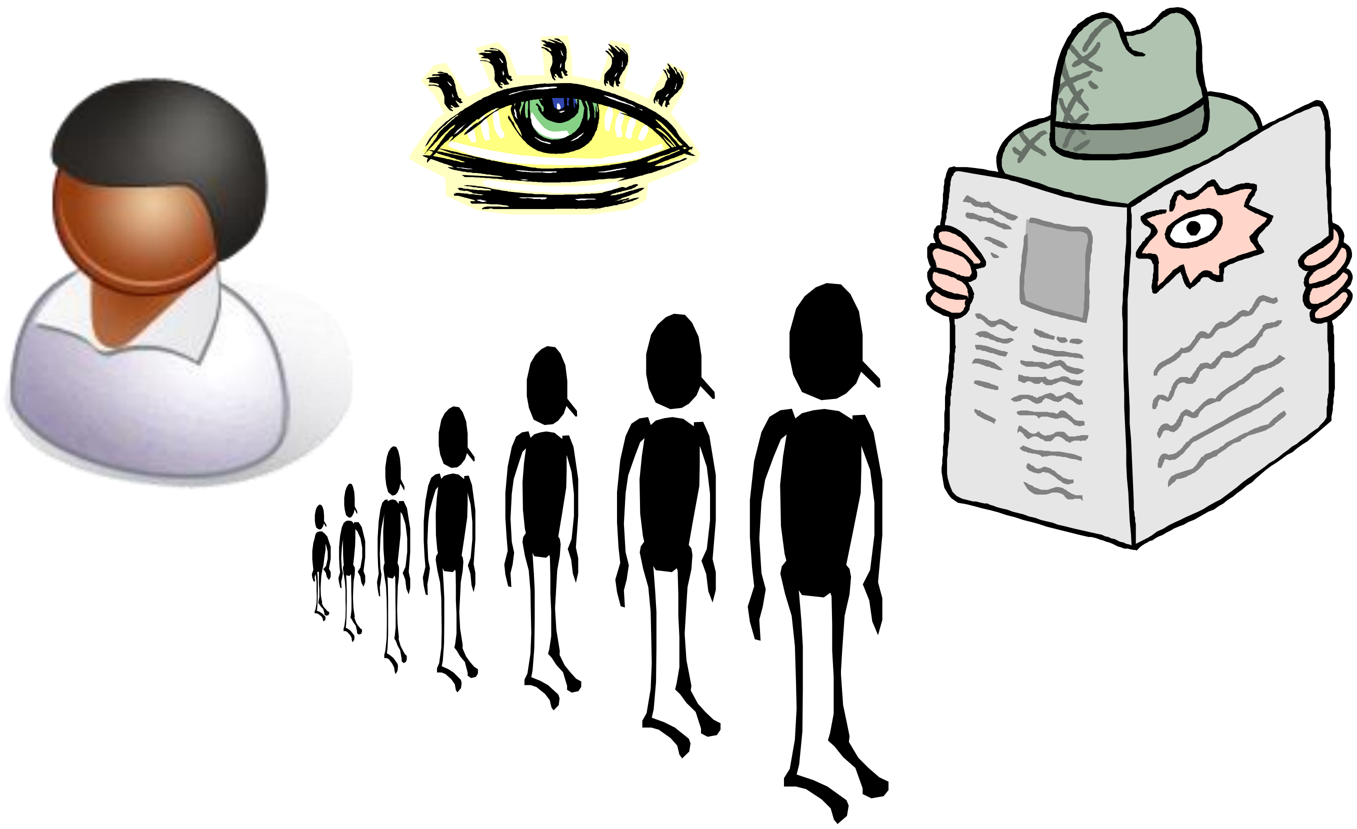
Interact with Strangers…



RATE:
Recommendation-aware Trust Evaluation in Online Social Networks

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Outline

1. Introduction
2. Motivation
3. RATE Scheme
4. Experimental Evaluation
5. Conclusion & Future Work

Introduction

- Online Soical Networks

Facebook Twitter Google+ Tencent QQ Sina WeiBo Renren

Epinions

Introduction

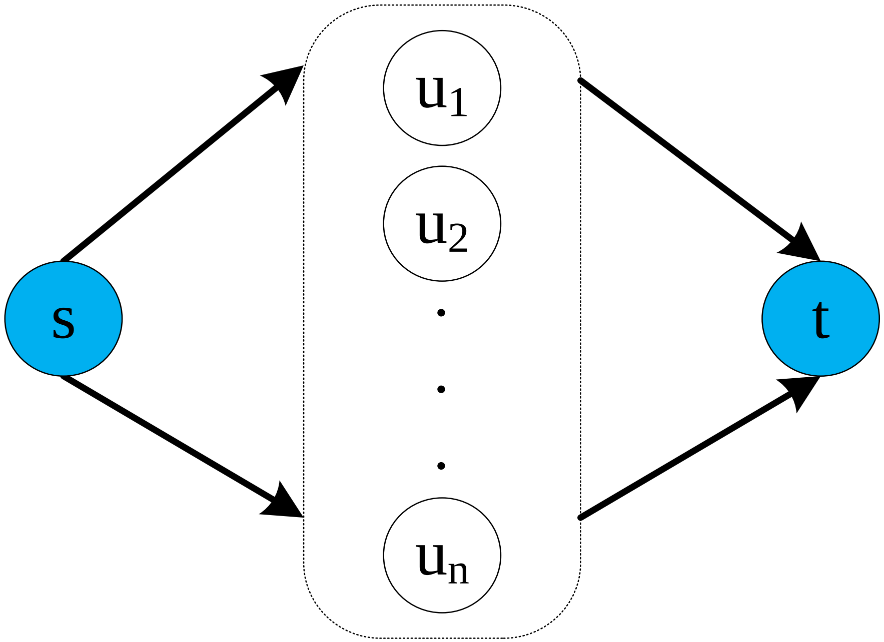
- Trust Issues & Trust Evaluation

Trust issues exist in any application whenever a person (e.g., source *s*) needs to estimate the trust level of another (e.g., target *t*), so as to decide whether or not to conduct further interactions.

