Exploring the Impact of Dynamic Mutual Influence on Social Event Participation

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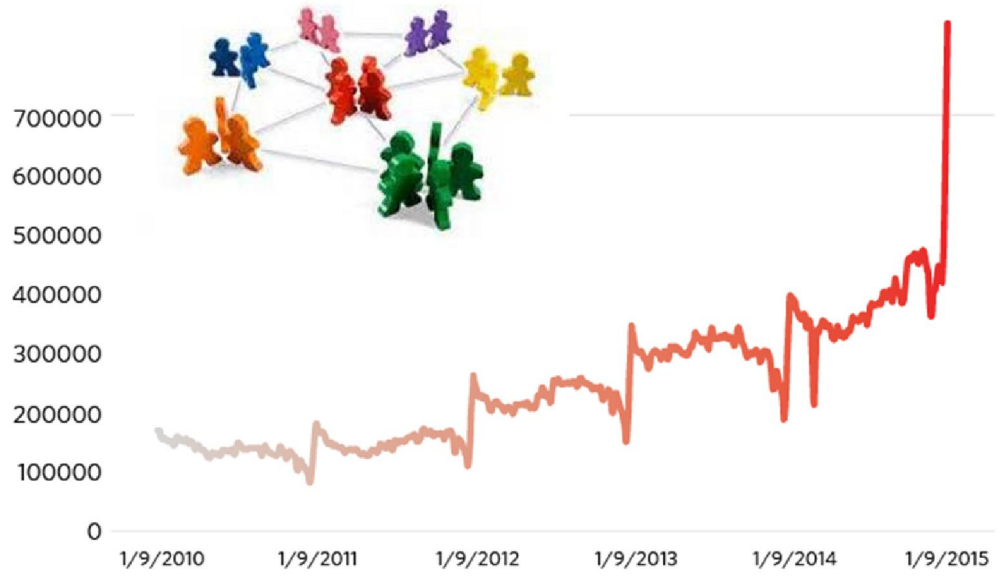
Background

- Offline social events emerge, which connect cyber and physical social network.
- New challenges raise to organize events and predict attendance.

