



Trust Network Inference for Online Rating Data Using Generative Models

Freddy Chong Tat Chua School of Information Systems Singapore Management University

Ee-Peng Lim

School of Information Systems

Singapore Management University

SIGKDD'10, July 25–28, 2010, Washington, DC, USA.

Motivation

 Many content providing websites have implemented rating and social network features.

• E.g. Youtube, Amazon, Epinions







Trust Antecedent Model



R. C. **Mayer**, J. H. Davis, and D. F. Schoorman. An integrative model of organizational trust. The Academy of Management Review, 20(3), 1995.



Factors For Online Scenarios



- Expressiveness
- Stringency



Variables

- Attributes (Continuous)
 –propensity, expressibility, stringency, ability
- Known Events (Discrete)
 - –expressing trust with positive/negative label
 –rating an object from 0 to 4
- Missing Events (Discrete with uncertainty)
 - -label of trust when it is not express



Graphical Model



- expressiveness
- propensity
- stringency
- ability
- trust label
- observability
- rating



Trust Inference

$$P(t_{i,j} = t | t_{i,-j}, o, r, \beta, \epsilon, \tau, \alpha)$$

$$\propto P(o_{i,j} | t_{i,j} = t, o_{i,-j}, \epsilon) P(t_{i,j} = t | t_{i,-j}, \tau, \alpha)$$

$$P(r_{i,j} | t_{i,j} = t, r_{i,-j}, \beta)$$

$$P(o_{i,j}|t_{i,j} = t, o_{i,-j}, \epsilon) = \frac{n(o_i^0|t) + \epsilon}{n(o_i^0|t) + n(o_i^1|t) + 2\epsilon}$$

$$P(t_{i,j} = t | t_{i,-j}, \tau, \alpha) = \left[\frac{n(t_i^t) + \tau}{n(t_i^0) + n(t_i^1) + 2\tau}\right] \left[\frac{n(t_j^t) + \alpha}{n(t_j^0) + n(t_j^1) + 2\alpha}\right]$$

$$P(r_{i,j}|t_{i,j} = t, r_{i,-j}, \beta)$$

$$= \left[\Gamma\left(m.n\left(r_i^r|t\right) + 2\beta\right) \Gamma\left(\sum_{r=0}^m r.\left[n(r_i^r|t) + n(r_{i,j}^r|t)\right] + \beta\right) \left[\Gamma\left(\sum_{r=0}^m r.n(r_i^r|t) + \beta\right) \Gamma\left(\sum_{r=0}^m (m-r).n(r_i^r|t) + \beta\right) \right]$$

$$\Gamma\left(\sum_{r=0}^m (m-r).\left[n(r_i^r|t) + n(r_{i,j}^r|t)\right] + \beta\right) \right]$$

$$\Gamma\left(m.\left[n(r_i^r|t) + n(r_{i,j}^r|t)\right] + 2\beta\right) \right]^{-1}$$

ALI

UNIVERSITY

SINGAPORE MANAGEMENT

School of Information Systems

Parameters Estimation

$$P(y_i|t_i, \tau, \alpha) \sim Beta\left(\tau + n(t_i^1), \tau + n(t_i^0)\right)$$
$$P(a_j|t_j, \tau, \alpha) \sim Beta\left(\alpha + n(t_j^1), \alpha + n(t_j^0)\right)$$
$$P(e_{i|t}|t_i, o_i, \epsilon) \sim Beta\left(\epsilon + n(o_i^1|t), \epsilon + n(o_i^0|t)\right)$$

$$P(b_{i|t}|r_{i}, t_{i}, \beta) \propto P(b_{i|t}|\beta) \prod_{j,k} P(r_{i,j,k} = r|t_{i,j}, b_{i|t})$$

$$\propto b_{i|t}^{\beta-1} (1 - b_{i|t})^{\beta-1} \prod_{j,k} \prod_{r} \binom{m}{r} b_{i|t}^{r} (1 - b_{i|t})^{m-r}$$

$$\sim Beta\left(\sum_{r=0}^{m} r \ n(r_{i}^{r}|t) + \beta, \sum_{r=0}^{m} (m-r) \ n(r_{i}^{r}|t) + \beta\right)$$

SSMU SINGAPORE MANAGEMENT

Data Set

We used the Epinions data set from trustlet.org.

```
Product reviews \Rightarrow Objects
Review contributors \Rightarrow Trustees
Review raters \Rightarrow Trustors
```

We only consider trust links where rater have rated at least one object of the contributor

Raters	Contributors	# Known Trust Links	# Missing Trust Links	Total
85,132	75,294	467,047	3,575,298	4,042,345



Baseline



Ignores the trustee's ability and the trustor's expressibility.



Experiments

- Five fold cross validation.
- By dividing the links in round robin
- Perform training on four sets and testing on one set
- Repeat 5 times
- Average the 5 set of Precision and Recall curves.



Precision Recall Curves



School of

Prediction of Missing Trust Labels



Conclusion

- Proposed a model for modeling the user behavior attributes, rating and trust in online social networks
- Ideas in Management Science are useful in Computer Science
- Recover the latent trust network from explicit user interactions.







The End Thank You

Freddy Chua Singapore Management University