Social Role-Aware Emotion Contagion in Image Social Networks
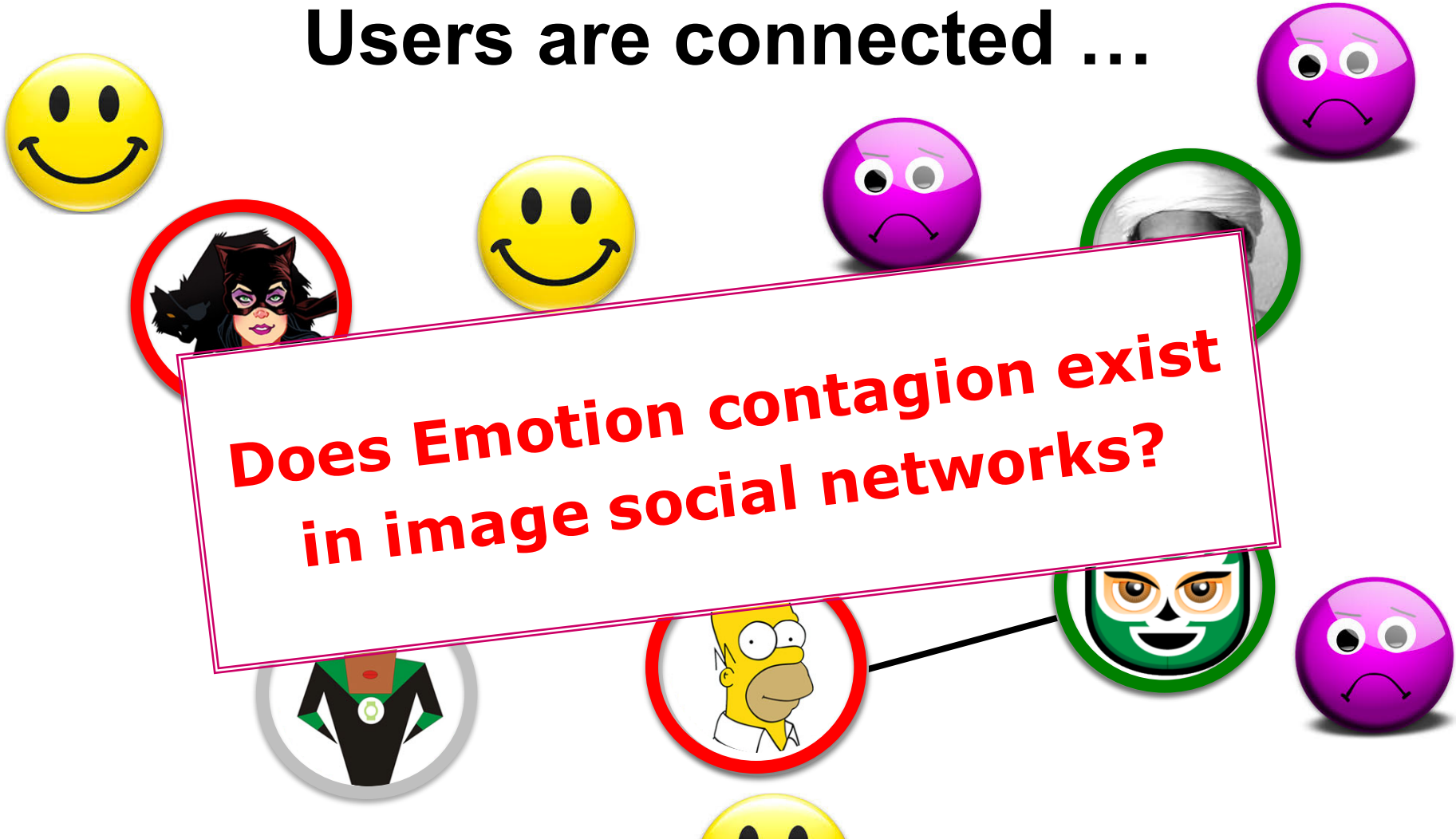
Yang Yang, Jia Jia, Boya Wu, and Jie Tang

