Social Role-Aware Emotion Contagion in Image Social Networks

AAAI'16
Authors: Y.Yang et al.
Seminar Presenter: Jun Yang

Outline

- Background
- Related Works
  - Image Emotion Inference
  - Social Roles Analysis
- Problem
- Exploratory Analysis
- Proposed Model
- Experimental Results and Analysis
- Conclusion

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Authors

Yang Yang

- 2011-2016
  Ph.D. Candidate of *Knowledge Engineering Lab, Tsinghua University*
- 2016-
  Assistant Professor of *Zhejiang University*

- Information Diffusion Modeling
- Social Tie Mining
- User Profiling
- Probabilistic Graphical Models

Emotion Classification

- Categorical Approach
  - Ekman's six emotions: *{happiness, surprise, anger, disgust, fear, sadness}*
- Dimensional Approach
  - Wundt: *{"pleasure or unpleasure", "arousing or subduing" , "strain or relaxation"}*
  - Mehrabian & Russel: *{pleasure, arousal, dominance}*
  - Watson & Tellegen: *{positive, negative}*

Sentiment Analysis

- Knowledge-based Techniques
- Statistical Methods
- Hybrid Approaches

Emotion Contagion

- Emotion Contagion *vs* Information Diffusion/Propagation
- Node-based; Link-based
- Epidemic Model; Linear Threshold Model; Independent Cascade Model

Emotion Contagion

Research on Facebook

- Guillory et al.(2011)
- Kramer et al.(2014)

- Emotional contagion occurs via text-based computer-mediated communication.
- People's emotional expressions on Facebook predict friends' emotional expressions, even days later.
- Emotions or moods are contagious in the absence of direct interaction between experiencer and target.

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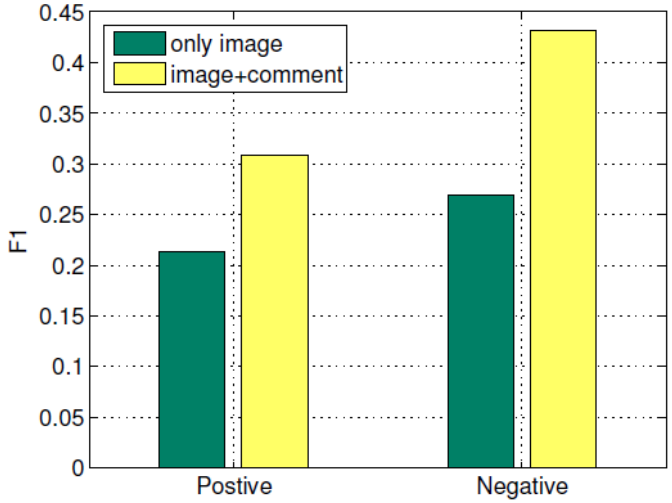
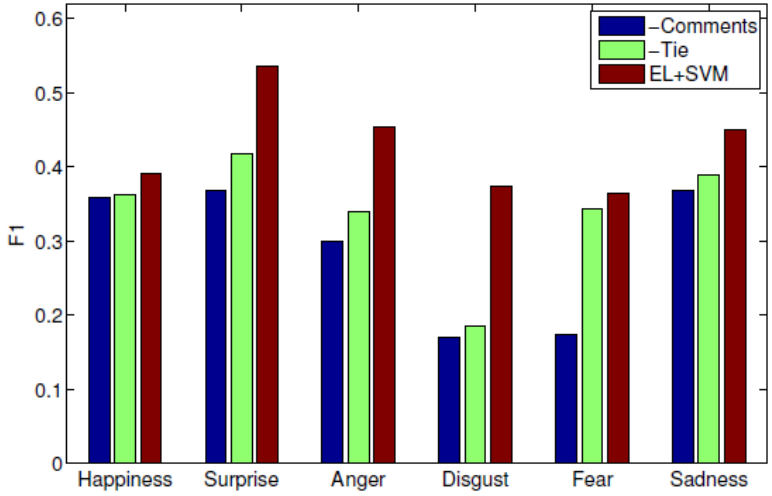
Image Emotion Inference

Yang Y, Jia J, Zhang S, et al. How do your friends on social media disclose your emotions?[C]//AAAI. 2014, 14: 1-7.

- **Image content**, such as *color distribution, contrast* and *saturation*.
- **Comments by friends** help extract emotions from images.
- Most improvements are due to interactions between **closest friends**.





Social Roles Analysis

Yang Y, Tang J, Leung C W, et al. RAIN: Social Role-Aware Information Diffusion[C]//AAAI. 2015: 367-373.

Structural properties reflect users' **social roles**.

Social roles affect the influence between users, and hence the **information diffusion process**.

- Opinion Leader
- Structural Hole Spanner

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- Opinion Leader
- Structural Hole Spanner

1% of users as **opinion leaders** posted 50% of URLs on Twitter. via Wu et al.(2011)

Users with high **PageRank scores**.

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- Opinion Leader
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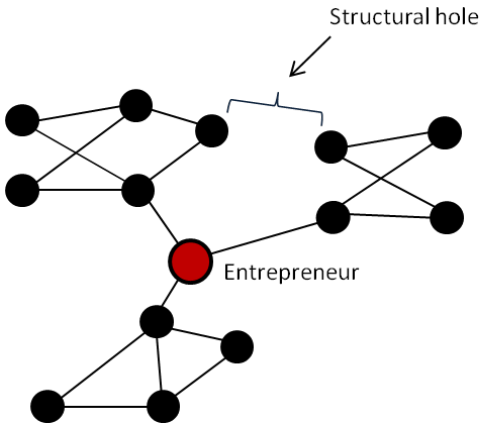
1% of users as **structural hole spanners** control 25% of information diffusion. via Lou et al.(2013)

Users with small **network constraint scores**.



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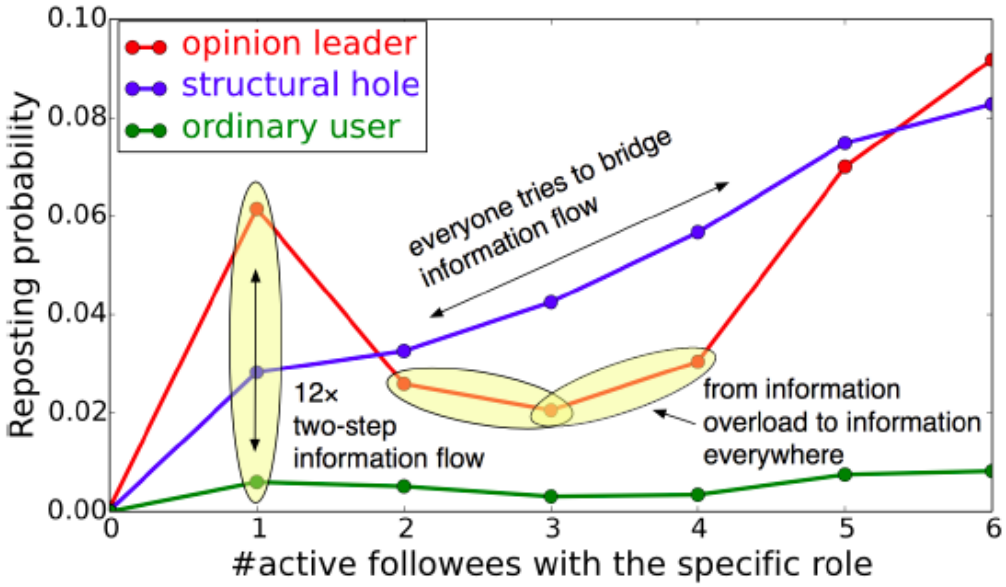

Social Role-Aware Emotion Contagion in Image Social Networks

Yang Yang, Jia Jia, Boya Wu, and Jie Tang

Department of Computer Science and Technology
Tsinghua University

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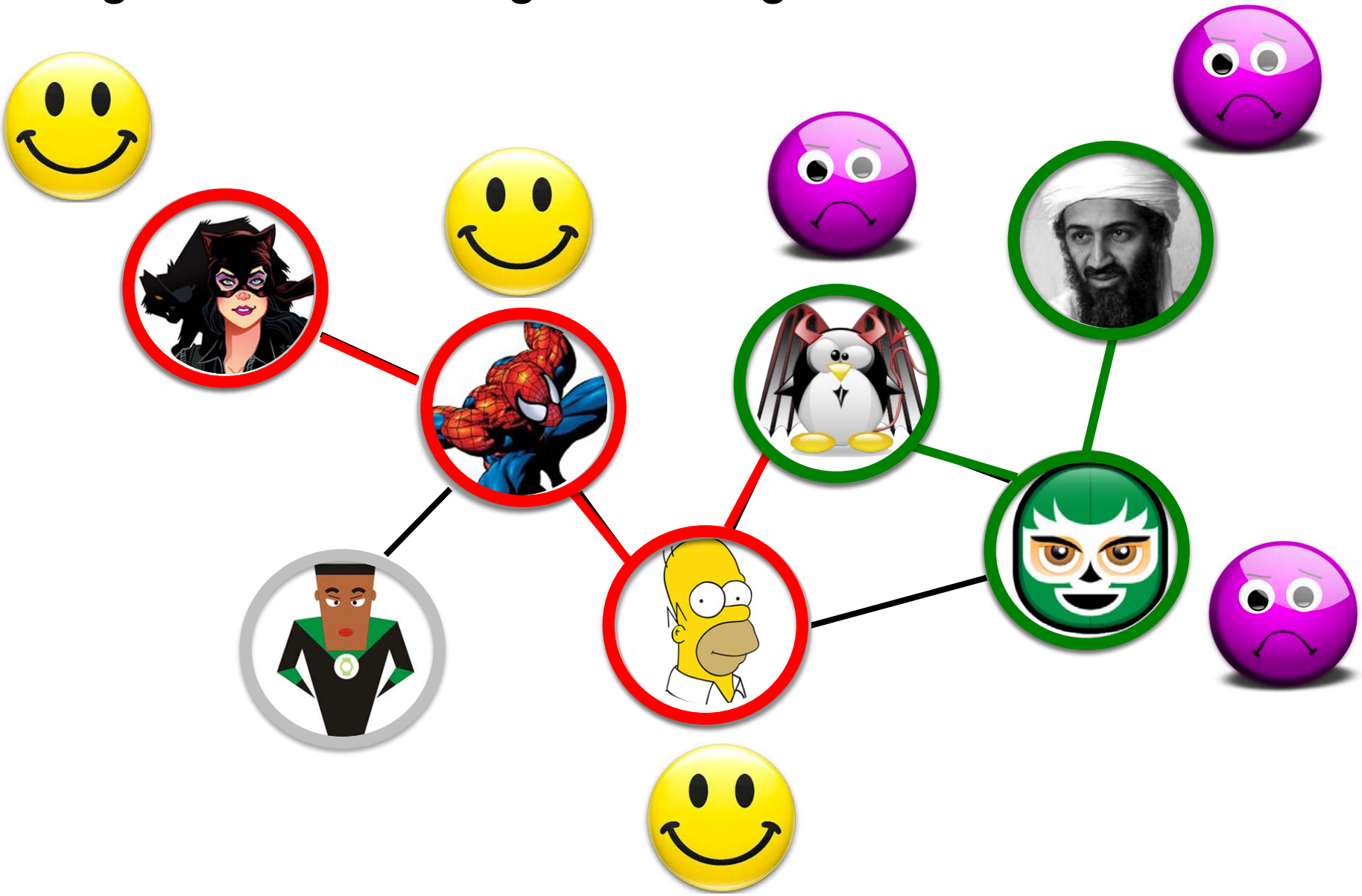

