Preference-Aware Content Dissemination in Opportunistic Mobile Social Networks

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Conclusion

Introduction

PrefCast Protocol

Evaluation

Conclusion
Mobile social networks (MSN) vs DTNs
- Social feature/ social preference
Issues in Mobile Social Networks
- Community detection
- Content distribution
- Data dissemination
Traditional routing in DTNs vs Data dissemination in MSNs

Target:
- DTNs: Delivery ratio, delivery delay, etc.
- MSNs: Data dissemination in social preferred/interested nodes.

Start point:
- DTNs: path delivery likelihood or contact profile
- MSNs: different interest or preference from the content.
Introduction
Previous work:

Does not consider the heterogeneous user preferences for various content objects

Fig. 1. Example of Heterogeneous Preference.
PrefCast Protocol
✓ Contact duration is limited, only one object can be forwarded in each time slot.

✓ Each object is only forwarded once from the same hop.

✓ Buffer size is limited, if full, drop object with least local utility
<table>
<thead>
<tr>
<th>Notations</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mathcal{V}$</td>
<td>the set of users in an MSN</td>
</tr>
<tr>
<td>$M$</td>
<td>the set of content objects</td>
</tr>
<tr>
<td>$\mathcal{V}_f^\tau$</td>
<td>the set of users that have contact with forwarder $f$ in time-slot $\tau$</td>
</tr>
<tr>
<td>$M_f^\tau$</td>
<td>the set of objects owned by forwarder $f$ in time-slot $\tau$</td>
</tr>
<tr>
<td>$u_{i,m}$</td>
<td>preference (utility) of user $i$ for object $m$</td>
</tr>
<tr>
<td>$d_{fi}$</td>
<td>the duration of contact between user $f$ and $i$</td>
</tr>
<tr>
<td>$\mathcal{T}$</td>
<td>the set of feasible forwarding time-slots for a forwarder</td>
</tr>
<tr>
<td>$\omega^l_{m,t}$</td>
<td>total local utility contribution of broadcasting object $m$ by forwarder $f$ in time-slot $t$</td>
</tr>
<tr>
<td>$\omega^g_{m,t}$</td>
<td>total global utility contribution of broadcasting object $m$ by forwarder $f$ in time-slot $t$</td>
</tr>
<tr>
<td>$U(i,m,t)$</td>
<td>the future utility contributed by $i$ if it gets object $m$ in time-slot $t$</td>
</tr>
<tr>
<td>$x_{m,t,x}$</td>
<td>an indicator denoting if forwarder $f$ sends object $m$ in time-slot $t$, and its matrix form</td>
</tr>
<tr>
<td>$\Omega(x), \Omega^*$</td>
<td>the total utility contributed by a forwarder schedule $x$, and the maximal total utility $\Omega^* = \max_x \Omega(x)$</td>
</tr>
<tr>
<td>$G = (M_f^\tau \cup \mathcal{T}, E)$</td>
<td>the bipartite graph used for forwarder $f$ to solve the forwarding schedule in time-slot $\tau$</td>
</tr>
<tr>
<td>$M$</td>
<td>a bipartite matching in graph $G$</td>
</tr>
</tbody>
</table>
Goal:

\[ \omega_{m, \tau}^g = \sum_{i \in \mathcal{V}_f^T, m \notin \mathcal{M}_i^T} U(i, m, \tau) \]

\[ \Omega(x) = \sum_{m \in \mathcal{M}_f^T, t \geq \tau} x_{m,t} \omega_{m,t}^g \]

<table>
<thead>
<tr>
<th>Object</th>
<th>Future Utility Contribution</th>
<th>( U(i, m, \tau) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m = m_1 )</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>( m = m_2 )</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

(a) Future utility contribution

<table>
<thead>
<tr>
<th>Object</th>
<th>Global Utility</th>
<th>Time-Slot Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m = m_1 )</td>
<td>1+5=6</td>
<td>5</td>
</tr>
<tr>
<td>( m = m_2 )</td>
<td>3+2=5</td>
<td>2</td>
</tr>
</tbody>
</table>

(b) Global utility

TABLE II
Example of utility contribution
✓ Maximum-utility forwarding problem:

\[
\Omega^* = \max_x \Omega(x) = \max_x \sum_{m \in M_f^T, t \in T} x_{m,t} \omega_{m,t}^g
\]

\[
= \max_x \sum_{m \in M_f^T, t \in T} \left( x_{m,t} \sum_{i \in \mathcal{V}_f^T, m \notin M_i^T, t < \tau + d_{fi}} U(i, m, t) \right)
\]

subject to

\[
\sum_{m \in M_f^T} x_{m,t} \leq 1, \forall t \in T \tag{3b}
\]

\[
\sum_{t \in T} x_{m,t} \leq 1, \forall m \in M_f^T \tag{3c}
\]

\[
x_{m,t} \in \{0, 1\} \tag{3d}
\]
Optimal forwarding scheduling
Maximum weight bipartite matching problem
Idea: contact profile:

\[
\Phi_{j,k,m}(t) = q_{jk}^{t-1} + \sum_{z=1}^{t-1} (1-q_{jk})q_{jk}^{t-1-z} \Phi_{k,m}(z).
\]

\[
\sum_{z=t}^{T_{m}^{\max} - 1} (1-q_{ij})q_{ij}^{T_{m}^{\max} - 1-z} \Phi_{j,m}(z)
\]

\[
\sum_{z=t}^{T_{m}^{\max} - 1} (1-q_{ij})q_{ij}^{T_{m}^{\max} - 1-z} \Phi_{j,m}(z)(1 - d_{i,m}(z)).
\]
✓ Idea: contact profile:

\[
\kappa_{i,j,m}(t) = u_{j,m} \sum_{z=t}^{T_{m}^{max} - 1} (1 - q_{ij}) q_{ij}^{T_{m}^{max} - 1 - z} \Phi_{j,m}(z)(1 - d_{i,m}(z))
\]

\[
U(i, m, t) = \sum_{n=0}^{\infty} \left( n \sum_{F \in F_n} \prod_{j \in F} \kappa_{i,j,m}(t) \prod_{j \notin F} (1 - \kappa_{i,j,m}(t)) \right)
\]

\[
U(i, m, t) \approx \sum_{j \in \mathcal{V} \setminus \{i\}} \kappa_{i,j,m}(t)
\]
Evaluation