Department of Computer Science and Technology

Tsinghua University

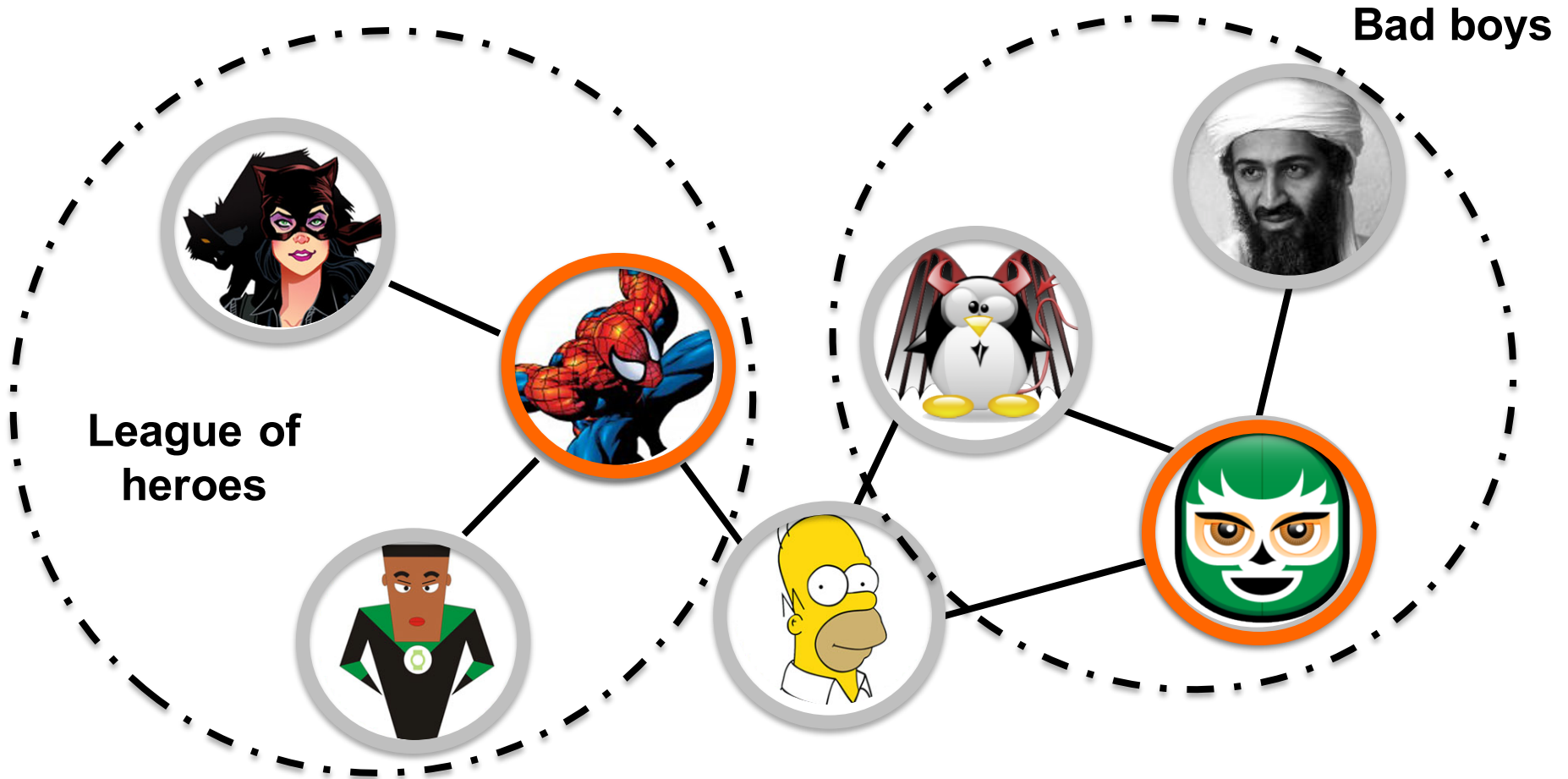# Image social network (e.g., Flickr) users post photos, which express their emotional statuses.

Users are connected …

Does Emotion contagion exist in image social networks?

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

Social Roles of Users

League of heroes

Bad boys

Opinion leaders: users taking central positions in communities

Social Roles of Users

Bad boys

League of heroes

Will social roles influence emotion contagions?

Structural hole spanners: users bridge otherwise disconnected communities

Predicting Users' Emotional Status

- **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

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

[1] Yang, Y.; Jia, J.; Zhang, S.; Wu, B.; Chen, Q.; Li, J.; Xing, C.; and Tang, J. 2014. How do your friends on social media disclose your emotions? In AAAI'14, 2014.

Related Work

Predicting users' emotions by jointly modeling images and comments.

Yang, Y.; Jia, J.; Zhang, S.; Wu, B.; Chen, Q.; Li, J.; Xing, C.; and Tang, J. 2014. How do your friends on social media disclose your emotion 01

Predicting u~~...~~ calling/mess~~...~~

Tang, J.; Zhang~~...~~ study of individu~~...~~

Images drive ~~...~~ gagement (e.g., clicking "like" or adding comments) 100 times faster than text on Facebook.

Wang, X.; Jia, J.; Cai, L.; and Tang, J. Modeling emotion influence from images in social networks. IEEE TAFFECT COMPUT'15, 2015.