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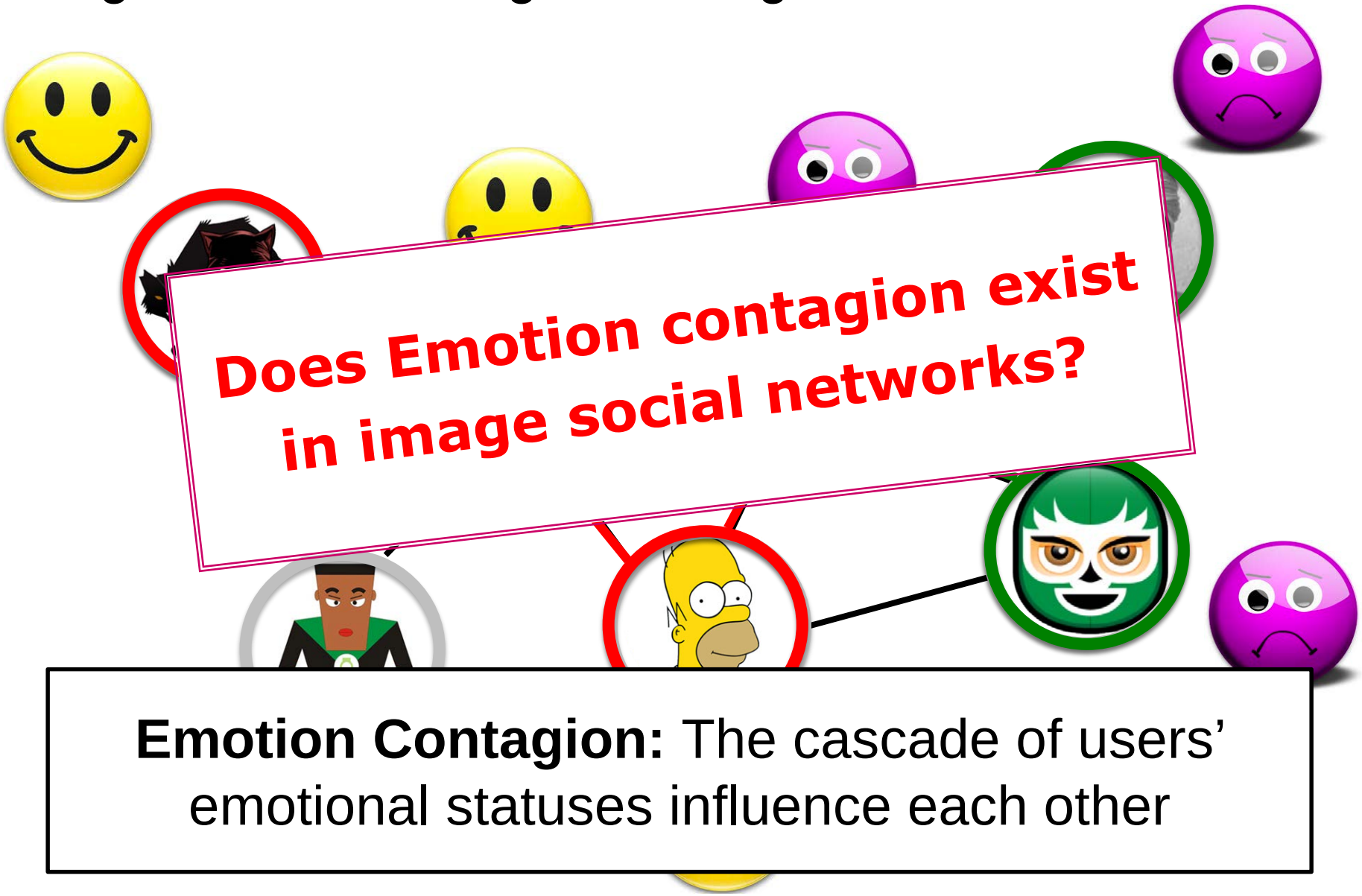
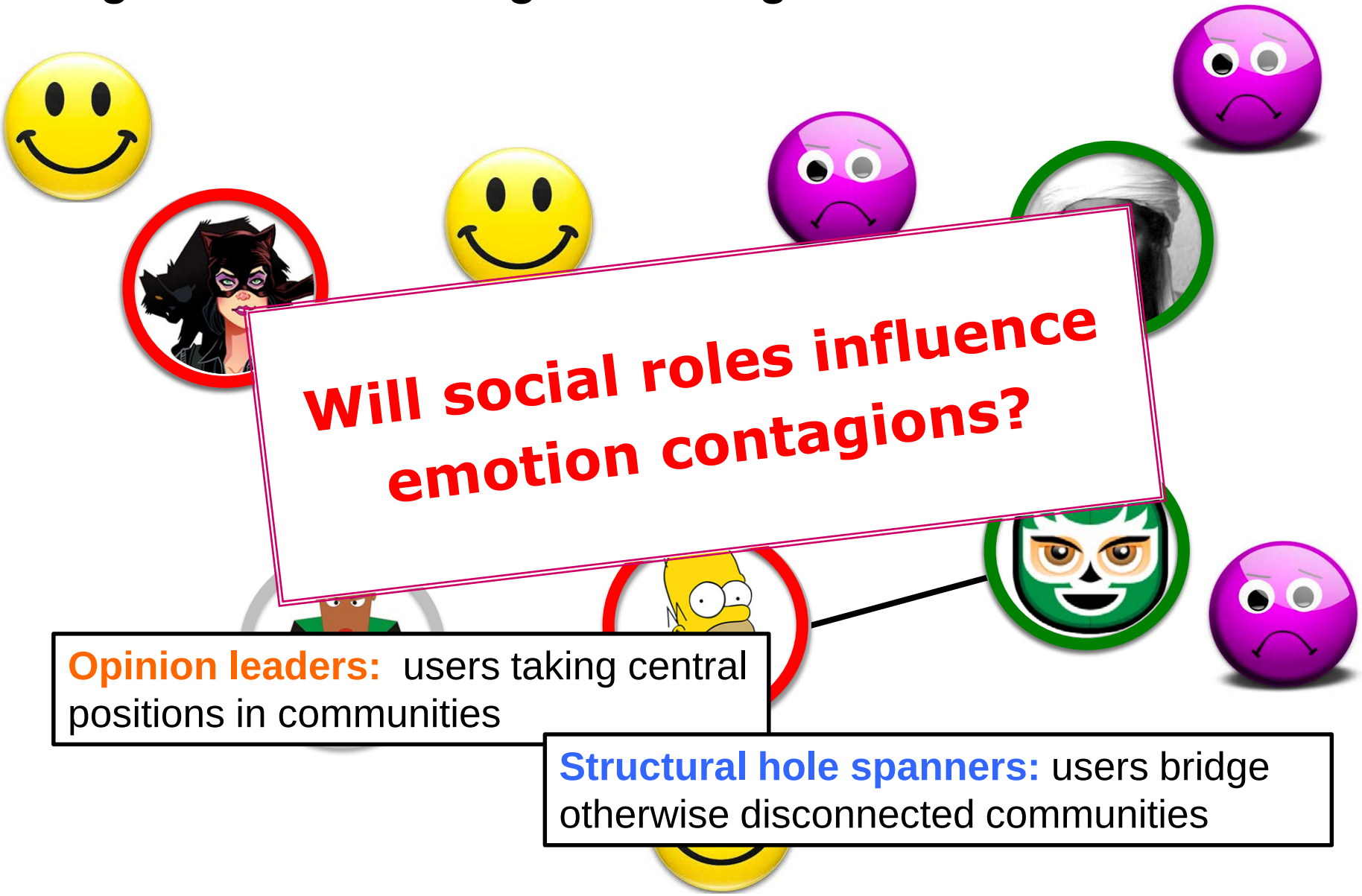


Emotion Contagion: The cascade of users' emotional statuses influence each other

Image Emotion Contagion in Image Social Networks



Will social roles influence emotion contagions?

