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Expanding Trusted Neighborhood for Effective Recommendation in Virtual Reality Environments

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Outline

- Introduction
  - Background
  - Motivation
- Research progress
- Future work

Background

- Personalized Recommendation in VR
  - Recommend useful information
    - Information overload: large amount of info => difficult to manage: selection, filtering, …
  - Improve the interactions
  - 2D versus 3D
    - Different recommendation objects
      - 2D: books, news, article, movie, etc.
      - 3D: 3D virtual objects

Background

- Recommender System (RS)
  - Collaborative Filtering
    - Find a group of like-minded users (neighborhood) based on similarity
    - Aggregate neighbors' opinions to do recommendations
  - Issues
    - Suffers from data-sparsity, cold-start problem
    - Performance is not good in accuracy and coverage

Background

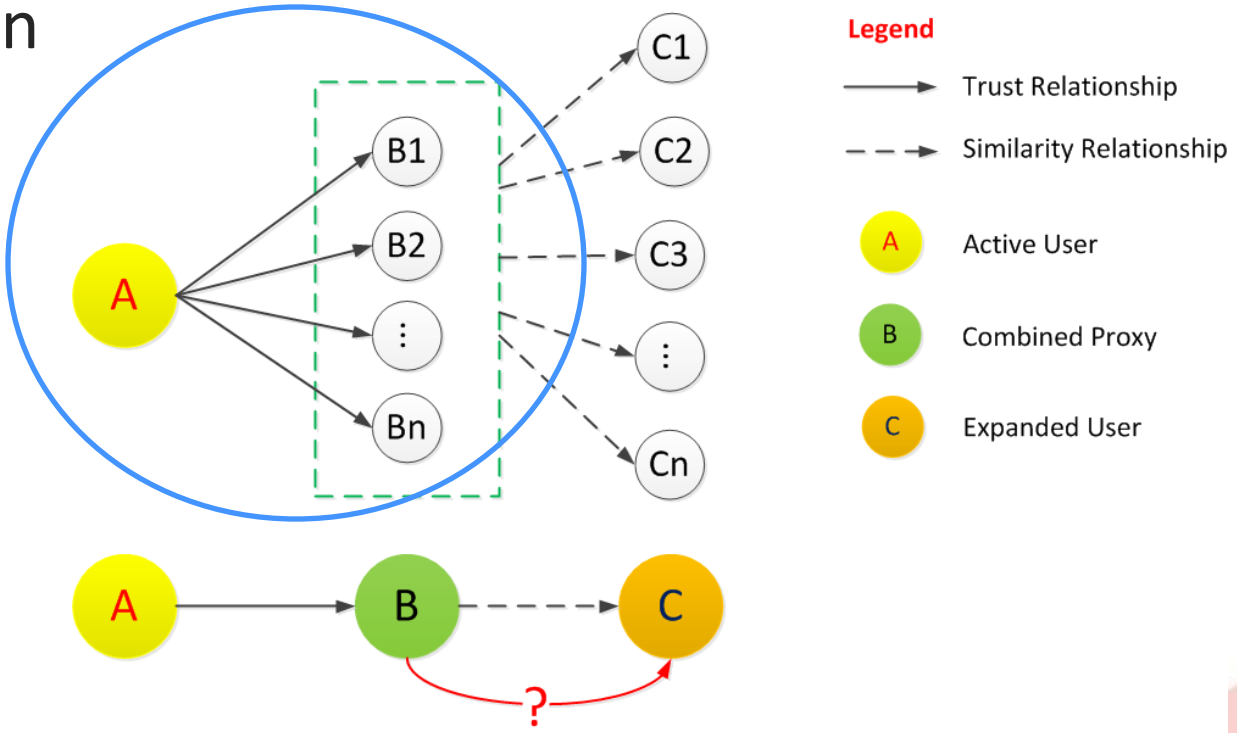
- Trust aware RSs (TARSs)
  - Social relationship is easily available
    - Friendship (Konstas et al. 2009), membership (Yuan et al. 2009), trust list (Massa et al. 2007)
  - Trust is good for
    - Word-of-mouth marketing => more trustable systems
    - Transparent recommendation => more user control
    - Alleviate CF's suffering
      - Users without ratings but involved in trust network => cold start users
      - Trust propagation => data sparsity
      - Better performance (accuracy and coverage)
      - More robust (assist copy, pushing/nuking attacks)