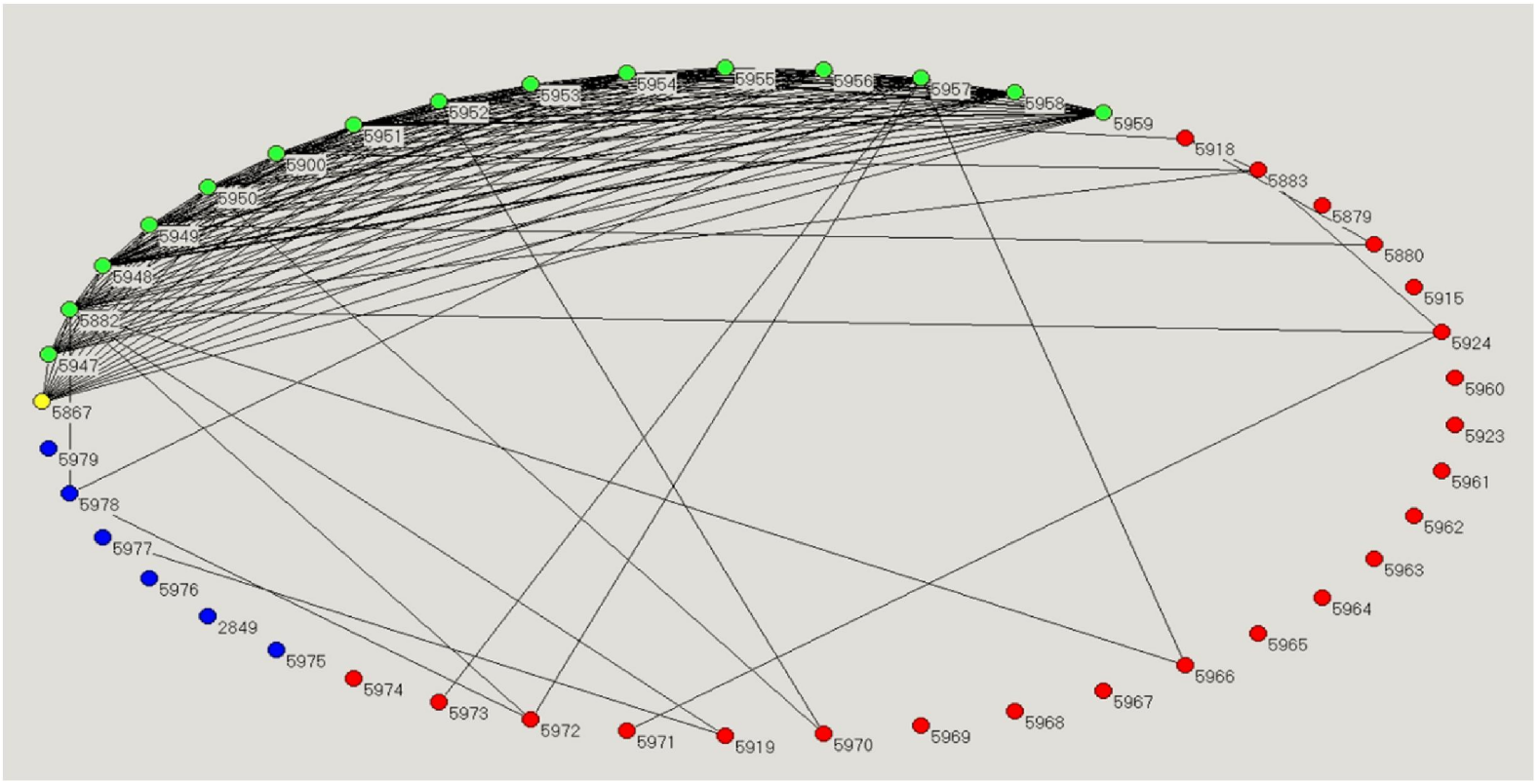


Motivation 1 – Social Factors

- Social factors affect decision-making process of social event participation.
  - People rely on familiars when RSVPs occur, which results in correlation of offline activities.
  - Correspondingly, active members in social group tend to have stronger connections than average.

Table 1: Comparison for social factors in event series.

	Average for All Events		First Attendance	
	Density	Ave. Weight	Degree	Ave. Weight
Active	0.7849	0.2343	0.1249	0.0109
Overall	0.4694	0.1305	0.0498	0.0062
P-Value	0.000	0.000	0.001	0.004



- Significant distinction between attenders and absentees.