Opinion leaders: users taking central positions in communities

Structural hole spanners: users bridge otherwise disconnected communities

Problem Definition

- **Input:** An image social network G=<V, M, E, R>, where V is a set of **users**, M is a set of **images**, E represents **following** relationships between users, and each element in R (v, m, t) denotes that user v **publishes** image m at time t.
- We use a matrix Y to denote users' **emotional status**, where y_{vt} indicates v's emotion at time t. $y_{vt} \in$ {happiness, surprise, anger, disgust, fear, sadness}
- Task: Given G, Y, a time stamp t, our goal is to learn

$$f : G = (V, M, E, R), t, Y_{.1\ldots t-1} \rightarrow Y_{.t}$$

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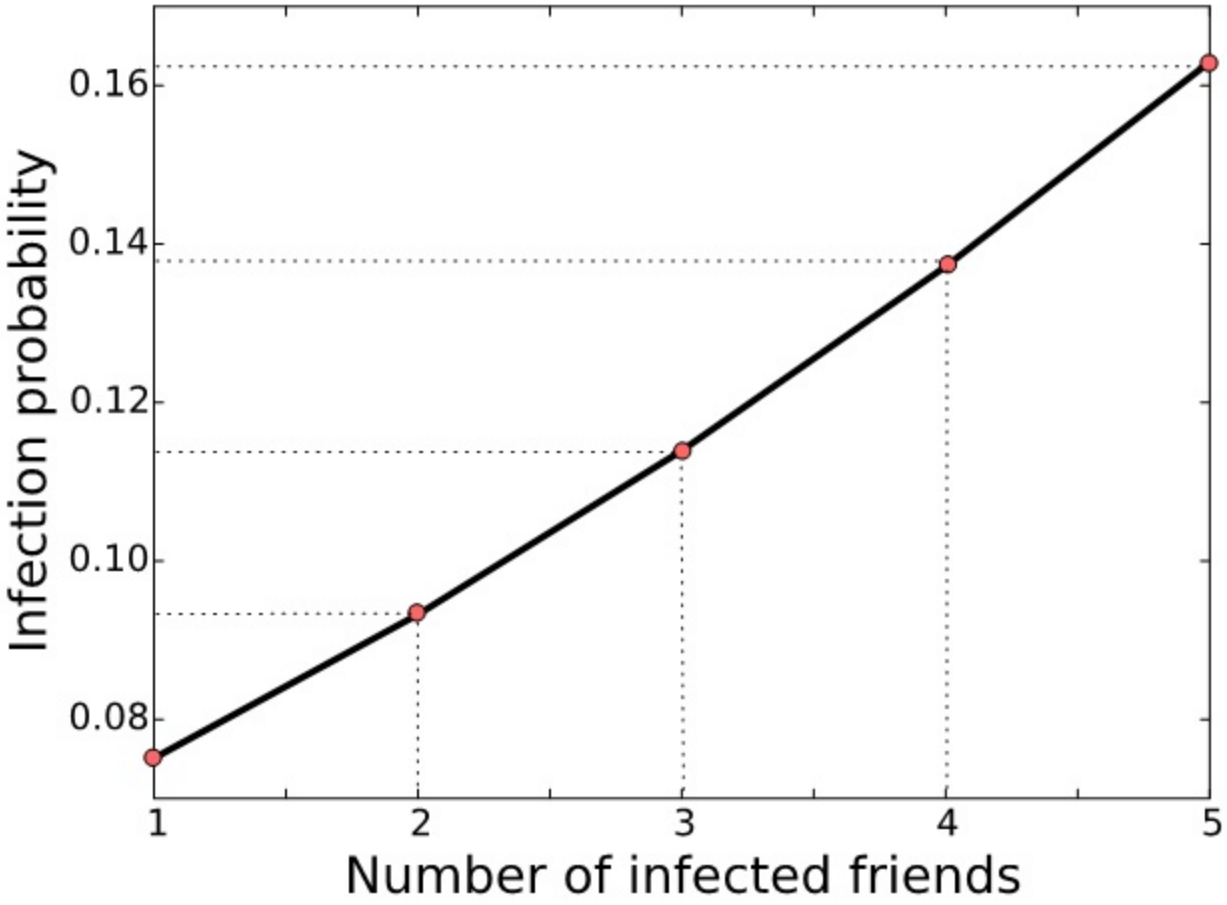
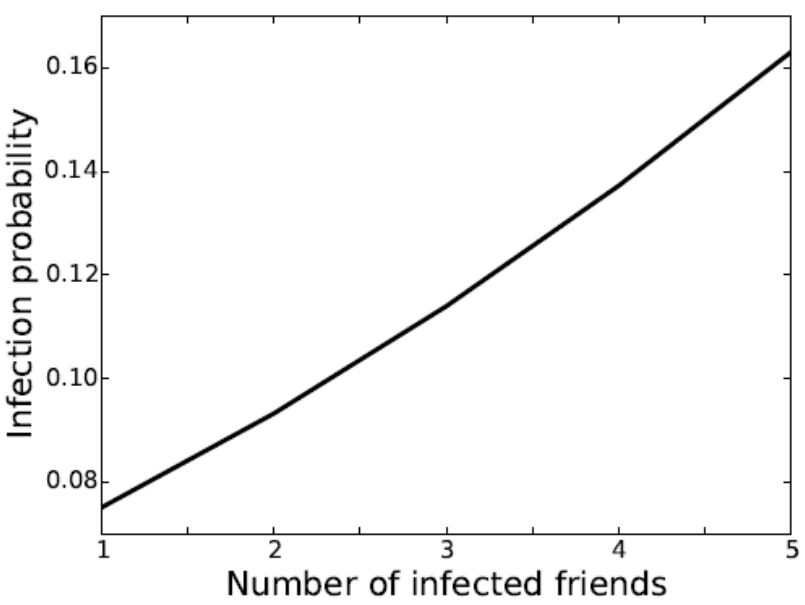
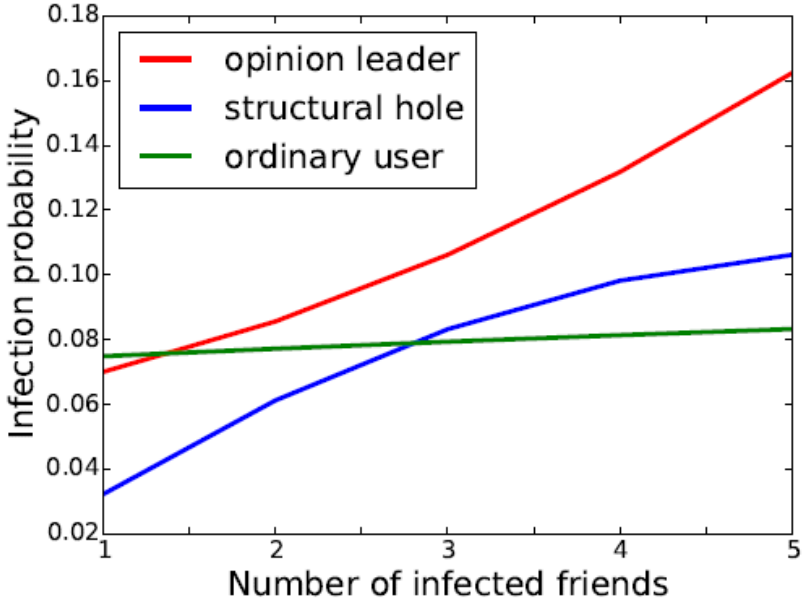
Correlation Analysis



Role-Aware Correlation Analysis



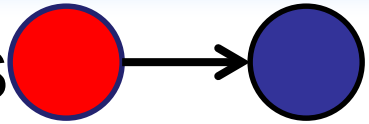
(a) Role unaware

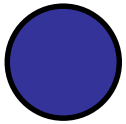


(b) Role aware

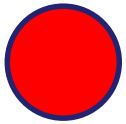
Opinion Leaders: Superlinear
Structural Hole Spanners: Sublinear

Role-Aware Correlation Analysis





Happy **Fear**



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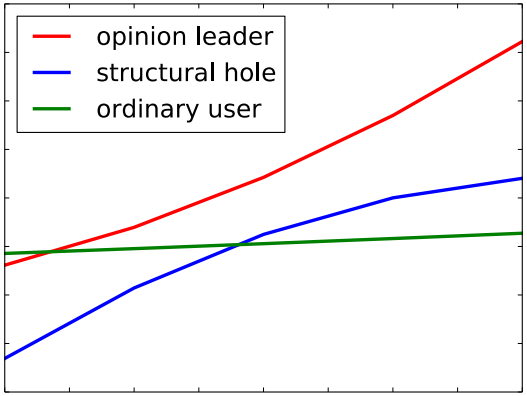

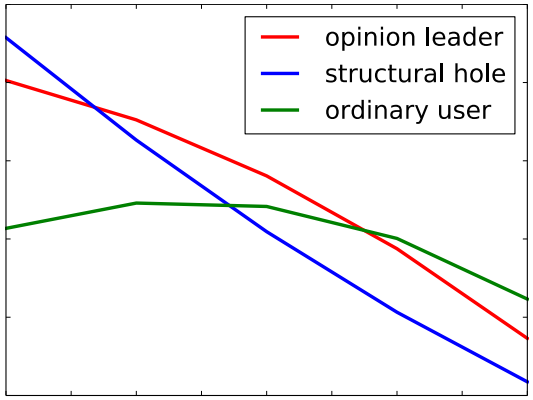

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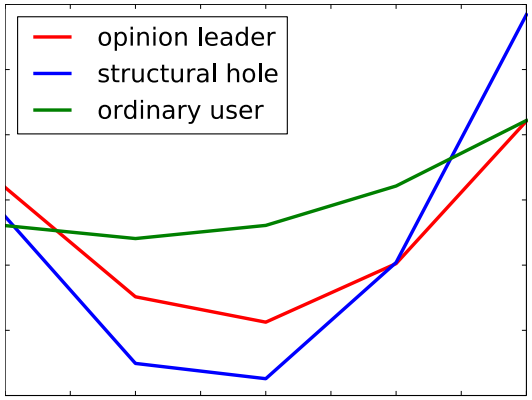
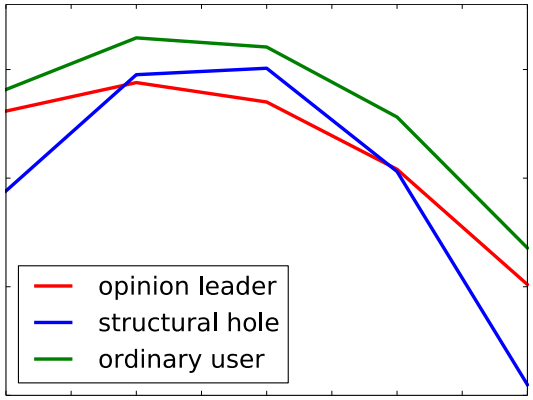
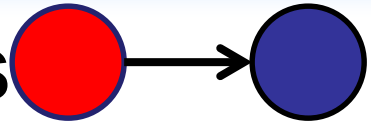


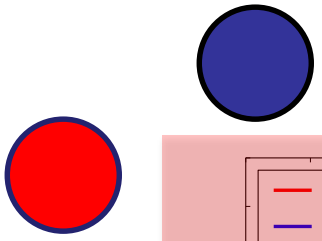


X: number of friends with different social roles.