How to better predict users' emotions by considering emotion contagions?

Treat each individual independently

Three Qs to Answer

- **Q1:** Does emotion contagion exist in image social networks?

- **Q2:** Will social roles influence emotion contagion?

- **Q3:** How to better predict the emotional status of users in social networks by considering emotion contagion?
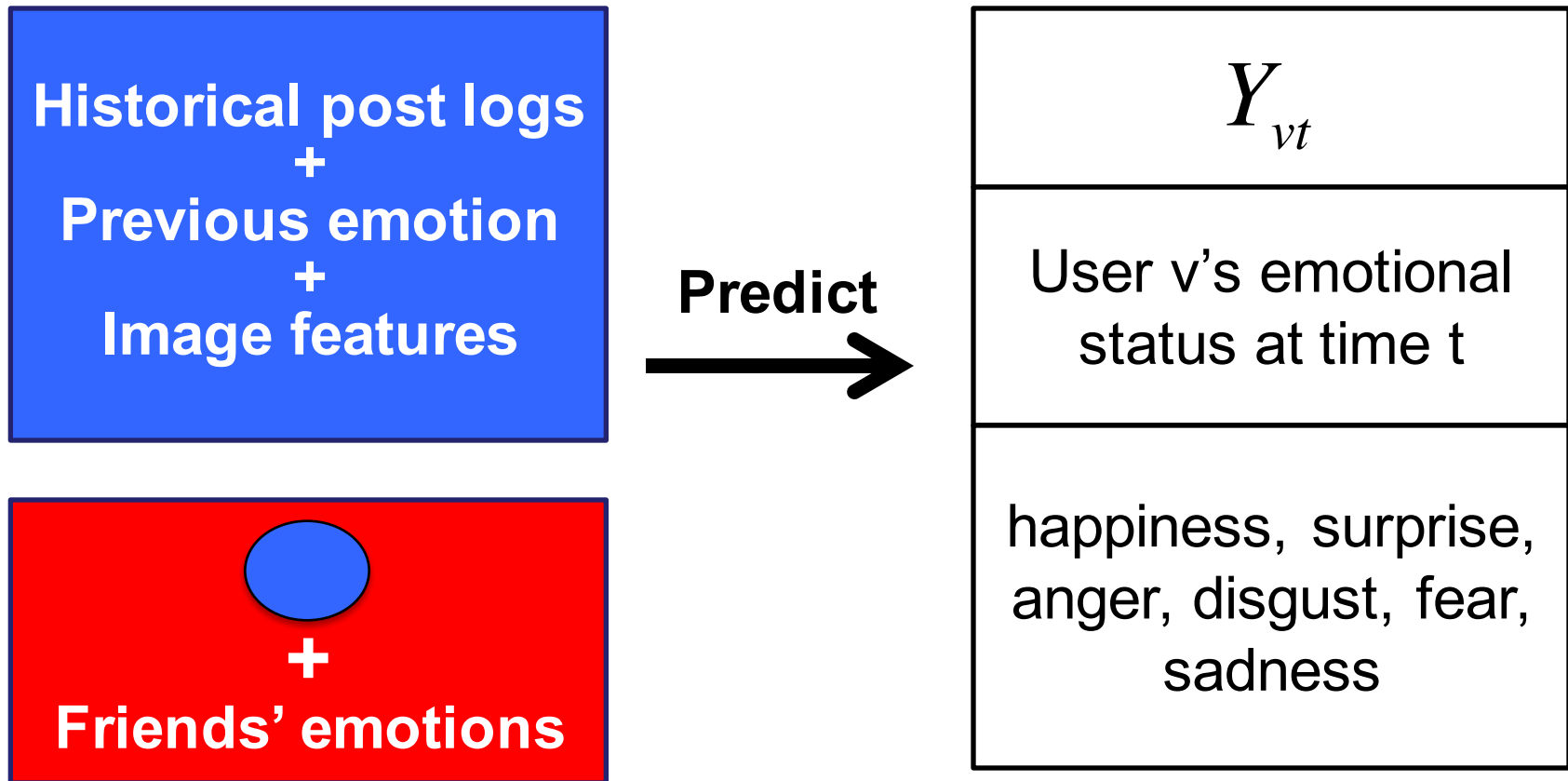
Q1: Existence