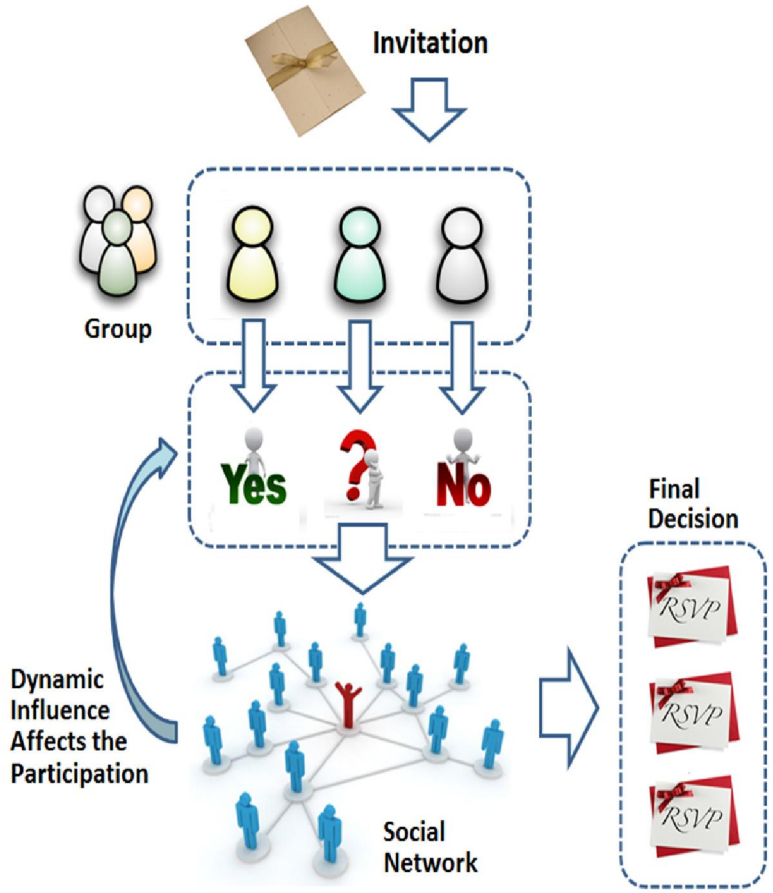
Prior Arts

- Traditional techniques tend to introduce social factors as features or constraints.
  - Basic Assumption: Social connections usually indicate similar preference, then intuitively similar decisions on attendance.
- However, they may fail to simulate the novel factors of *event-based social network*.
  - Potential attenders are always changing, leading to various influence.
  - ***Connections may not directly affect preference.***

Motivation 2 – Dynamic Influence

- **D**ynamic **S**ocial **I**nfluence (DSI) may exist within decision-making process.
  - Domino Effects:

    One change leads to chain reactions.
  - Dynamic Equilibrium: Final agreement achieved when all influence are stable.



DSI – Problem Statement

- Basic Assumption
  - Social factors may not indirectly affect preference.
  - Instead, they directly influence the decisions. To be specific, they influence the **threshold** of discrimination.

$$\mathcal{I}(f_{i,k} - h_{i,k})$$

- Tendency
  - User Preference
  - Event attributes
- Threshold
  - Social Influence
  - General Enthusiasm