Y: probability being a certain emotion.

Role-Aware Correlation Analysis





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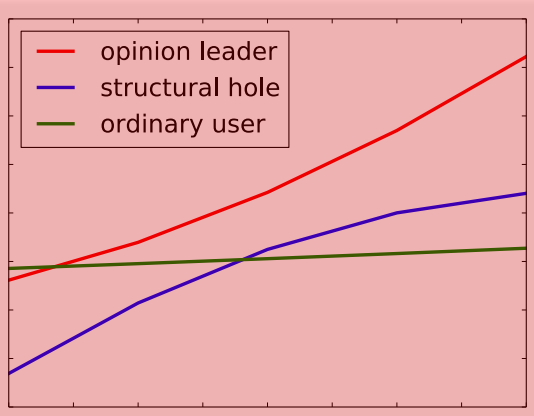

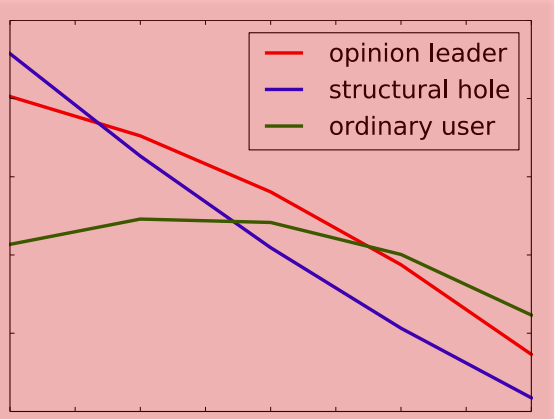

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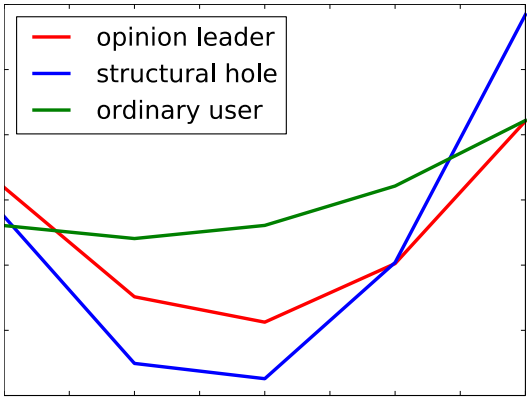

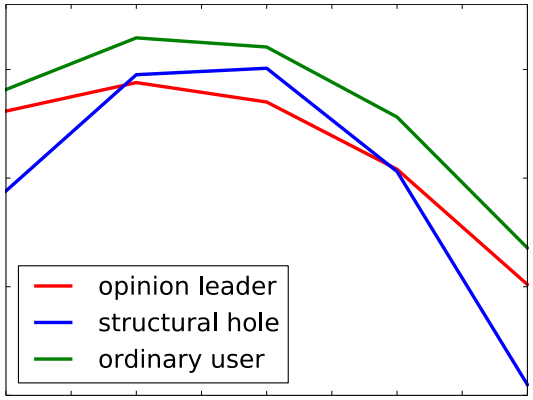

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positive emotion delights friends

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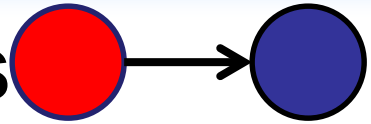

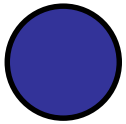

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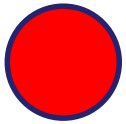

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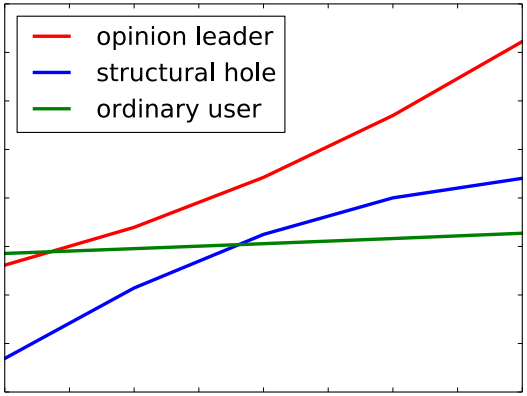

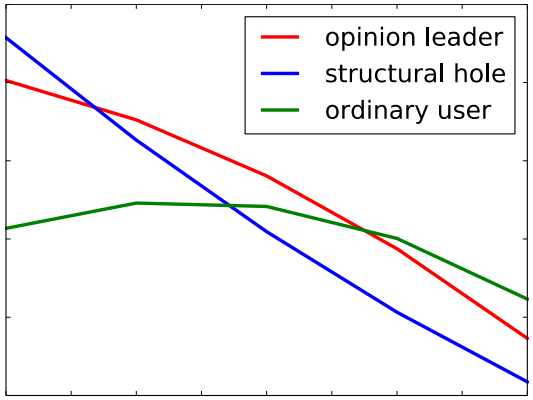

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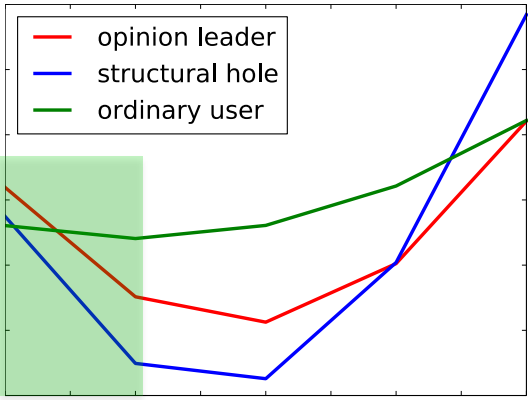

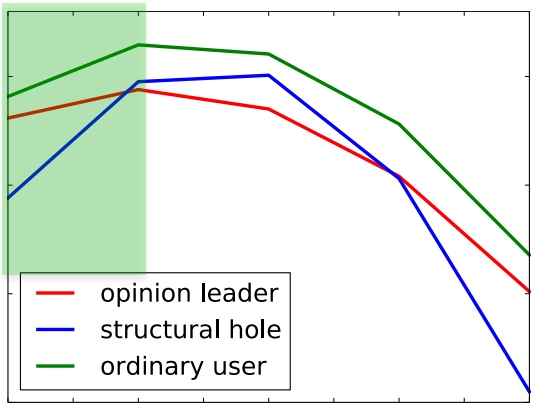

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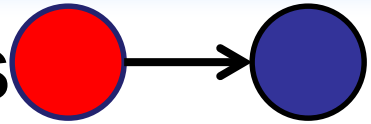
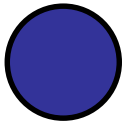
negative emotion infects when 1-2 friends are in negative emotion

Role-Aware Correlation Analysis





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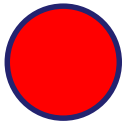

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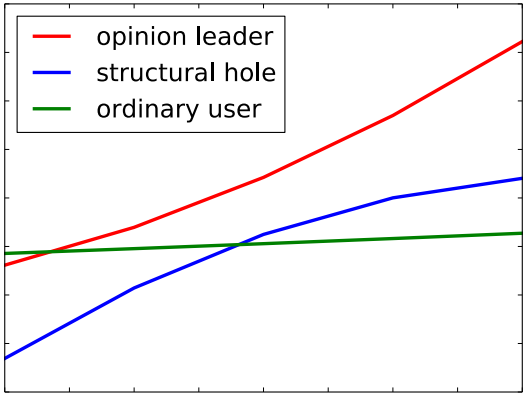

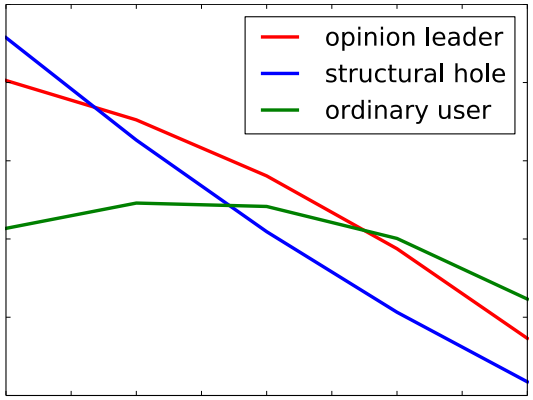

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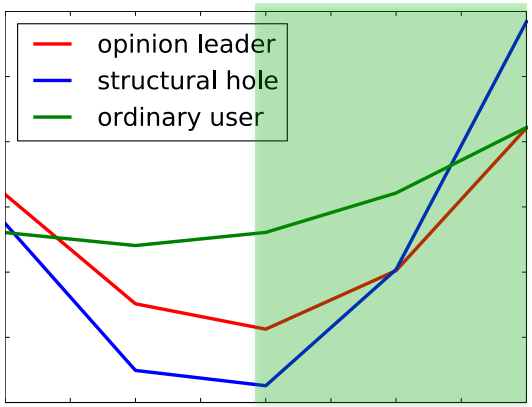

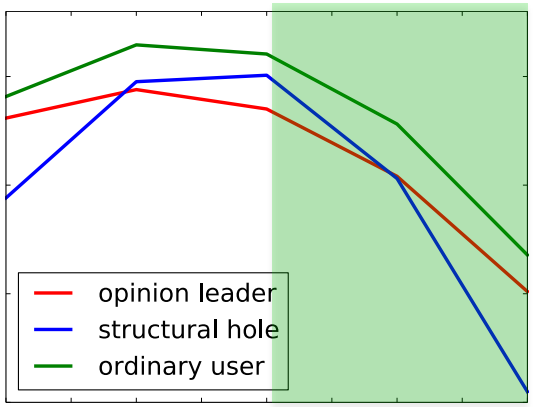

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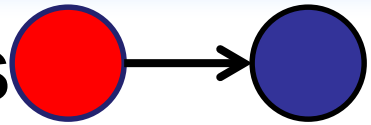
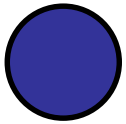
"Emotional comfort" phenomena

Role-Aware Correlation Analysis





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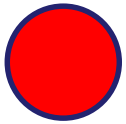