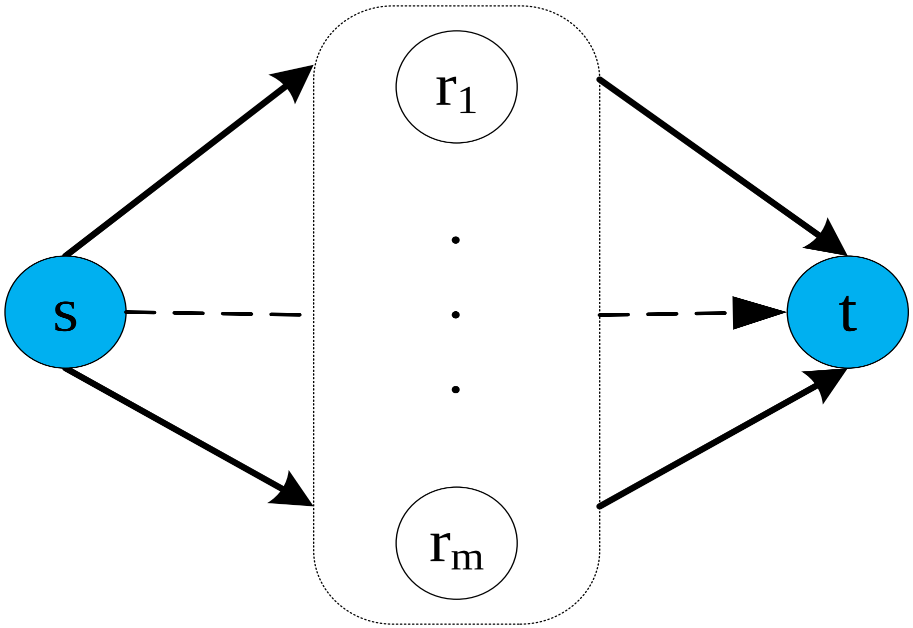
Trust Evaluation is a process to predict the trust worthiness of a target *t*, from the perspective of *s*.

Motivation

- From Social Graph to Trusted Graph



(a) Social Graph



(b) Trusted Graph

$N_s = \{ u_1, \ldots, u_n \}$ ⇒ $R = \{ r_1, \ldots, r_m \}$

Motivation

- Select Whom As Recommenders?

The direct trust?

Social relationships?

Possible cost?

Risk (uncertainty)?

The Problem
- Recommender Selection Problem

Given: a social network $G = (V, E)$; Two nodes, s and t, s is the source and t is the target.

