**Motivation**

- How to capture users’ perceptions when they are using network applications?

<table>
<thead>
<tr>
<th>Network Application</th>
<th>Delay Jitter</th>
<th>Loss Rate</th>
<th>User Satisfaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Small</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Large</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Which network configuration is better from users’ perception?

**Methodology**

**User experiments**
- Ask users to click a button whenever you feel dissatisfied with the quality
- Users do not need to be well-trained to participate as only an intuitive click action is required.

**Data analysis**
- Apply Poisson regression to model the relationship between network factors and the click rate (average number of times the subject clicks the button in one second)
- Predictor: click rate
- Dependent variable: network factors

Assume the click rate is $C(t)$ and the network factors are $N_1(t)$, $N_2(t)$, ..., $N_k(t)$ at time $t$. Then, the Poisson regression equation is:

$$\log(C(t)) = \alpha + \alpha_1 N_1(t) + \ldots + \alpha_k N_k(t),$$  \hspace{1cm} (1)

where $\alpha_i$ denotes the Poisson regression coefficients, which are estimated by the maximum likelihood method.

**Users’ delay response**
- Problem: users may unintentionally delay the click actions after they become aware of the degraded application quality
- Solution: shift the click event process and search for the average delay time $d_{avg}$ by fitting the regression model for network factors and click event processes with different time lags
- $d_{avg}$ is computed as:

$$\arg\min_{d_{avg}} \{ \text{deviance of (1)} \text{ by replacing } C(t) \text{ with } C(t+d) \}$$

After obtaining the best model fit, we compute the expected click rate as:

$$\exp(\beta_0 + \beta_1 N_1 + \ldots + \beta_k N_k),$$

where $\beta_i$ is the Poisson regression coefficients by fitting $C(t+d_{avg})$ with $N_i$, $1 \leq i \leq k$.

**Experimental Setup**

- A song is played by the sender host, transmitted to the receiver via AIM or MSN Messenger, and played on the subject’s earphone attached to the receiver host
- Subjects: three computer science students to perform the experiments, where each experiment lasts for 6 minutes

**Result: Expected Click Rate**

- Loss rate $< 20\%$: MSN leads to a higher click rate
- Loss rate $> 30\%$: AIM leads to a higher click rate
- AIM is less tolerant of an extremely high packet loss rate than MSN Messenger, even though it is more tolerant at low packet loss rate

**Result: Comfort Regions**

- "Comfort region": the set of network scenarios that leads to an expected click rate lower than a certain threshold

| Threshold = 0.4 or 0.6: AIM is better (larger comfort regions) |
| Threshold = 0.8 or higher: Comparable |

→ MSN Messenger is more tolerant of packet loss and AIM is more tolerant of network delay jitters

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**Contribution**

- Present a lightweight, non-intrusive, and efficient framework called OneClick to learn about users’ experiences in using network applications
- Demonstrate the effectiveness of assessing the users’ perceptions under different network factors.