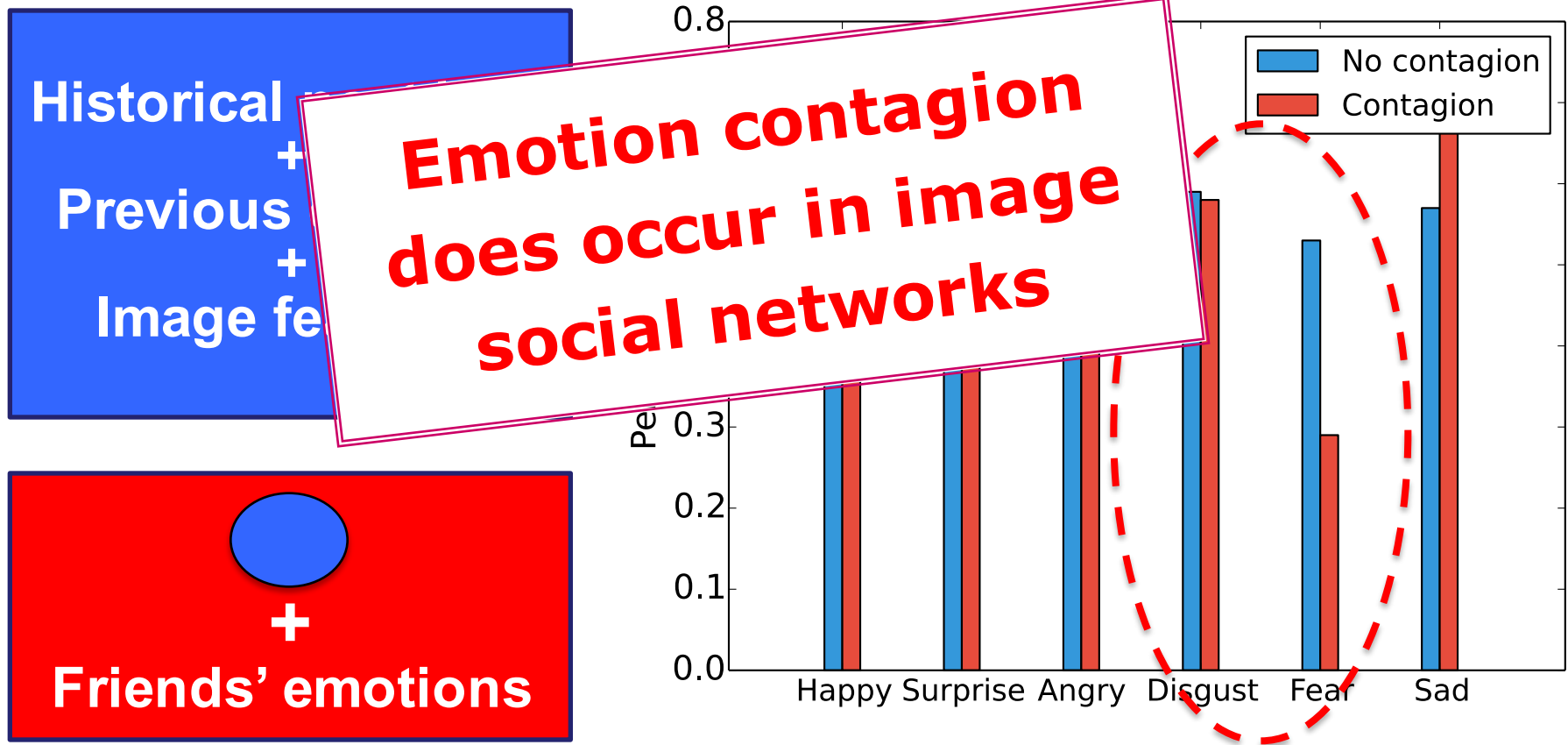**Q1.1:** When your friends are happy, will you be happy?
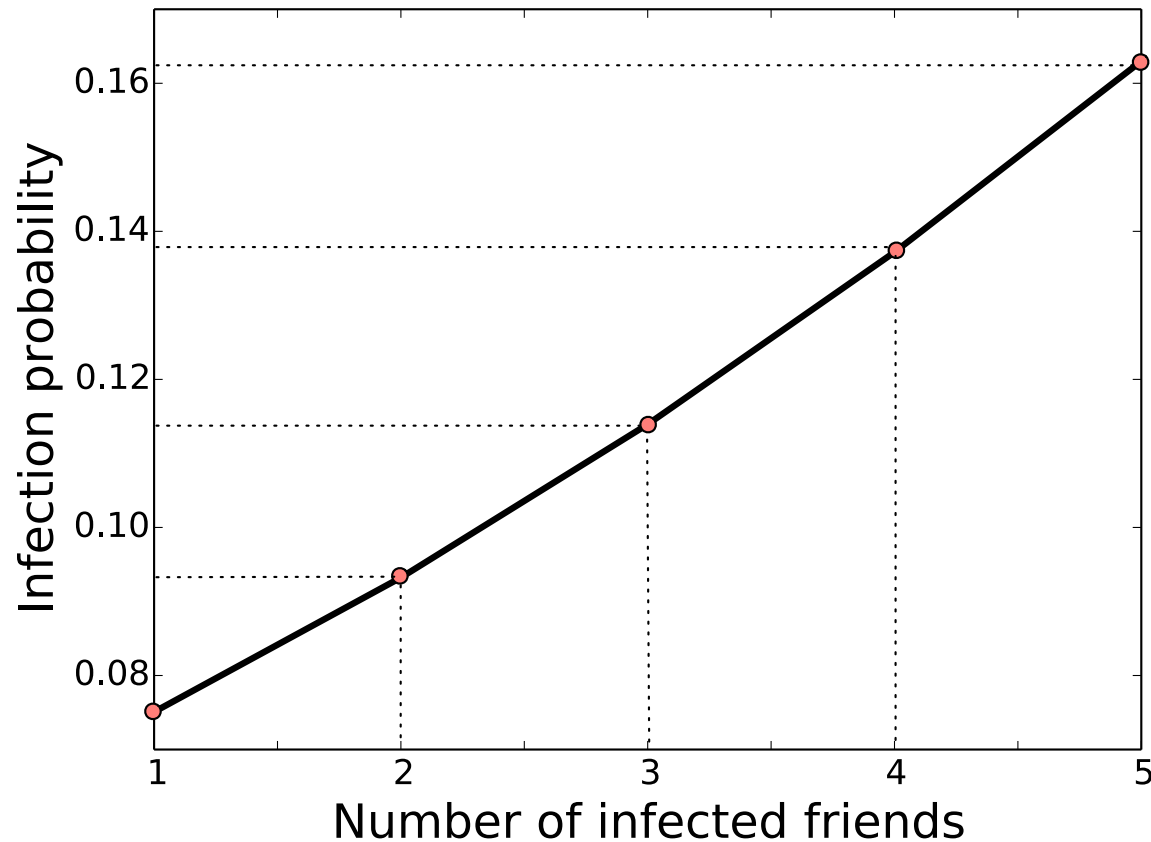
Q1: Existence