Find: the best recommenders $R = \{r_1, ..., r_m\}$

Objectives: making a proper decision (to trust or not to trust t), meeting the optimal requirements of higher accuracy, lower risk (uncertainty), and less cost.

RATE Scheme

- Metrics Identification

Trustworthiness (t_{uv}): Honesty, and the capability to provide real information

Influence (i_{uv}): The closer the relationship exists between two persons, the larger the possibility that one's opinion will influence the other's.

Uncertainty (u_{uv}): It is lower, when the evidence for success/failure dominates, and it is larger when there is little or no evidence.

Cost (c_{uv}): Just as in daily life, the source wants to contact the target. Regardless of whether it contacts directly or indirectly, some cost will be charged.

$$M_{uv} = < t_{uv}, \quad i_{uv}, \quad u_{uv}, \quad c_{uv} >$$

RATE Scheme

- Utility Functions And The Objective

$$F = w_t \times t + w_i \times i \qquad (1)$$
$$G = w_u \times u + w_c \times c \qquad (2)$$

where w_t, w_i, w_u, w_c are the weights of the four metrics t, i, u, and c, respectively (determined by the source s);
$0 < w_t, w_i, w_u, w_c < 1$, $w_t + w_i = 1$, $w_u + w_c = 1$.

The objective: maximize F and minimize G

Normalized Utility: $\lambda * F + (1 - \lambda) * (1 - G)$ where $0 < \lambda < 1$.

RATE Scheme
- 1-hop Recommender Selection

Issue 1: How to measure the quality of a recommender?

measure the quality of a recommender

Issue 2: How many recommenders are enough, and are efficient for, decision-making?

decide the size of the optimal recommender set

RATE Scheme

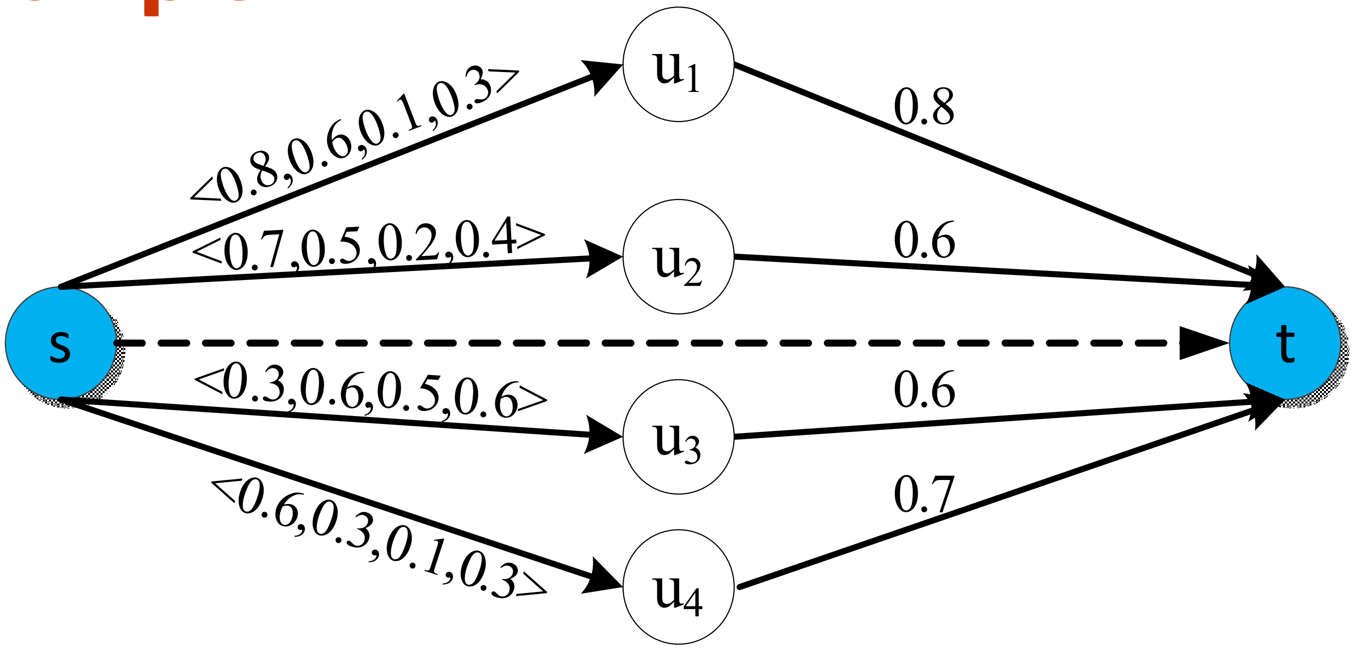
- Measure The Quality Of A Recommender

Quality of Recommender (QoR) comprises requirements on a recommender, taking trustworthiness, influence, uncertainty, and cost, as attributes.