Motivation

- Problems of existing TARSs
  - Cold-start problem
    - Users may only specify few or none trusted peers
  - Bottleneck: how to find out more neighbors?
    - Mechanism for 2D & 3D environments
- How far are we in TARSs? (Shi, 2011)
  - By comparing state-of-art trust models with naïve ones
    - Coverage is better
    - Accuracy is better in a sense, sometimes worse
  - Trust is not well-exploited yet

Current progress

- A computational model for trusted neighborhood expansion



The computational model

– Confidence

$$c(w_1, w_{-1}) = \int_0^1 \left| \frac{x^{w_1}(1-x)^{w_{-1}}}{\int_0^1 x^{w_1}(1-x)^{w_{-1}}\,dx} - 1 \right| dx$$

– Similarity

$$w_{u,v} = \frac{\sum_{i \in I_{u,v}} (r_{u,i} - \bar{r}_u)(r_{v,i} - \bar{r}_v)}{\sqrt{\sum_{i \in I_{u,v}} (r_{u,i} - \bar{r}_u)^2} \sqrt{\sum_{i \in I_{u,v}} (r_{v,i} - \bar{r}_v)^2}}$$

The computational model

PERFORMANCE OF APPROACHES FOR UNIFORM, IDEAL, SPARSE AND SUFFICIENT INFORMATION SCENARIOS

Our Methods

MAE/RC							
Views	Algorithms						
	CF	MT1	MT2	MT3	TrustAll	ENMT	ETMT
All	0.876	0.845	0.852	0.832	0.821	0.711	0.646
	51.24%	26.34%	57.64%	71.68%	88.20%	77.87%	67.37%
Cold Users	1.032	0.756	0.916	0.890	0.857	0.672	0.621
	3.22%	6.57%	22.06%	41.73%	92.92%	47.20%	44.50%
Heavy Users	0.873	0.847	0.848	0.827	0.818	0.716	0.649
	57.41%	29.28%	62.40%	75.36%	87.50%	80.87%	69.26%

MAE

Coverage

Table 3. Performance on Epinions

Approaches	Co								
OPGP	0.49							:0.002	0.622±0.012
MPGP	0.62							:0.002	0.782±0.009
EPGP	0.63							:0.003	0.773±0.003
EPGP+	0.83							:0.007	0.559±0.025

Approaches	Co								
OPGP	0.50							:0.009	0.912±0.002
MPGP	0.63							:0.005	1.343±0.039
EPGP	0.644±0.005	0.914±0.003	0.521±0.007	1.351±0.021	0.535±0.005	1.329±0.034	0.504±0.006		1.342±0.038
EPGP+	0.827±0.017	0.814±0.053	0.701±0.013	1.502±0.024	0.534±0.008	1.414±0.018	0.676±0.009		1.498±0.037

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Future work

- E-commerce in VR
  - Limitless time and space
  - Avatar, real world-like, real-time interactions
    - Cognitive trust is needed

- Future work: A cognitive model for virtual reality environments

Cognitive Trust Theory

- Trust from computational perspective
  - Emphases only on ability/competency (O'Donovan 2005)
  - Trust approaches in 2D are not suitable for VR
- Trust from cognitive perspective
  - Trust is a complex cognitive procedure
    - May be affected by internal, external, self factors
    - Internal factors: competency, willingness, un-harmfulness
    - External factors: risk, opportunity
    - Self factors: confidence

Trust Cognitive Models

- C. Castelfranchi, R. Falcone, "Trust Theory: A Socio-Cognitive and Computational Model," Wiley, 2010, 20
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- S. Marsh and P. Briggs, *Computing with social trust*. Springer, 2009, ch. Examining trust, forgiveness and regret as computational concepts.
- …

Issues with cognitive trust models

- General cognitive trust models
  - Possible, but not easy to implement, not useful
    - FCM (Venanzi et al., 2011), BDI (Hubner et al, 2009)
    - Incomplete information to model all factors
  - More concrete models are needed!

Our proposal

- Concrete cognitive trust model
  - Incorporating cognitive factors
    - Competency, Willingness , Risk, Uncertainty
  - Model these factors and inspect their impacts
  - Formalize our cognitive model
  - Evaluations
    - Build up virtual reality environment
    - Volunteers to participate in

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Q & A

Thank you!

Any comments?

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