RTBIMS: ACCURACY ENHANCEMENT IN ITERATIVE MULTIPLICATION STRATEGY FOR COMPUTING PROPAGATED TRUST

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OUTLINE

- Introduction
- Trust Propagation and IMS
- Our Proposed Algorithm: RTBIMS
- Experiments and Results
- Conclusion and Future Work

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INTRODUCTION

- Definition of Trust:

  Trust is a subjective expectation an agent has about another's future behavior based on the history of their encounters.

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INTRODUCTION

Trust Management Applications

- Computer Networks (WSN, MANET, …)
- Agent-based systems
- Web
- Semantic Web
- Access Control
- Game Theory
- Social Networks
- E-Commerce
- . . .

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INTRODUCTION

- Two approaches to evaluate the value of trust:
  - Policies:
    - the conditions necessary to obtain trust
    - exchange or verification of credentials
  - Reputation:
    - an assessment based on the history of interactions with or observations of an entity, either directly or as reported by others

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INTRODUCTION

Web of Trust:

Each entity maintains reputation information on other entities, thus creating a “web” that is called web of trust.

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TRUST PROPAGATION AND IMS

- A trust decision can be a transitive process: Trusting one entity may result in trusting another entity.
- Example:

  one might trust a book because of the publisher, and the publisher itself may be trusted because of the recommendation of a friend.

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TRUST PROPAGATION AND IMS

- If there is no link between a pair of entities→ trust transitivity can be applied
- Example:

  If A trusts B and B trusts C

  then A trusts C
- Also known as trust propagation.
- However there is discussion:
  - How much transitivity is valid?
  - Which formula or algorithm should be used for evaluating propagated trust value in each field?

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TRUST PROPAGATION AND IMS

- Trust if often represented as a value between 0 and 1.
- Trust propagation is based on the transitivity property of trust:

$$T_{A,C} = T_{A,B} \circ T_{B,C} \qquad (1)$$

- o is concatenation operator, i.e. multiplication:

$$T_{A,C} = T_{A,B} * T_{B,C}$$

- Example:
  - Let A has no experience of previous interaction with C.
  - However $Trust_{A \to B} = 0.8$ and $Trust_{B \to C} = 0.5$
  - We can infer $Trust_{A \to C} = 0.8 * 0.5 = 0.4$.

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TRUST PROPAGATION AND IMS

- Generalization → Iterative Multiplication Strategy
- If there is a path (chain of trust) between v_1 and v_n in the web of trust, we can estimate the value of $Trust_{X \to Y}$ by multiplying the trust labels of the links on this chain.

$$T_{1,n} = T_{1,2} * T_{2,3} * \ldots * T_{n-1,n} = \prod_{i=1}^{n-1} T_{i,i+1} \qquad (2)$$

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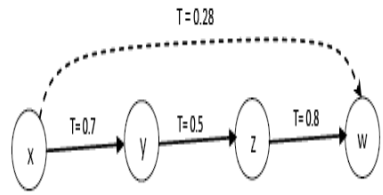
TRUST PROPAGATION AND IMS

Example of IMS:



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OUR PROPOSED ALGORITHM: RTBIMS

- We illustrate that it is important to distinct between *competence trust* and *recommendation trust* in using IMS.
- Based on this idea, we propose RTBIMS.
- RTBIMS: Recommendation-Trust Based Iterative Multiplication Strategy
  - an accuracy-enhanced version of IMS

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OUR PROPOSED ALGORITHM: RTBIMS

- In the formula of IMS, $T_{A,B}$ denotes the amount of trust that A holds for B (the value of A's **belief on *B's competence*)**.
- However this value is used as a measure of the ***correctness of B's recommendation*** about C.
- These two concepts are not the same.
- We should distinct between
  - Competence Trust: A's belief on *B's competence*
  - Recommendation Trust: *validity of B's recommendations about a third party.*

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OUR PROPOSED ALGORITHM: RTBIMS

- Let

  CT = Competence Trust

  RT = Recommendation Trust
- So we have:

  $CT_{A,C} = RT_{A,B} * CT_{B,C}$ (4)

  $RT_{A,C} = RT_{A,B} * RT_{B,C}$ (5)

$$CT_{1,n} = (RT_{1,2} * RT_{2,3} * \dots * CT_{n-1,n} = \prod_{i=1}^{n-2} RT_{i,i+1} * CT_{n-1,n}$$

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RTBIMS - ESTIMATING RECOMMENDATION TRUST

- In many cases we have only the values of CT
  - We should estimate RT
- we use the degree of similarity between A's and B's recommendations about other entities as a measure of $RT_{A \rightarrow B}$.
- We compute the similarity matrix, based on Euclidean distance.

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RTBIMS - DECISION ON MULTIPLE PATHS

- When there is more than one path from v_1 to v_n, we may compute the final trust based on:
  - Maximum of the results from different paths
  - average of the results from different paths
  - another way of combination
- Depends on the application and source disposition to trust.

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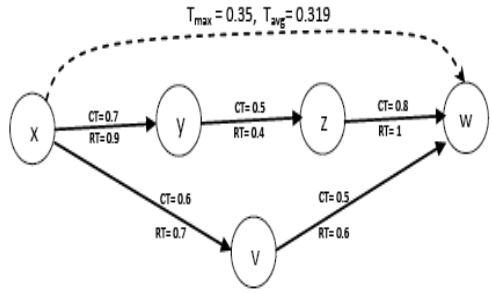
RTBIMS – DECISION ON MULTIPLE PATHS

- Example:



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EXPERIMENTS AND RESULTS

- We examined IMS and RTBIMS on the dataset of Advogato.
- Advogato contains trust information between members of an internet forum of programmers.

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EXPERIMENTS AND RESULTS

- Advogato contains 71,000 rows of text data representing trust information between about 14,000 programmers.
- The amount of the programmer's trust to other programmers is specified with one of the words "Master", "Journeyer", or "Apprentice". These words should be interpreted as numbers between 0 and 1 i.e. 1, 0.8, and 0.6 respectively.

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EXPERIMENTS AND RESULTS

- To estimate the values of RT, we calculated the degree of similarity between their opinions about other programmers:
  - for any two programmers p_i and p_j, we extracted their recommendation list about other programmers and computed the similarity between the two lists as Rt_{ij}.
- Three types of experiments were directed:
  - Using IMS
  - Using RTBIMS considering the maximum value among results from different paths
  - Using RTBIMS considering the average of results from different paths

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EXPERIMENTS AND RESULTS

- Evaluation technique: Leave-One-Out
  - We chose pairs that direct trust between them was available and compared the list of these values with the propagated trust estimated for that pairs by each algorithm.
- Comparison measures:
  - Correlation coefficient
  - Average of differences
  - Average of absolute differences.

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EXPERIMENTS AND RESULTS

Algorithm	Correlation	Average of differences	Average of absolute differences
IMS	0.61	0.24	0.25
RTBIMS using maximum	0.73	-0.06	0.06
RTBIMS using average	0.75	-0.003	0.05

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CONCLUSION AND FUTURE WORK

- Iterative Multiplication Strategy is not so accurate because it does not distinct between competence trust and recommendation trust.
- We have proposed a new algorithm, RTBIMS, that uses recommendation trust values in estimating propagated trust.
- We have suggested a way to estimate the recommendation trust based on similarities.

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CONCLUSION AND FUTURE WORK

- We will work to further improve the accuracy of the estimation of propagated trust.
- We will also try to find ways for reducing the communication among nodes so that the algorithm will be practical for distributed systems.
- We will work on the case of multiple paths to determine the most accurate method to combine the results from different paths in different applications.

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Thanks

for your attention