Users can set multiple quality constraints Q^t, Q^i, Q^u, Q^c (e.g., thresholds)

RATE Scheme

- Example



$Q^t>0.5$, $Q^i>0.5$,
$Q^u<0.3$, $Q^c<0.5$

Qualified recommenders:
u_1, u_2

RATE Scheme

- The Size Of The Recommender Set

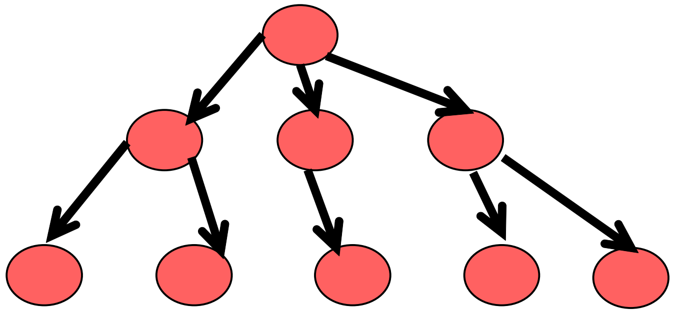
- Selecting all qualified neighbors.
- Selecting a fixed number of qualified neighbors

  e.g., 3, 6, etc.
- Selecting a fixed proportion of qualified neighbors e.g., 1/3, 1/6, etc.

RATE Scheme

- The Size Of The Recommender Set

- Flexibly selecting some top m qualified neighbors, $m \leqslant n$.



We continue to select qualified recommenders until the number of next hop neighbors is no less than the current ones.

RATE Scheme

- The Effects Of RATE

By comparing the performance of sorting or not sorting the neighbors with QoR, the effects of RATE scheme can be analyzed.

Extension
- Multiple Hop Scenario

Trustworthiness $$t_{p(a_1,\ldots,a_n)} = \prod_{e(a_j,a_{j+1})\in p(a_1,\ldots,a_n)} t_{a_j,a_{j+1}}$$

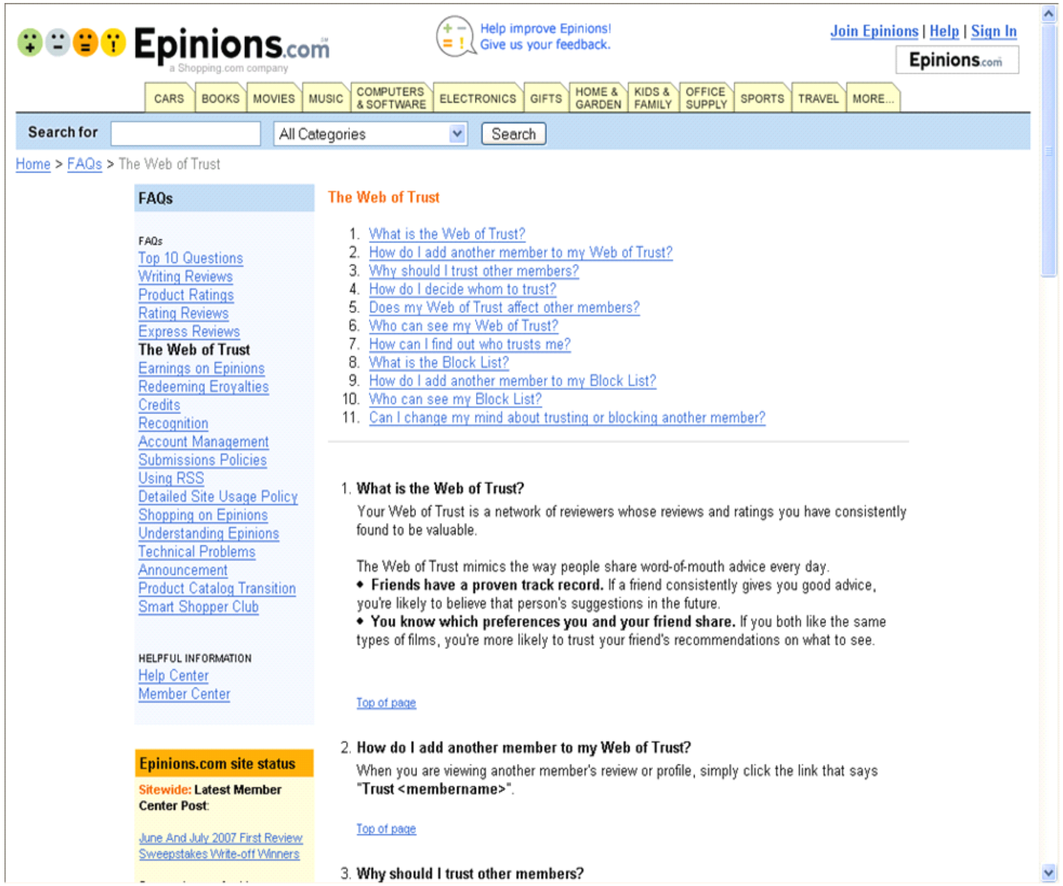
Influence $$i_{p(a_1,\ldots,a_n)} = \prod_{e(a_j,a_{j+1})\in p(a_1,\ldots,a_n)} i_{a_j,a_{j+1}}$$