Q1.2: When predicting a user's emotional status, will her friends help?

**Historical post logs
+
Previous emotion
+
Image features**

Predict →

**+
Friends' emotions**

Y_{vt}

User v's emotional status at time t

happiness, surprise, anger, disgust, fear, sadness

Q1: Existence

Q1.2: When predicting a user's emotional status, will her friends help?

Historical ~~~~
+
Previous ~~~~
+
Image fe~~~~

+
Friends' emotions

Emotion contagion does occur in image social networks

0.8

No contagion
Contagion

0.3

0.2

0.1

0.0

Happy Surprise Angry Disgust Fear Sad

Q2: Social Role

- **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**.
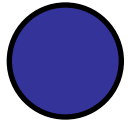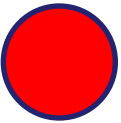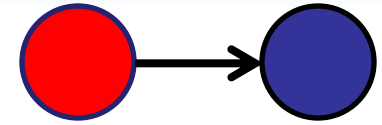
OL and ~~~~ rdinary users ~~~~ 15].

Still holds in emotion contagion?

[1] Y. Yang, J. Tang, C. W.-k. Leung, Y. Sun, Q. Chen, J. Li, and Q. Yang. Rain: Social role-aware information diffusion. In AAAI'15, 2015.

Q2: Social Role

Happy   **Fear**

X: number of friends with different social roles.