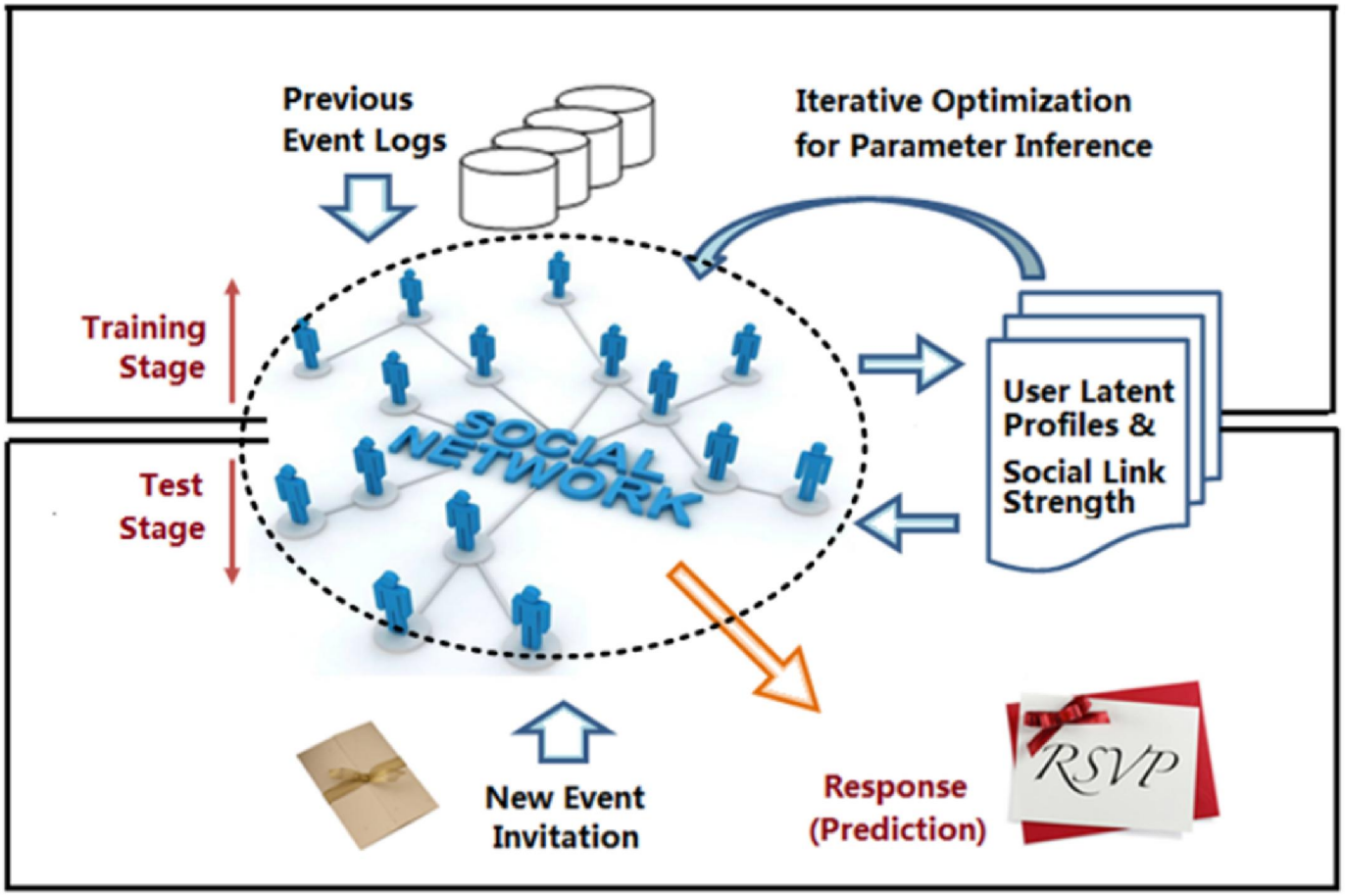
DSI – Formulation of Influence

- Social influence are determined by two factors
  - Connection strength.
  - Their own attitude.

$$h(u_i, e_k) = h_{i,0} \cdot \prod_{j \in N_i} [1 - \mathcal{I}(f_{j,k} - h_{j,k}) \cdot w_{ji}]$$

- Enthusiasm, lower means active to participate events
- Friends' opinions
- Connection Strength

DSI – Two-stage Framework



DSI – Two-stage Framework

- Global Target: To achieve stable decisions.
- Training Stage: User profiling with personal preference, enthusiasm and social connections.
  - Minimizing the discriminant error.

$$\arg \min_{\mathbf{p},h_0,w} \sum_{u_i \in U} \sum_{e_k \in E} [s^0_{i,k} - \mathcal{I}(f_{i,k} - h_{i,k})]^2$$

- Test Stage: Participation analysis on given social event and target user group.
  - Updating $\mathcal{I}(f_{i,k} - h_{i,k})$ for each user.

Technical Solution

- Difficult to directly optimize the loss function due to mutual dependence within attenders.
- To ease the optimization task, we propose a step-by-step iterative approach.

$$F^t(U,E) = \sum_{u_i \in U} \sum_{e_k \in E} [s^0_{i,k} - \mathcal{I}(f^t_{i,k} - h^t_{i,k})]^2$$

- To be specific, opinions achieve in round ***t-1*** will only influence their friends in round ***t***.

$$h^t_{i,k} = h^t_{i,0} \cdot \prod_{j \in N_i} [1 - \boxed{\mathcal{I}(f^{t-1}_{j,k} - h^{t-1}_{j,k})} \cdot w^t_{ji}]$$

Algorithm 1 Iterative Solution for Training Stage.