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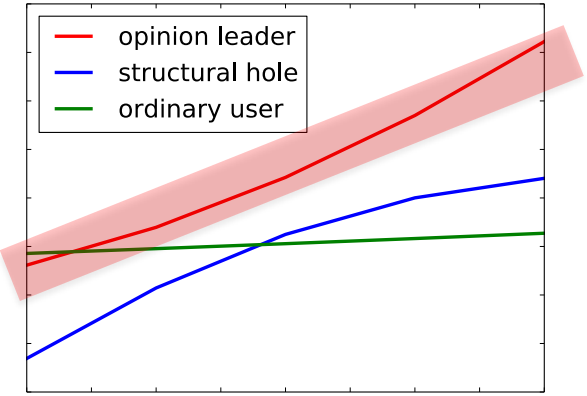

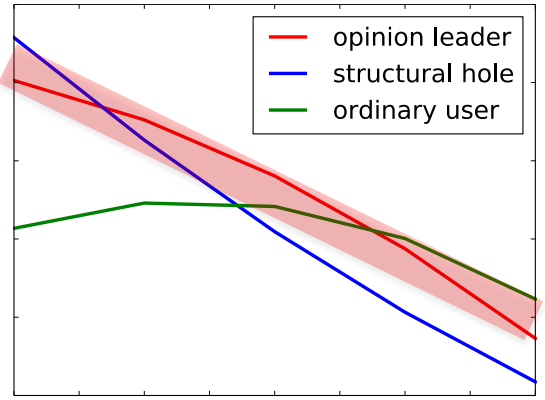

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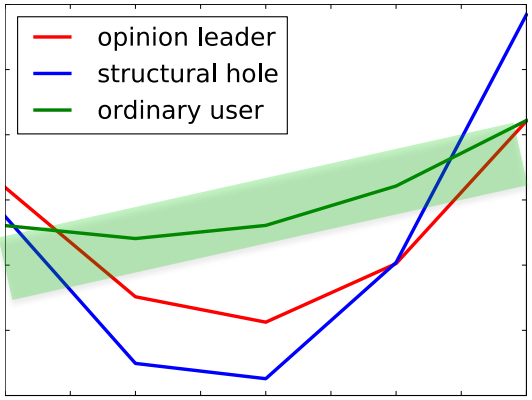

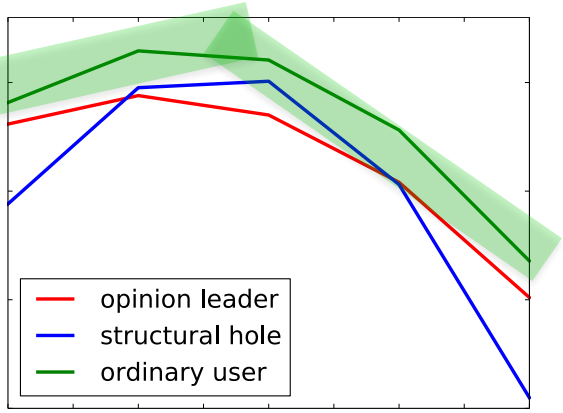

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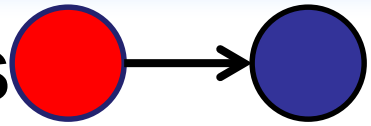
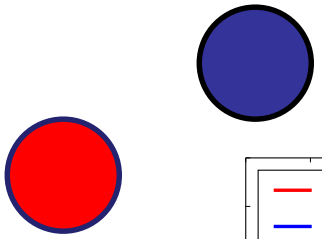
Y: probability being a certain emotion.

Opinion leaders are more influential on positive emotions

Ordinary users are more influential on negative emotions

Role-Aware Correlation Analysis





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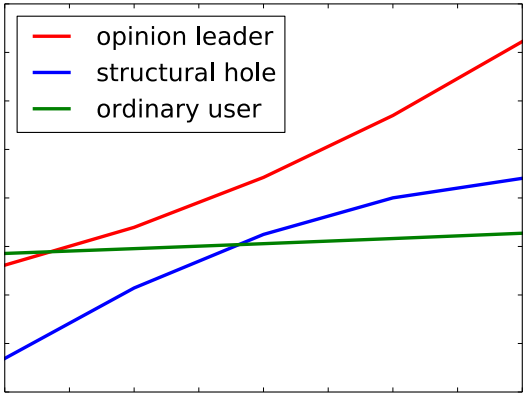
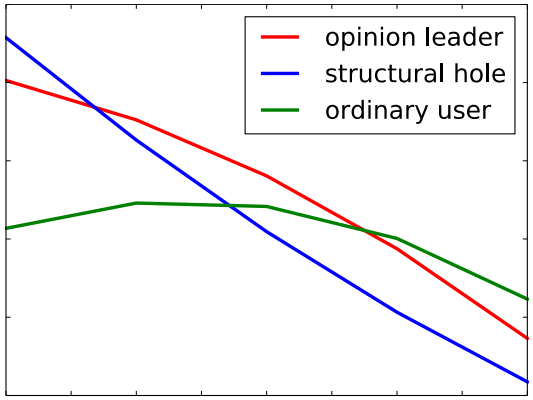
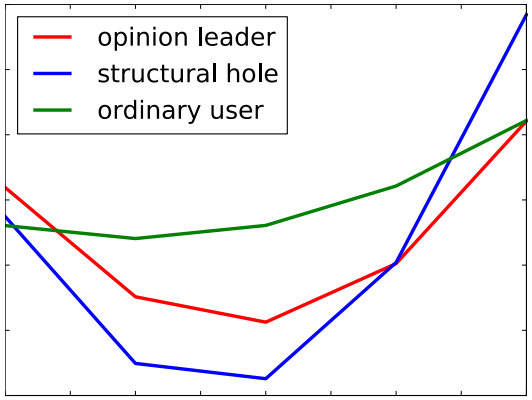
Fear

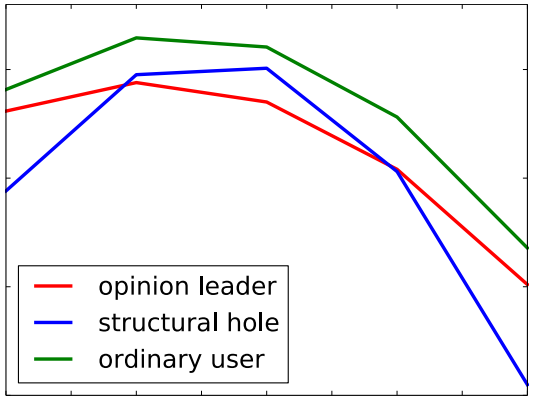
Happy





Fear





X: number of friends with different social roles.

Y: probability being a certain emotion.

Influence of opinion leaders and structural holes change faster than ordinary users.

- Background
- Related Works
  - Image Emotion Inference
  - Social Roles Analysis
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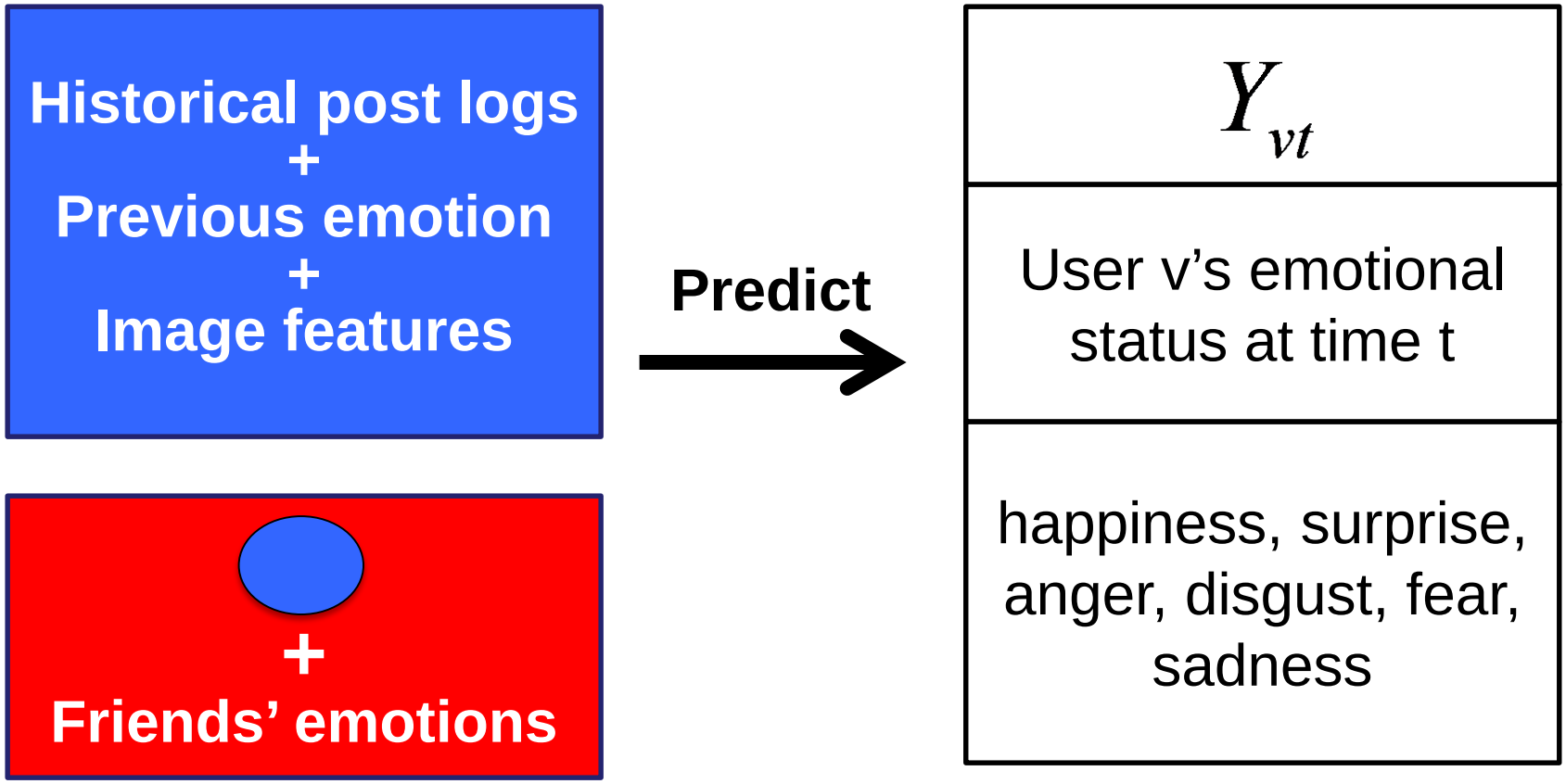
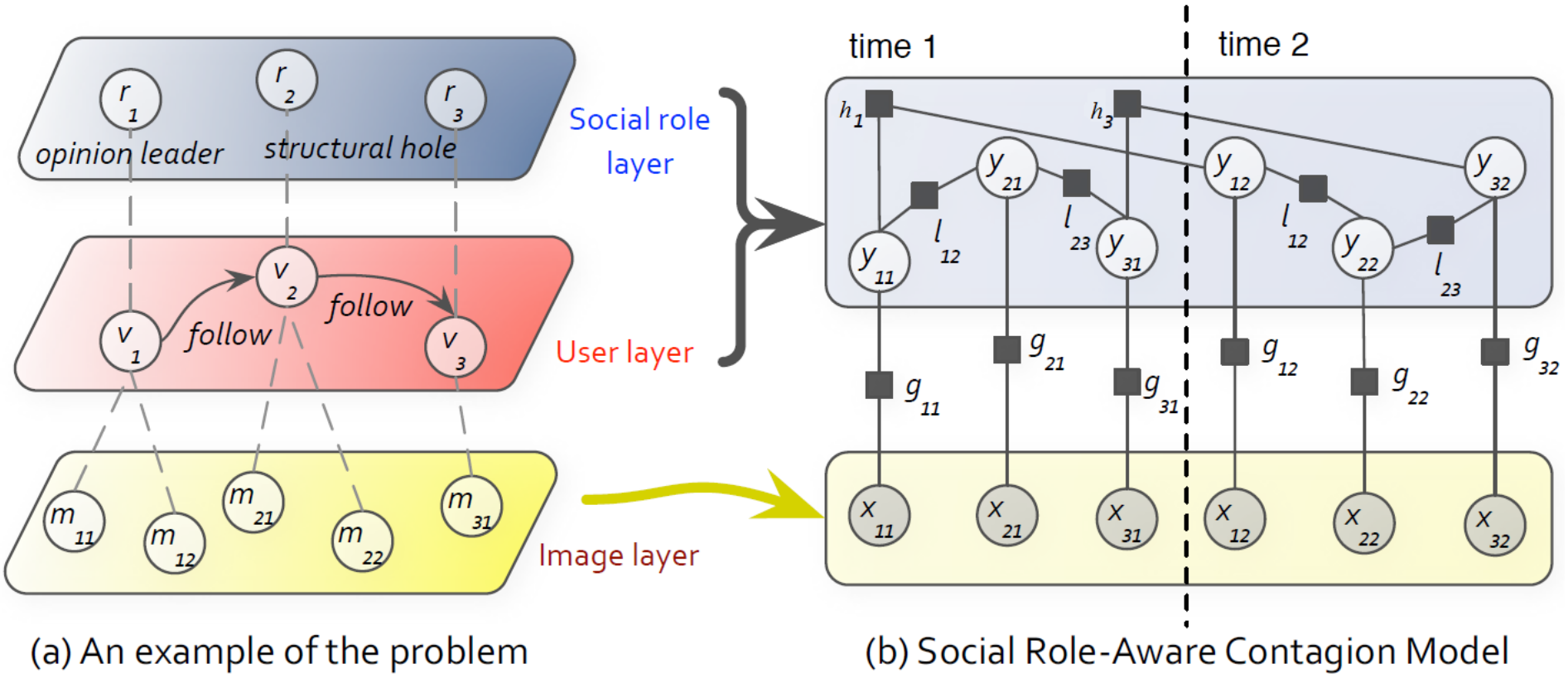
Features and Target