Y: probability being a certain emotion.
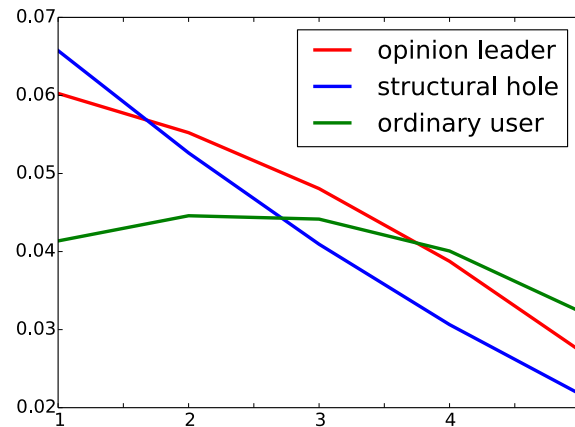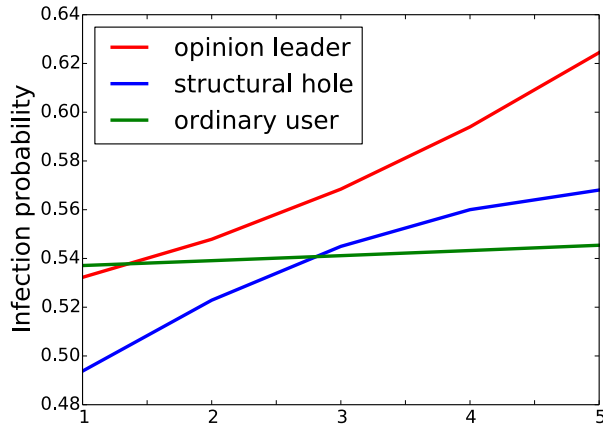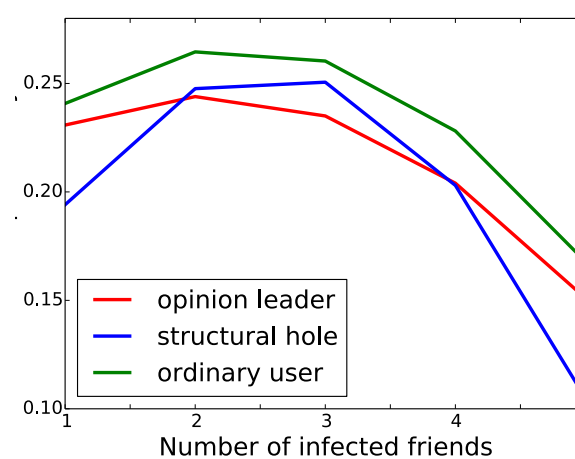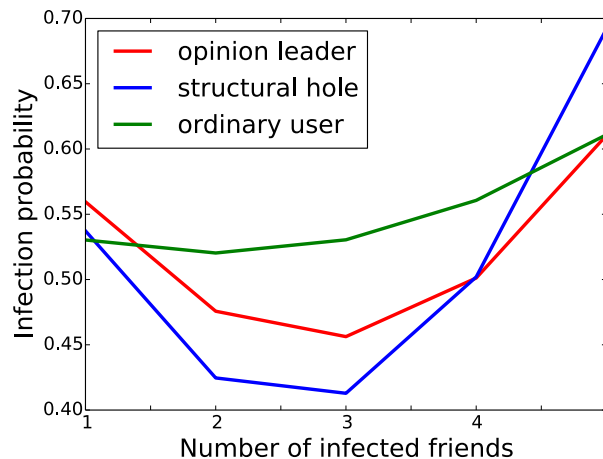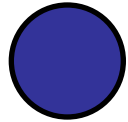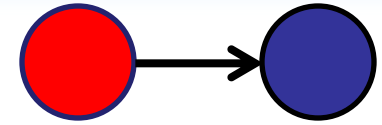
Q2: Social Role

Happy   **Fear**
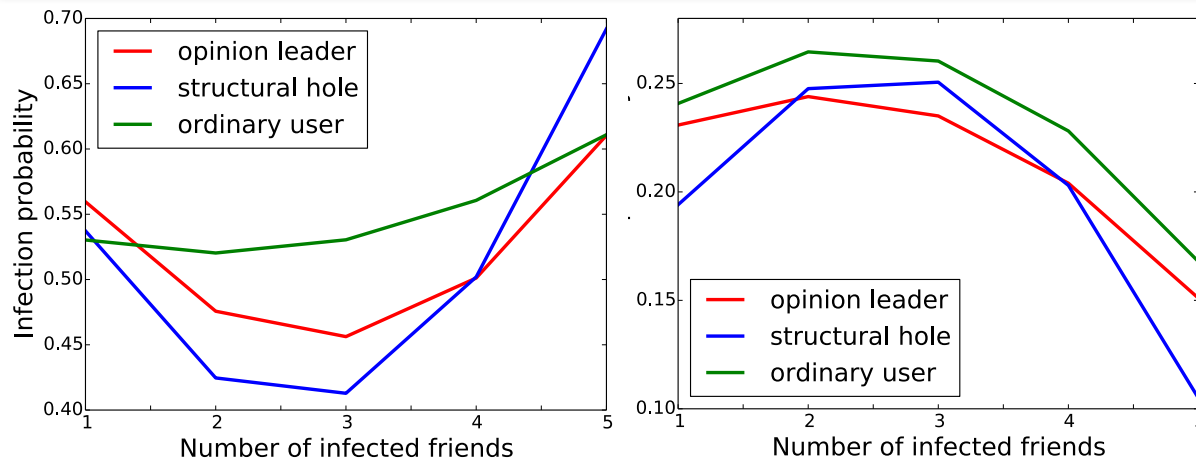
X: number of friends with different social roles.

Y: probability being a certain emotion.