Uncertainty $$u_{p(a_1,\ldots,a_n)} = 1 - \prod_{e(a_j,a_{j+1})\in p(a_1,\ldots,a_n)} (1 - u_{a_j,a_{j+1}})$$

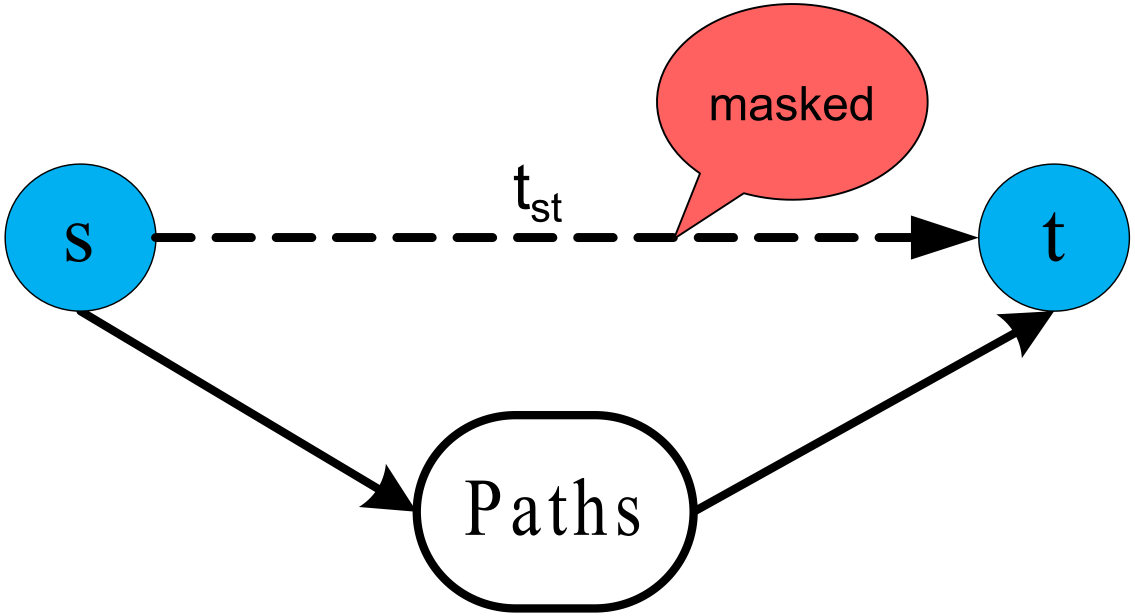
Cost $$c_{p(a_1,\ldots,a_n)} = \sum_{e(a_j,a_{j+1})\in p(a_1,\ldots,a_n)} c_{a_j,a_{j+1}}$$

Experimental Evaluation

- Dataset Epinions (www.epinions.com)



Experimental Evaluation
- Method: Leave-One-Out



If there is an edge between two nodes, that edge is masked, and trust is calculated through algorithms; then, we compare the calculated value with the masked value.

