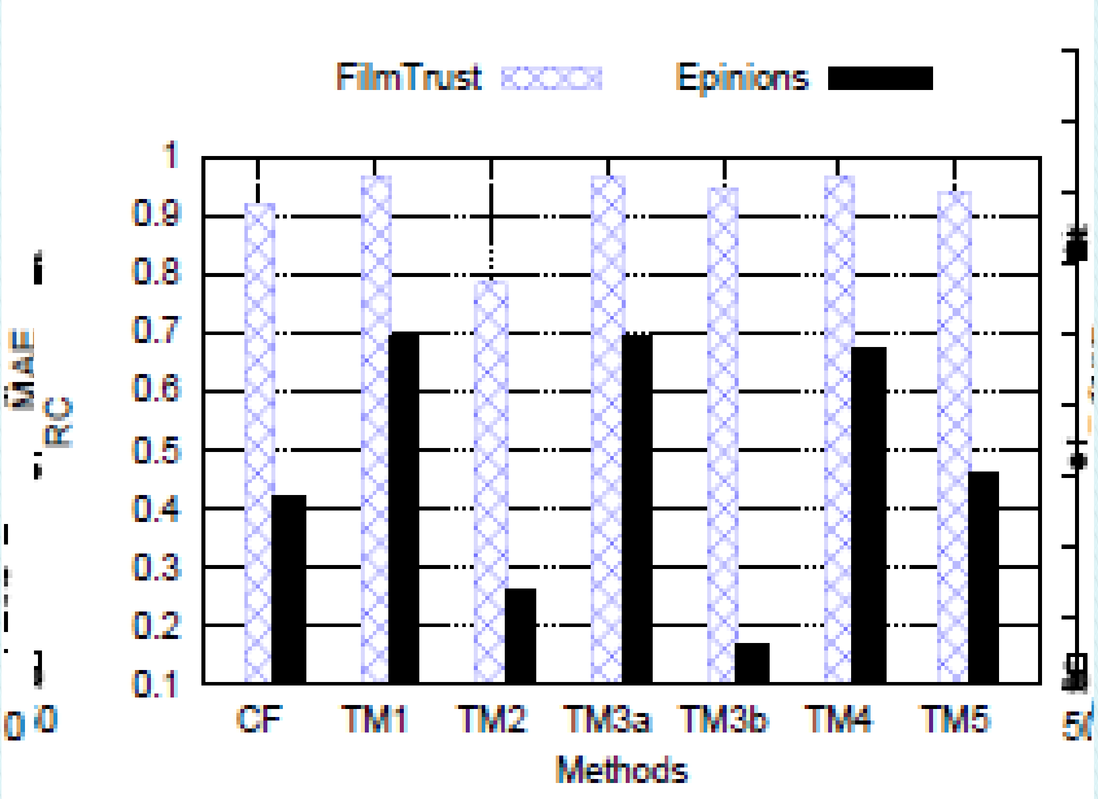
Evaluation

- Performance of rating prediction



(c) Rating Coverage

Evaluation

- Performance of rating prediction

Table 3: Significance tests of the MAE differences relative to the CF method in FilmTrust

Methods	Mean Diff.	df	t	p-value
TM1 – CF	0.0055	9	9.075	7.978e-6
TM2 – CF	0.0258	9	12.926	4.077e-7
TM3a – CF	0.0162	9	14.254	1.756e-7
TM3b – CF	-0.0005	9	-0.357	0.729
TM4 – CF	0.0073	9	7.719	2.943e-5
TM5 – CF	0.0049	9	11.691	9.614e-7

Table 4: Significance tests of the MAE differences relative to the CF method in Epinions

Methods	Mean Diff.	df	t	p-value
TM1 – CF	-0.0324	9	-38.992	2.386e-11
TM2 – CF	0.0276	9	39.747	2.009e-11
TM3a – CF	-0.0284	9	-20.978	5.957e-9
TM3b – CF	0.0248	9	23.531	2.155e-9
TM4 – CF	-0.0320	9	-40.137	1.841e-11
TM5 – CF	-0.0031	9	-37.747	3.190e-11

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Summary

- Summary
  - Two kinds of metrics show more performance measures
  - Trust metrics relatively low
    - Explicit trust should be considered
    - Lack of consistency across datasets
    - Similarity-based metrics not work well
    - Similarity methods problematic themselves

Conclusion

- Studied 5 trust metrics
  - Properties of trust
- Proposed trust ranking metrics
- Conducted experiments
  - Trust metrics need improvement

Future Work

- Model-based approaches
- Utility comparison of explicit & implicit trust in predicting item ratings
- Enabling trust propagation
- More rating inform should be considered.

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Thank You!
&
Questions?