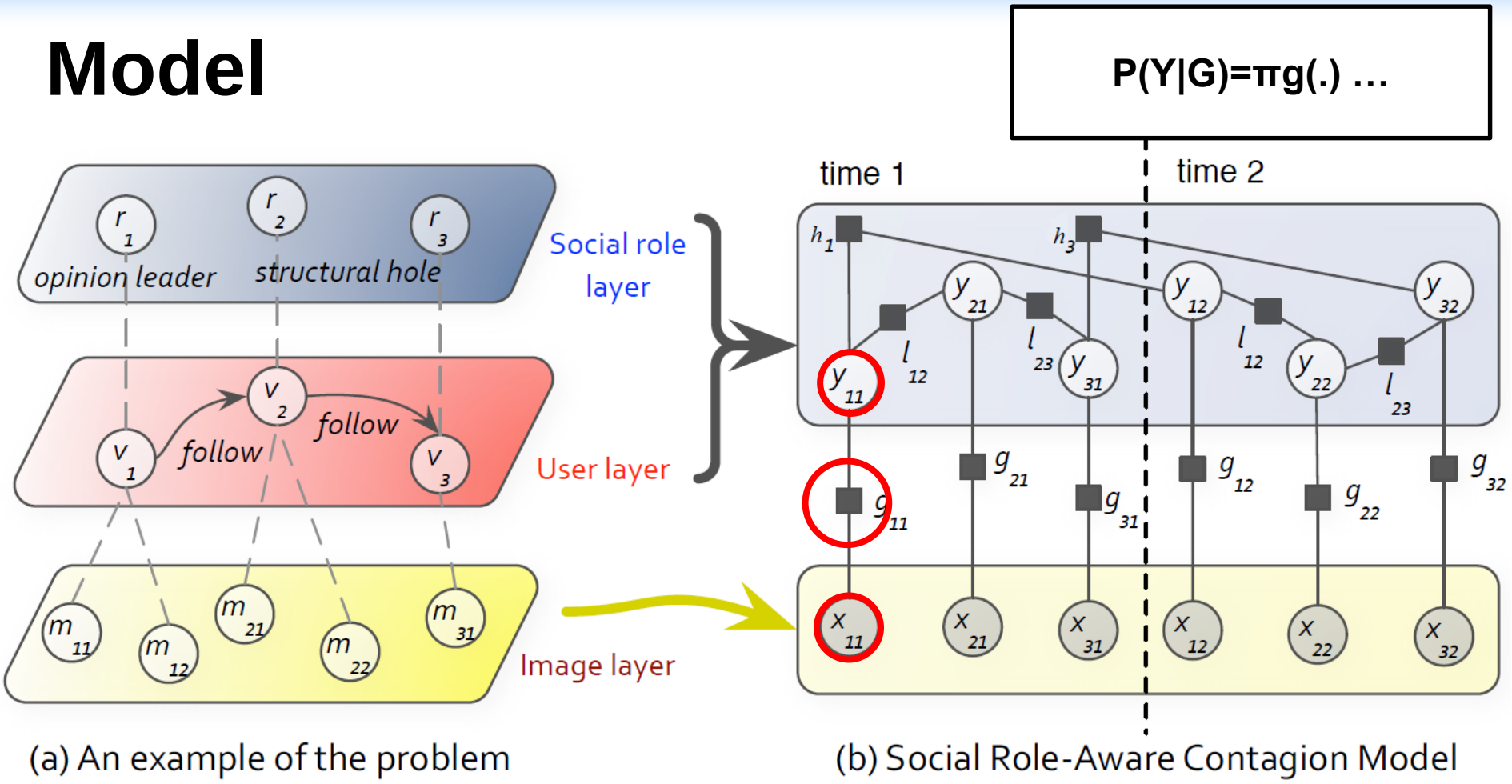
Model



P(Y|G): Conditional probability of users' emotional status given input data

Model

P(Y|G)=πg(.) …

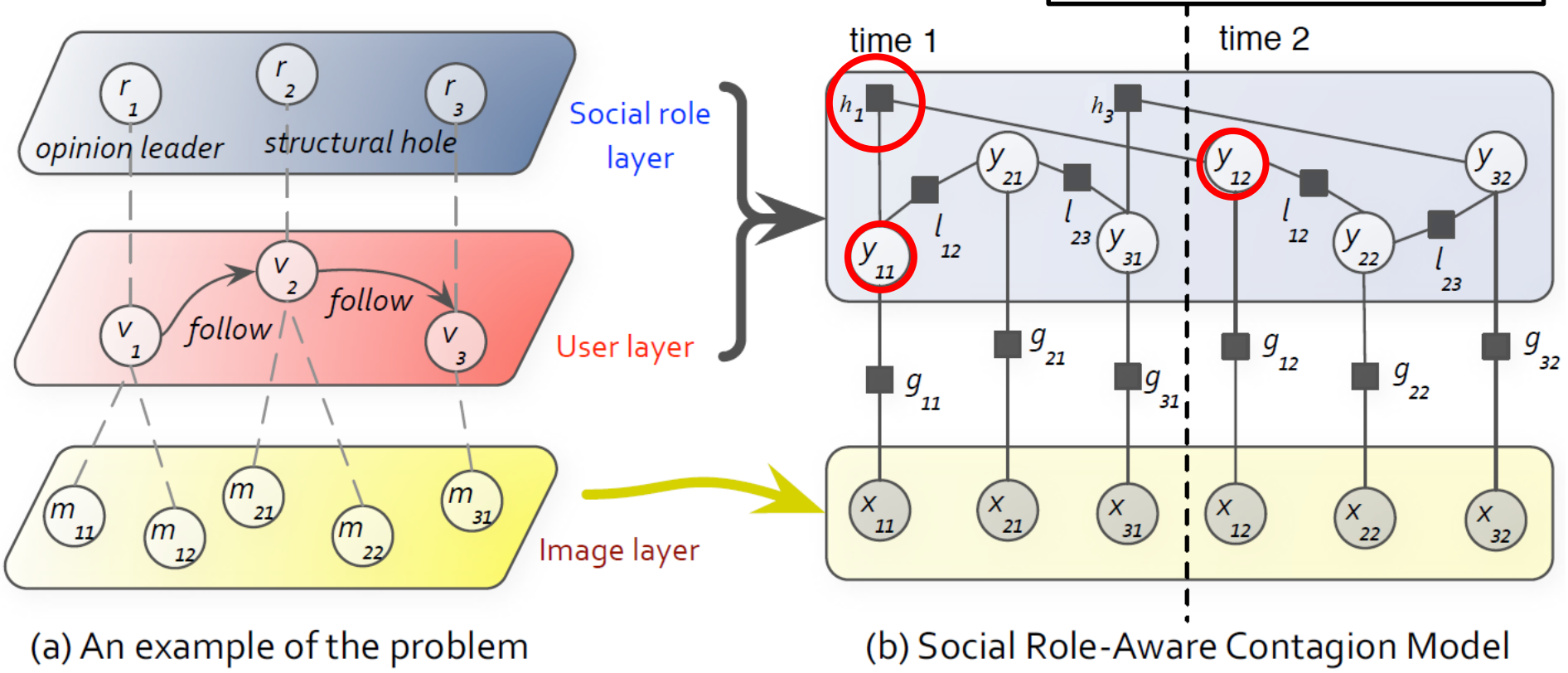


$g(x_{vt}, y_{vt})$: Correlation between v's emotion and the image she posts at t.