Experimental Evaluation
- Metrics: Precision, Recall, Fscore

$$\text{Precision} = \frac{A_t \cap B_t}{B_t}$$

$$\text{Recall} = \frac{A_t \cap B_t}{A_t}$$

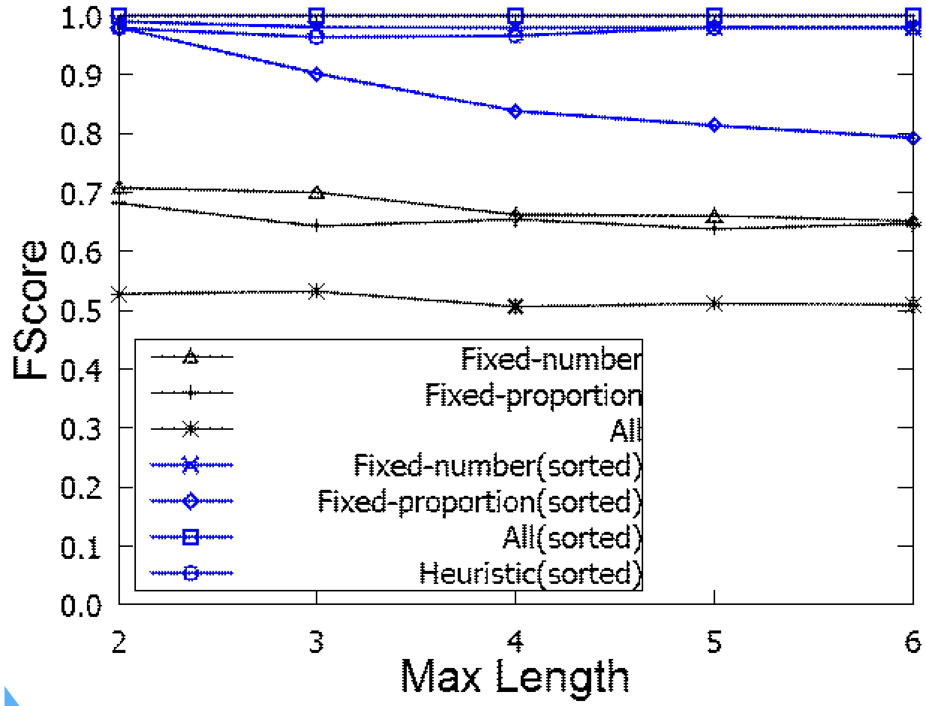
$$\text{Fscore} = \frac{2 \times \text{Recall} \times \text{Precision}}{\text{Recall}+\text{Precision}}$$

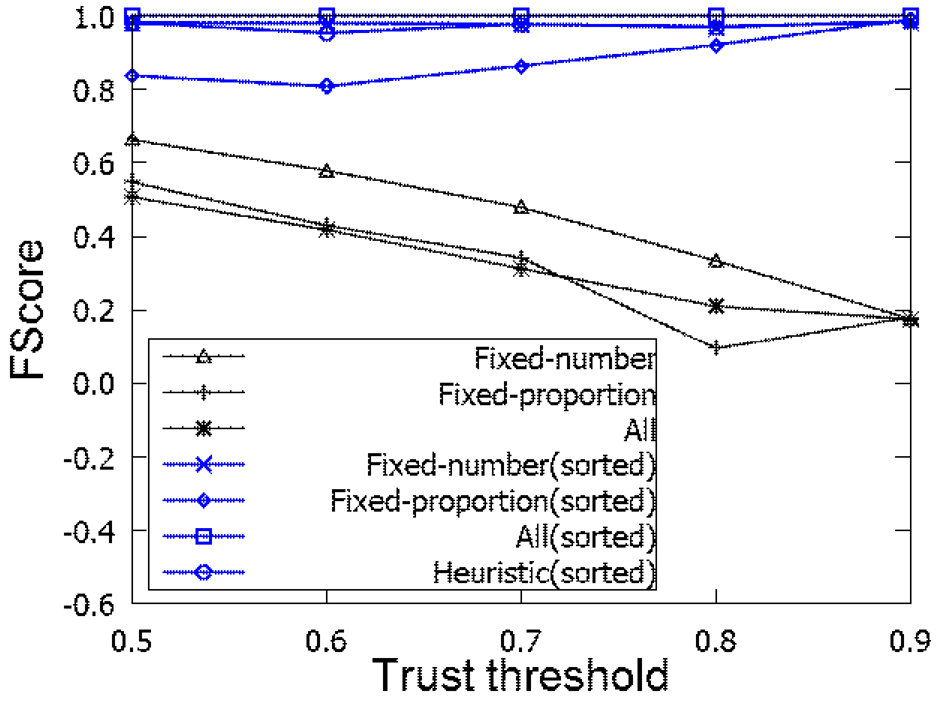
where At is the number of edges on which s trusts t directly, and Bt is the number of edges on which s trusts t, by trust calculated through an algorithm.