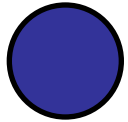**positive emotion delights friends**
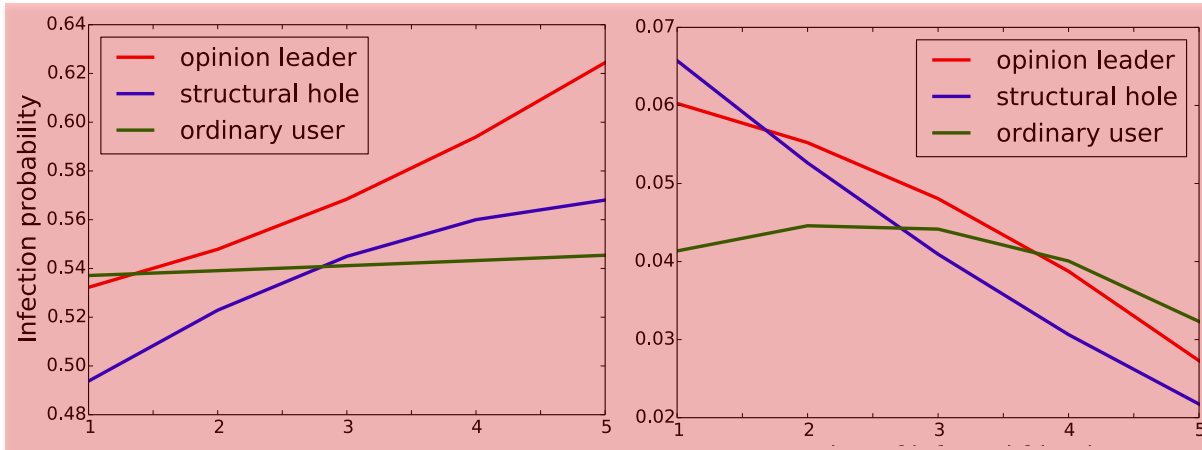
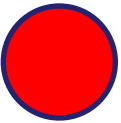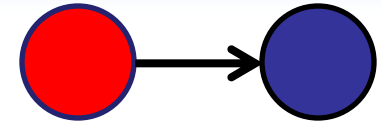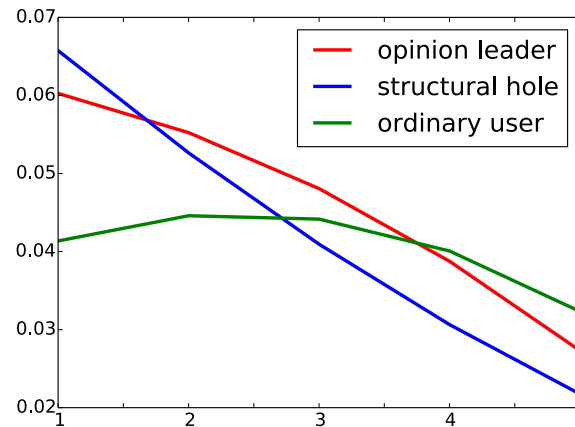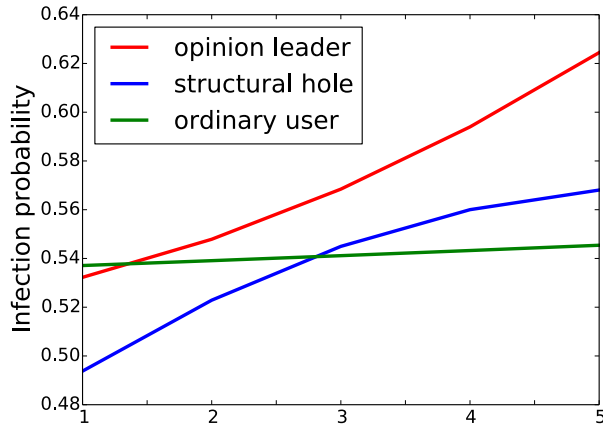# Q2: Social Role
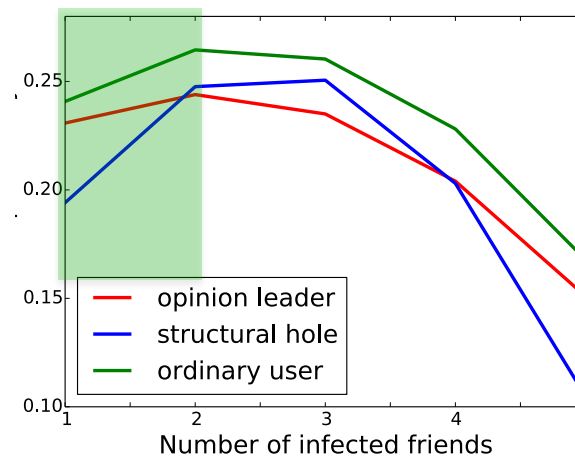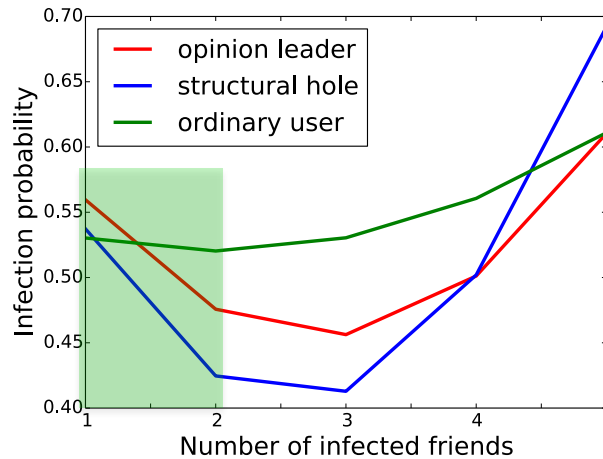