$$g(x_{vt}, y_{vt}) = \frac{1}{Z_1} \exp\{\alpha_{y_{vt}} \cdot x_{vt}\}$$

Model

P(Y|G)=π{g(.)h(.)} …

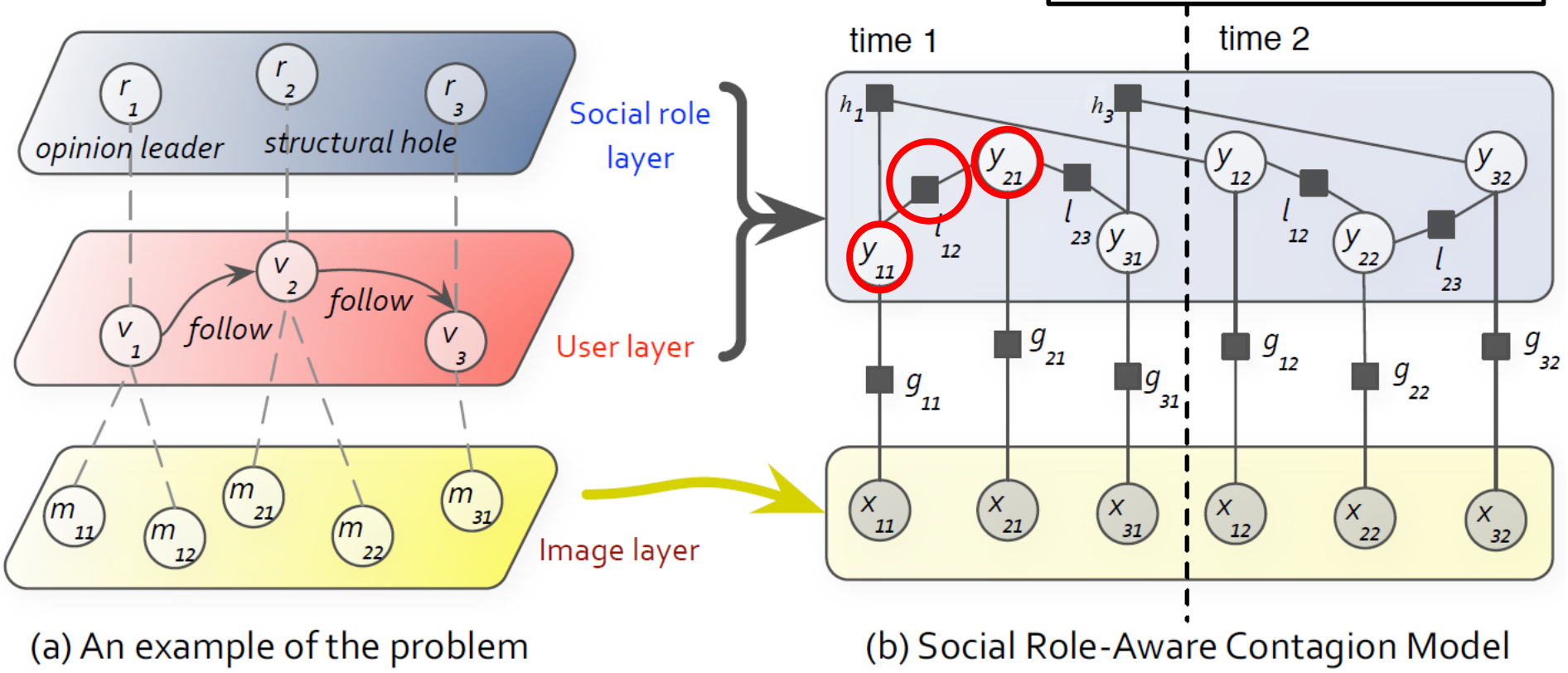


$h(y_{ut-t'}, y_{vt})$: Correlation between v's emotion at time t and t-t'.

$$h(y_{vt-\Delta t}, y_{vt}) = \frac{1}{Z_2} \exp\{\beta_{\Delta t} \cdot I(y_{vt-\Delta t}, y_{vt})\}$$

Model

$P(Y|G)=\pi\{g(.)h(.)l(.)\}$



(a) An example of the problem

(b) Social Role-Aware Contagion Model

$l(y_{ut-1}, y_{vt})$: How v's emotion at t is influenced by her friend u's emotion at t-1.

$$l(y_{ut-1}, y_{vt}) = \frac{1}{Z_3} \exp\{\gamma_{r_u r_v} \cdot I(y_{ut-1}, y_{vt})\}$$

Social role sensitive parameter

Model Learning

Hammersley-Clifford theorem

$$\begin{aligned}\mathcal{O}(\theta) &= \log P_\theta(Y|G) \\ &= \sum_t \sum_v \alpha_{y_{vt}} x_{vt} + \sum_t \sum_v \sum_{\Delta t} \beta_{\Delta t} I(y_{vt-\Delta t}, y_{vt}) \\ &+ \sum_t \sum_v \sum_{u, e_{vu} \in E} \gamma_{r_u r_v} I(y_{ut-1}, y_{vt}) - \log Z\end{aligned}$$

where $\theta = \{\alpha, \beta, \gamma\}$

Gradient Descent Method

$$\begin{aligned}\nabla &= \frac{\partial \log P(Y|G,\theta)}{\partial \theta} \\ &= \mathbb{E}_{P_\theta(Y^U|G,\theta)} \mathbf{Q}(Y^U) - \mathbb{E}_{P_\theta(Y|G,\theta)} \mathbf{Q}(Y)\end{aligned}$$

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Dataset

- 2,060,353 images and 1,255,478 users from Flickr.
- Ground truth obtained by **user tags**.

Distribution of users' emotional statuses on Flickr:

- happiness: 46.2%
- surprise: 9.7%
- anger: 8.0%
- disgust: 5.3%
- fear:17.3%
- sadness: 13.5%

- ***Opinion leaders:*** 20% of users with largest PageRank scores;
- ***Structural hole spanners:*** 20% of users with lowest network constraint scores;
- Others are remaining as ***ordinary users***.

Experimental Results

Emotion	Method	Precision	Recall	F1-score	Emotion	Method	Precision	Recall	F1-score
Happiness	SVM	0.5490	0.4682	0.5054	Disgust	SVM	0.5721	0.6223	0.5962
	LR	**0.5726**	0.4234	0.4868		LR	0.5902	0.5847	0.5874
	NB	0.5604	0.4679	0.5100		NB	0.5657	0.7244	0.6353
	BN	0.5605	0.5129	0.5357		BN	0.5666	0.6811	0.6186
	RBF	0.5744	0.2676	0.3651		RBF	0.5246	0.4346	0.4754
	CRF	0.5590	0.5938	0.5759		CRF	0.8304	0.5889	0.6891
	Role-aware	0.5285	**0.9327**	**0.6747**		Role-aware	**0.9758**	**0.9947**	**0.9852**
Surprise	SVM	0.5103	0.4821	0.4958	Fear	SVM	0.5253	0.5521	0.5384
	LR	0.5231	0.4108	0.4602		LR	0.5523	0.4703	0.5080
	NB	0.5124	0.5324	0.5222		NB	0.5350	0.5295	0.5322
	BN	0.5241	0.4712	0.4963		BN	0.5446	0.5189	0.5315
	RBF	0.4990	0.1756	0.2597		RBF	0.5227	0.2859	0.3696
	CRF	0.5810	0.8014	0.6736		CRF	0.5074	0.2123	0.2993
	Role-aware	**0.8992**	**0.9181**	**0.9086**		Role-aware	**0.8123**	**0.9996**	**0.8963**
Anger	SVM	0.5186	0.6371	0.5718	Sadness	SVM	0.5733	0.5740	0.5723
	LR	0.5275	0.4634	0.4934		LR	0.5664	0.4866	0.5234
	NB	0.5201	0.4959	0.5078		NB	0.5632	0.4991	0.5292
	BN	0.5260	0.5207	0.5233		BN	0.5730	0.5662	0.5695
	RBF	0.5062	0.2441	0.3294		RBF	0.5344	0.4292	0.4761
	CRF	0.6036	0.8015	0.6886		CRF	0.6382	0.8726	0.7372
	Role-aware	**0.9346**	**0.9593**	**0.9468**		Role-aware	**0.8741**	**0.9550**	**0.9128**

Experimental Results

Emotion	Method
Happiness	SVM
	LR
	NB
	BN
	RBF
	CRF
	Role-aware
Surprise	SVM
	LR
	NB
	BN
	RBF
	CRF
	Role-aware
Anger	SVM
	LR
	NB
	BN
	RBF
	CRF
	Role-aware

Baselines

Methods do not consider emotion contagion:
SVM, Logistic Regression (LR),
Naïve Bayes (NB), Bayesian Network (BN),
Gaussian Radial Basis Function Neural Network (RBF).