Experimental Evaluation
- Trust Evaluation Stragies

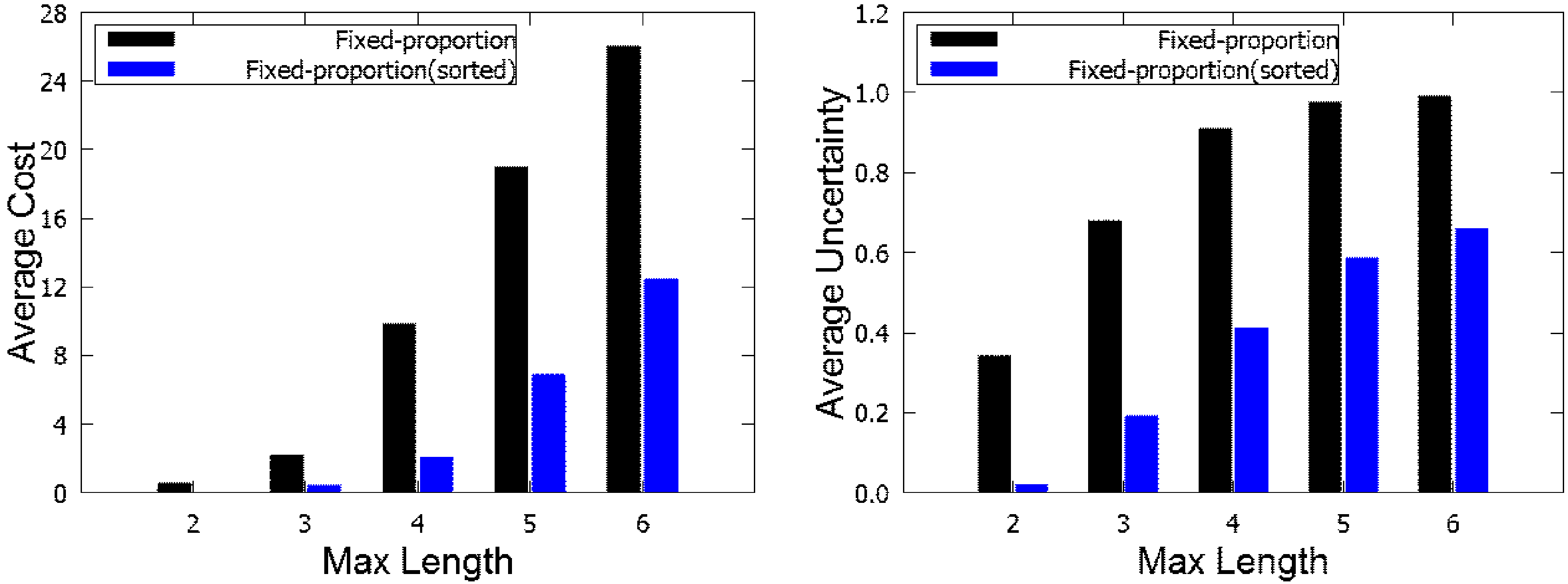
AveR-MaxT
AveR-WAveT
MaxR-MaxT
MaxR-WAveT

Experimental Evaluation
- Results (Accuracy)





Evaluation
- Results (Cost & Uncertainty)



Summary & Conclusion

- We propose a recommendation-aware trust evaluation scheme: RATE.

  We take a new perspective on the selection of good recommenders, to help people make proper decisions.

- We evaluate RATE using a real trust network, Epinions.

  The results demonstrate how each metric can impact the performance of RATE, and show that RATE can predict trust with higher accuracy (at least 22.4% higher), lower risk, and less cost.

Future Work

- The theoretical bounds of the size of an optimal recommender subset.
- The probability of success to make a proper trust decision.
- The extension of multiple targets scenario.

Thank you for your attention!

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