Input: target user group $\mathbf{U} = \{u_i\}$, event set $\mathbf{E} = \{e_k\}$ and attendance records $\{s^0_{i,k}\}$;
Store: event attributes $\mathbf{a}_k$ for each $e_k \in \mathbf{E}$;
Output: users' profile $\langle \mathbf{p}_i, h_{i,0} \rangle$ and social strength w_{ij}

Iteration = *True*;
while (Iteration)
  Iteration = *False*;
  for $u_i \in \mathbf{U}$, $e_k \in \mathbf{E}$
    update $\langle \mathbf{p}_i, h_{i,0} \rangle$ and $\{w_{ij}\}$ until convergency;
    update $f_{i,k}$, $h_{i,k}$ based on Equation 3.1;
    update $s_{i,k}$ as $\mathcal{I}(f_{i,k} - h_{i,k})$;
    if $s_{i,k}$ changed **then** Iteration = *True*;
    end if
  end for
end while
return $\{\langle \mathbf{p}_i, h_{i,0} \rangle\}$, $\{w_{ij}\}$;

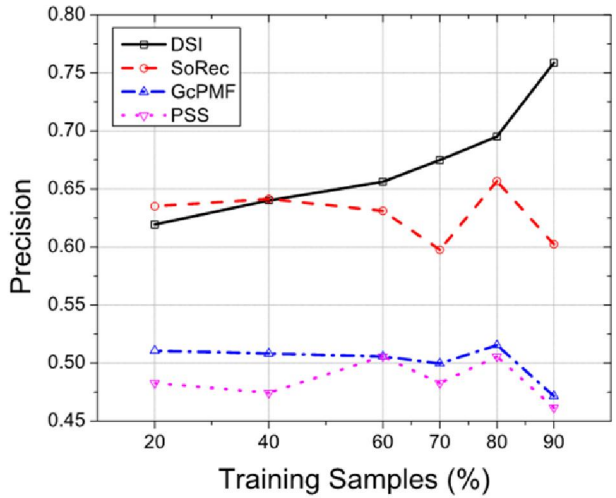
Experimental Results

- To verify the effectiveness, we perform extensive experiments on real-world data set extracted from official API of ***Meetup.com***.
- 422 user groups, 9,605 social events and 24,107 related users are analyzed in total.
- Several state-of-the-art techniques are compared as baselines, including social-constraint PMF and topic-sensitive social spread simulation model.

Experiments – Overall Results

Table 4: Overall performance of each approach.

	DSI	SoRec	GcPMF	PSS
Precision (%)	**75.88**	60.23	47.47	46.15
Improvement (%)	-	+25.98	+59.85	+64.42
Variance	**0.022**	0.102	0.134	0.059
P-Value	-	0.000	0.000	0.000
Recall (%)	**75.34**	75.21	21.73	41.82
Improvement (%)	-	+0.17	+246.71	+80.16
Variance	**0.030**	0.112	0.234	0.180
P-Value	-	0.063	0.000	0.000



- Significant margin occur compared with baselines, which validates the potential of dynamic social influence in analyzing social event participation.

Discussion – Interesting Rules

Group	A	B	C	D
Precision	96.15%	94.64%	48.20%	47.01%
Members	129	160	1088	273
Ave. Freshmen	20%	50%	35%	35%
Negative Edges	$< 1\%$	$< 1\%$	7%	4%

- To attend more events, you must be more social.
- Stable core leads to tight connection, while less attractive to freshmen, and vice versa.
- Negative connections results in difficult agreement, then worse predictions.

Conclusion

- Social connections may not only affect the user preferences, but also directly affect the decision-making process of event participation.
- Effects of social hubs should be highlighted during the event organization. They should be the first to be satisfied.
- It will be interesting to integrate the DSI framework with more types of social constraint, or some other motivation of attendance.

Thanks!

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