CS 59000-ENS: Navigation in Social Networks

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Decentralized Search

- Kleinberg’s model

- Empirical analysis and generalized models
  - Geographic data on friendship
  - Rank-based friendship
  - Social distance
  - Search as an instance of decentralized problem solving

- Other models
  - Generative
  - Evolution
Kleinberg’s model, quick recap

Random edge from \( v \) to \( w \) added with probability proportional to \( d(v, w)^{-q} \)

Optimal value for \( q \): dimension of grid

Search time: \( O(\log^2 n) \)
Empirical studies and generalized models

- **Search strategies**
  - Geographic routing (Nowell et al, 2005)
  - Search in social networks (Adamic and Adar, 2005)
  - Search in Power-Law networks (Adamic et al, 2001)

- **Generalized models (sociological aspects)**
  - Identity and search in social networks (Watts et al, 2002)
  - Search as instance of decentralized problem solving
    - Navigation using homophily and degree (Simsek and Jensen, 2008)

- **Other (generative?) models**
  - Evolution of navigable networks (Sandberg and Clarke, 2006)
  - How networks become navigable (Clauset and Moore, 2003)
Geographic routing in social networks (Nowell et al, 2005)

- Studies LiveJournal online community, 2004

Rank-based friendship
Figure 20.10: The probability of a friendship as a function of geographic rank on the blogging site LiveJournal. (Image from [277].)
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Fig. 2. Example illustrating a search path using information about the target’s position in the organizational hierarchy to direct a message. Numbers in the square give the h-distance from the target.

<table>
<thead>
<tr>
<th>Strategy</th>
<th>#steps median</th>
<th>#steps mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>High deg</td>
<td>16</td>
<td>43</td>
</tr>
<tr>
<td>Org. hierarchy</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Geography</td>
<td>6</td>
<td>11</td>
</tr>
</tbody>
</table>
Search in power-law networks: Adamic et al, 2001

- High-degree based search works well for Power-law networks
- High-degree based search works poorly for Poisson networks
- High-degree based search applied successfully to Peer-to-Peer networks (GNUTELLA)
Identity and search in social networks: Watts et al, 2002

- Propose a multi-parameter model (along several social dimensions) that offers an explanation for searchability
- Also propose a method for searching
- Potentially applicable to search problems in other networks, including P2P
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Other models for navigable small-world networks

- **Sandberg and Clarke, 2006**
  - Seeks to model growth and evolution of navigable graphs
  - Key idea: re-wiring in a random network
  - Simulations provided

- **Clauset and Moore, 2003**
  - Also based on re-wiring, but of a different kind (inspired by Web surfing)
  - Attempts to explain how navigability might have come about in social networks