A Lightweight Message Dissemination Strategy for Minimizing Delay in Online Social Networks

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Outline

• 1. Introduction
• 2. Model Description
• 3. Message Dissemination Strategy
• 4. Evaluation
1. Introduction

1.1 Motivation

• In Online Social Networks (OSNs), some time-insensitive messages (disaster warnings, virus alerts, and search notices, etc.) are badly in need of being disseminated to specific users or applications as soon as possible.

• Sudden message dissemination among users is bound to put a significant burden on network resources.

• A lightweight Message Dissemination strategy for Minimizing Delay in OSNs is required.
1. Introduction

1.2 Problem

• How to disseminate message in Online Social Networks. Each grid represents a kind of social application, each circle represents a user, which could disseminate the message to any other user in the same social application.
1. Introduction

1.3 Contributions

• We define the user’s activeness in OSNs according to the switch habit among different social application

• According to the user’s activeness, a lightweight message dissemination strategy for minimizing delay is proposed in OSNs

• We conduct extensive simulations based on the synthetic user’s activeness.
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2. Model Description

2.1 Continuous-time Markov model

- We define the parameter of the exponential distribution obeyed by a user’s residence time in each social application as user’s activeness. According to a user’s activeness, we achieve the expectation time for the first meeting between two users, which plays a major role in terms of making a message dissemination strategy, aiming to minimize delivery delay.

\textbf{Theorem 1:} \( \xi^X \sim \exp(c_1), \xi^Y \sim \exp(c_2), \) and then \( \xi \sim \exp(c_1 + c_2). \)

\textbf{Theorem 2:} \( \xi^X \sim \exp(c_1) \) and \( \xi^Y \sim \exp(c_2) \), the earliest time for A and B to meet each other \( (T = \inf\{t \geq 0; X_t = Y_t\}) \) satisfies: \( T \sim \exp(\frac{c_1 + c_2}{n-1}). \)
## 2. Model Description

### 2.2 Notations

<table>
<thead>
<tr>
<th>Notation</th>
<th>Explanation</th>
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<tbody>
<tr>
<td>$n$</td>
<td>Total number of social applications (i.e., number of grids) in OSNs</td>
</tr>
<tr>
<td>$e$</td>
<td>The set of different social applications, $e = {e_1, e_2, \cdots, e_n}$</td>
</tr>
<tr>
<td>$X_t$</td>
<td>The user’s state (social application being used) at time $t$, $X_t \in e$</td>
</tr>
<tr>
<td>$P_{i,j}(t)$</td>
<td>The probability that user’s state of time 0 is $i$, the state of time $t$ is $j$</td>
</tr>
<tr>
<td>$\tau_i$</td>
<td>The random residence time for a user in social application $e_i$</td>
</tr>
<tr>
<td>$c_k$</td>
<td>The parameter in exponential distribution of user $k$’s residence times</td>
</tr>
<tr>
<td>$T$</td>
<td>The earliest time for two users to meet each other</td>
</tr>
<tr>
<td>$E_{i,j}(T)$</td>
<td>The expected earliest time for two users to meet each other, with the condition that their initial states are $i$ and $j$</td>
</tr>
<tr>
<td>$\xi$</td>
<td>The first switch time (switch from one social application to another one) for any of the two users</td>
</tr>
<tr>
<td>$l$</td>
<td>The total number of users</td>
</tr>
<tr>
<td>$T_i$</td>
<td>The first meeting time between user $i$ and user $l$ (destination user)</td>
</tr>
<tr>
<td>$\lambda_{l,i}$</td>
<td>The parameter of $T_i$’s exponential distribution, $\lambda_{l,i} = \frac{c_l + c_i}{n-1}$</td>
</tr>
<tr>
<td>$T^{(l)}$</td>
<td>The dissemination delay from the lowest priority user to highest priority user for a $l$-users system</td>
</tr>
<tr>
<td>$r_l$</td>
<td>The expectation of $T^{(l)}$</td>
</tr>
</tbody>
</table>
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3. Message Dissemination Strategy

3.1 Strategy

**Theorem 3:** \( P(T_j < T_i, \forall i \neq j) = \frac{\lambda_{l,j}}{\lambda_{l,1} + \lambda_{l,2} + \cdots + \lambda_{l,l-1}}. \)

**Theorem 4:** \( E[T_j \chi_{T_j = \tau}] = \frac{\lambda_{l,j}}{(\lambda_{l,1} + \lambda_{l,2} + \cdots + \lambda_{l,l-1})^2}. \)

**Theorem 5:** \( \lambda_{l,1} > \lambda_{l,2} > \cdots > \lambda_{l,l-1}, \) if we exchange any pair of priorities \( \lambda_{l,i} \) and \( \lambda_{l,j} \), then the \( r_l \) will get bigger.

- When the user’s activeness is time-constant, we achieve the optimal dissemination strategy, which disseminates the message to the user of highest activeness in the current social application, in order to minimize dissemination delay.
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• 3. Scheduling and Drop Strategy

• 4. Evaluation
4. Evaluation

4.1 Two performance metrics

- 1. **Average delay**, which is the average elapsed time of the successfully delivered messages.

- 2. **Average hopcounts**, which is the average forwarding number of the successfully delivered messages.
4. Evaluation

4.2 Simulation Results

(a) Average delay
4. Evaluation

4.2 Simulation Results

(b) Average hopcounts
Future Work

• **Time-varying Activeness**

• **Real Data**
Thank You