Dynamic Communities in Referral Networks

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Based on Dynamic Communities in Referral Networks. In *Web intelligence and agent system: An international journal*, (2003) 105-116. P. Yolum and M.P. Singh

Outline

- Definitions of Community
- Understanding Communities
- Technical Framework
- Results
- Discussion

Definitions of Community

- Sociology
  - Comes from social network analysis in sociology
  - Vertices ->people, edges-> the social relationships
- Static link analysis
  - The vertices are pages and the edges are hyperlinks
  - The edges are unlabeled and do not change.
- Referrals and adaptivity
  - Vertices -> agents, edges -> the neighborhood relation
  - A system of interacting agent->an evolving social network

Understanding communities

- Potential applications
  - Endogenous
  - Exogenous
- Link-based communities
  - HITS
    - fans
    - centers

Understanding communities(cont.)

- Link-based communities
  - Limitations
    - Without semantics
    - Co-citation, participants are not aware of each other
    - Structures may not be sufficient to represent communities
    - Be discovered in a central manner, it violating the privacy of participants
- Referral-based communities
  - Natural advantages
    - Annotate links
    - Referrals are generated dynamically

Technical Framework

- Abstract Protocol
  - Agent intention: look for specified service
  - Expertise: quality of the services they provide
  - Sociability: quality of the referrals they provide
  - Acquaintance - neighbor
- Applicable domains
  - Commerce
    - Service providers are distinct from the service consumers
    - Consumer's expertise does not get better, while they can judge the quality.
  - Knowledge manager system
    - Consumers improve their expertise over time
    - Agent wont ask a question whose answer it already knows

Technical Framework(Cont.)

- Evaluation architecture
  - 400 agents, 5% service providers
  - Query agents: generate query and send to a subset of its neighbors, receive answers/referrals, ask referred agents
  - Answer agents: answer a query or answer a referral
  - Update mechanism:
    - Good answer-> the expertise of answering agent and the sociability of the referral agent are increased.
    - Bad answer-> the corresponding values are decreased
    - Each agent have a chance to choose new neighbors from among its acquaintances after a certain interval.
    - The number of neighbor is limited, so the agent must drop some neighbors when adding new neighbors

Results

- One-size doesn't fit all
  - Run HITS algorithm to generate bipartite communities
  - Number of good answers: more good answer from referral network
  - Authorities chosen by others may not serve the needs of every agents
- Referral community mining
  - Communities may not have clear boundaries
    - The approach is based on their level of membership
  - Strength of links matter
  - PageRank calculation
    - Each agent distributes its sociability rank based on the sociability weights on the edge

Results(Cont.)

- Correlation
  - Bipartite community vs. referral community
  - The top n agents from ranking is taken for comparison
  - Correlations values varying from –0.3 to –0.9
  - The ranking of the two communities do not agree
- Utility
  - Capability: resemble cosine similarity but also take into account the magnitude of the expertise vector (Eq. 4)
  - Utility: how easily an agent can access information it needs (Eq. 5)
  - Most referral communities yield higher utility than bipartite community

Discussion

- Related work
  - MIND, the earliest agent-based referral system
  - ReferralWeb by Kautz et al.
  - Referral network in scientific collaborations
- Benefits to our work
  - Endogenous valuation of the interactions
  - Multi-dimensional vectors
  - Two-level relations: acquaintance-neighbor
  - Interactions-based link-analysis
  - Some details are not presented in the paper
  - Dynamical evolution of agent service network