Methods ignore social role information: CRF

Our model: Role-aware

Experimental Results

Emotion	Method	Precision	Recall	F1-score
Happiness	SVM			
	LR			
	NB			
	BN			
	RBF			
	CRF			
	Role-aware			
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	LR			
	NB			
	BN			
	RBF			
	CRF			
	Role-aware			
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	LR			
	NB			
	BN			
	RBF			
	CRF			
	Role-aware			

Emotion	Method	Precision	Recall	F1-score

Evaluation Metrics:

- Precision
- Recall
- F1 Measure

Experimental Results

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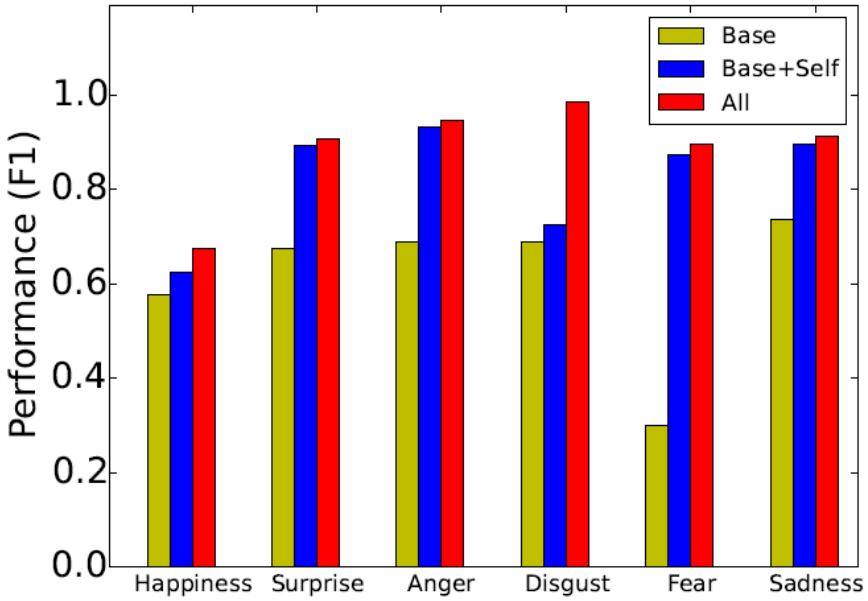
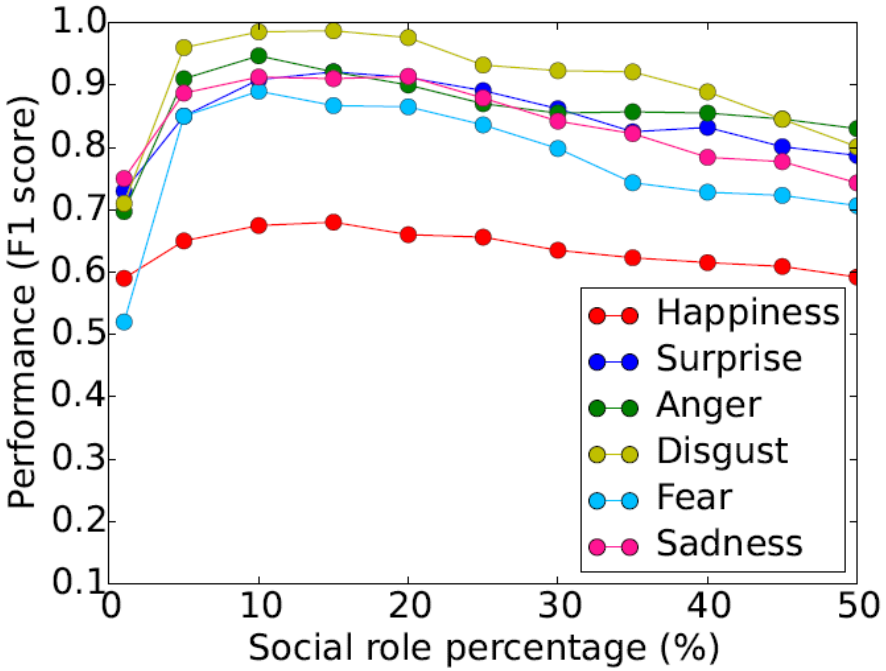
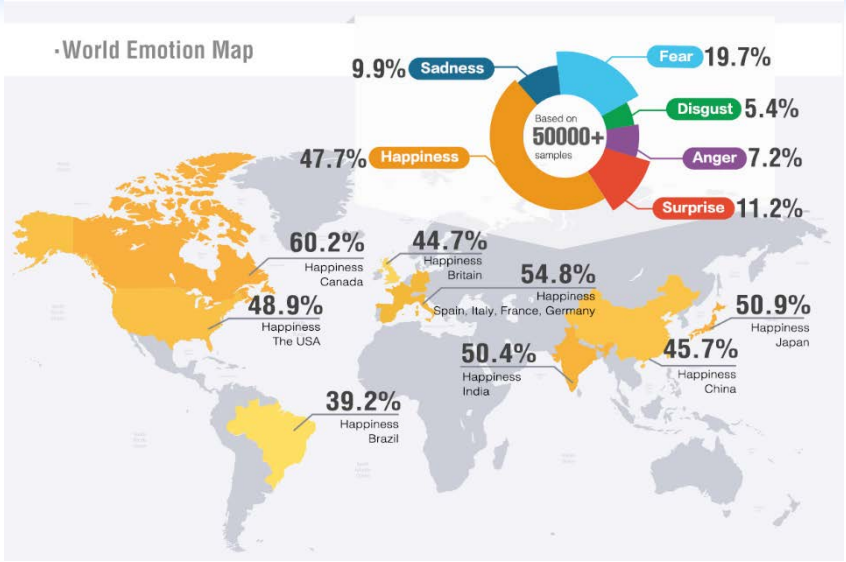
Further Analysis



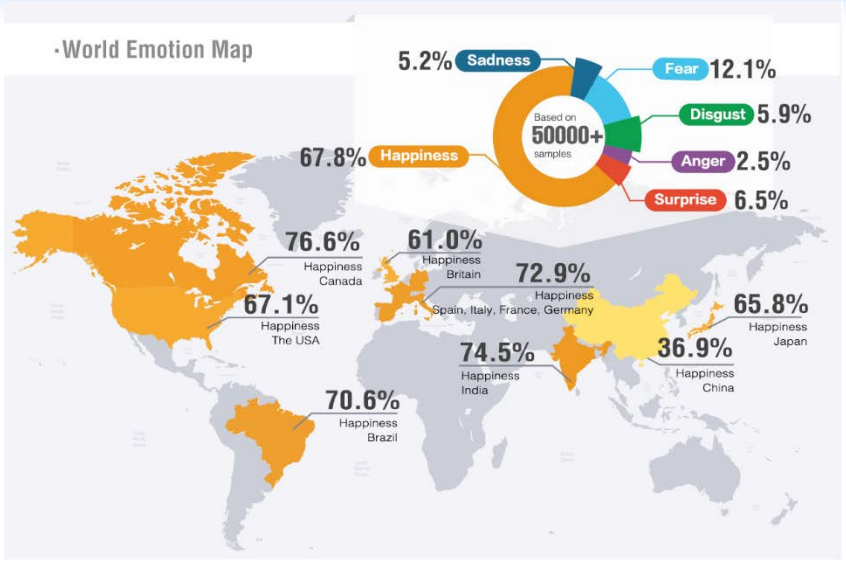
(a) Factor analysis.



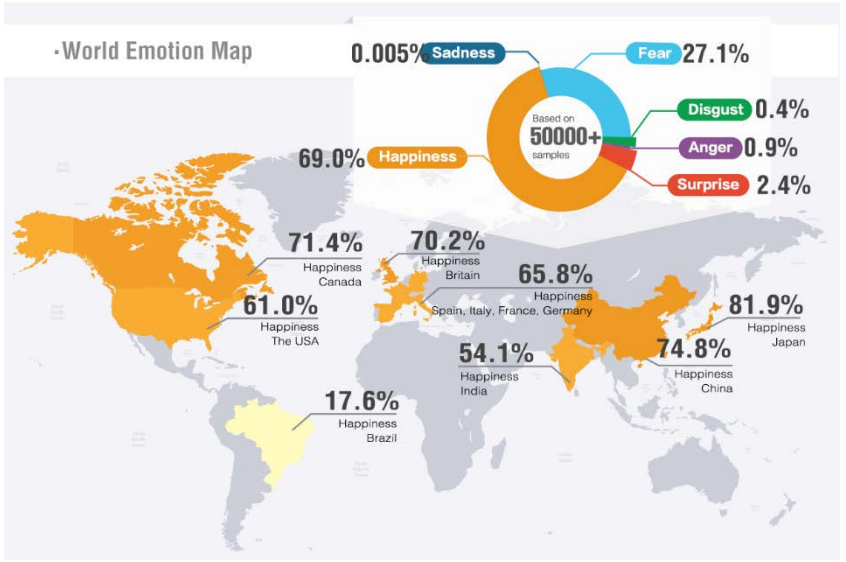
(b) Social role analysis.



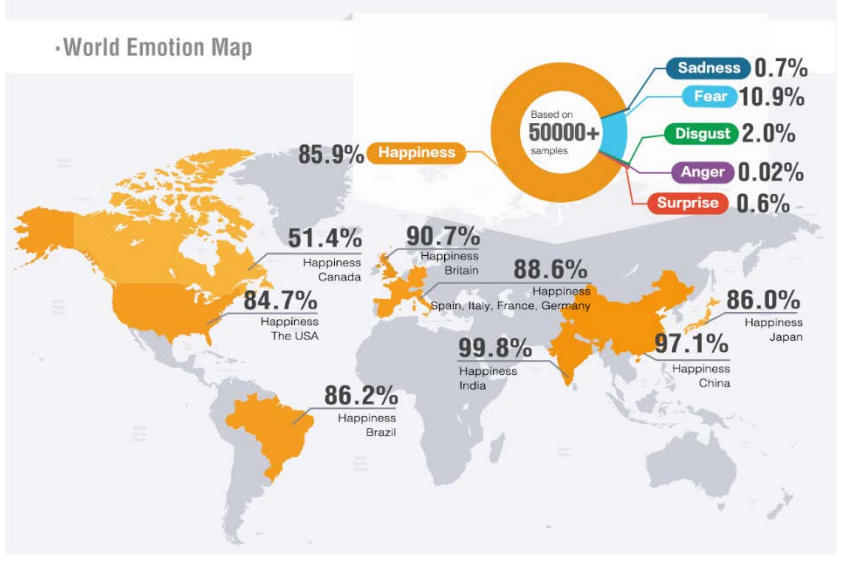
(a) Real Distribution



(b) Randomly Sampled Users



(c) Opinion Leaders



(d) Structural Hole Spanners

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Conclusion

- The authors study the interplay between users' ***social roles*** and ***emotion contagions*** by answering 3 questions.
  - Does emotion contagion ***exist***?
  - How social roles ***influence*** emotion contagion?
  - How to better ***predict*** users' emotional status?
- The authors propose the ***social role-aware contagion model*** and validate it on a real social network.

THANK YOU!

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