Happy   **Fear**

X: number of friends with different social roles.

Y: probability being a certain emotion.
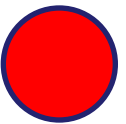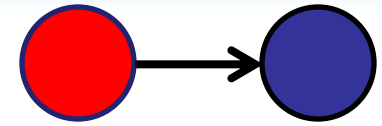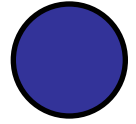
Q2: Social Role
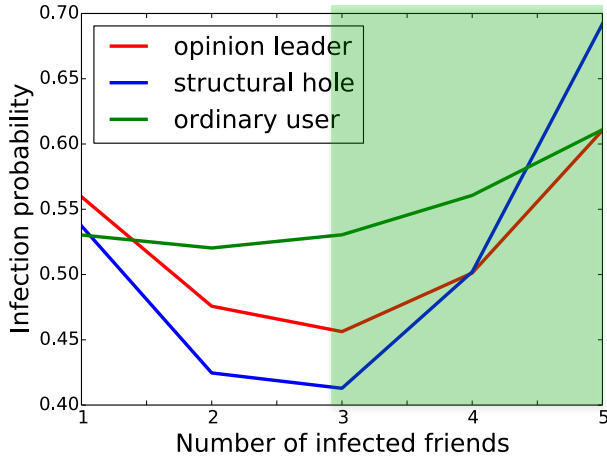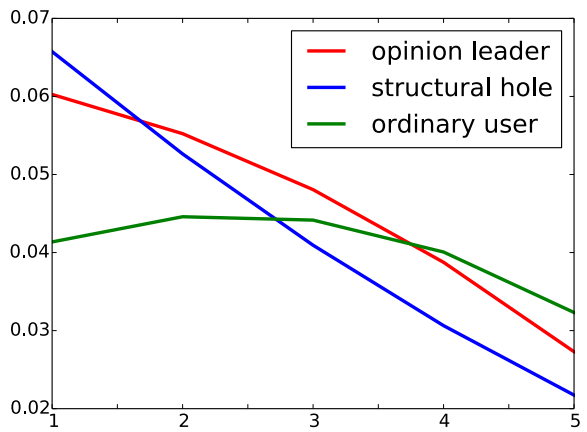
Happy

Fear

X: number of friends with different social roles.

Y: probability being a certain emotion.

"Emotional comfort" phenomena

Q2: Social Role
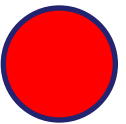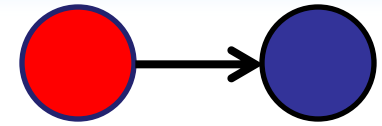
Happy
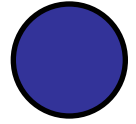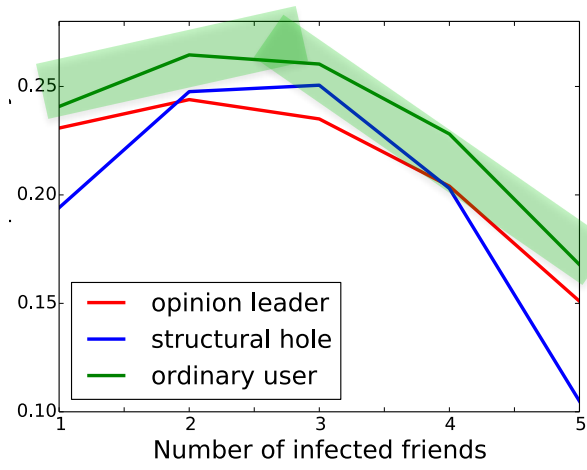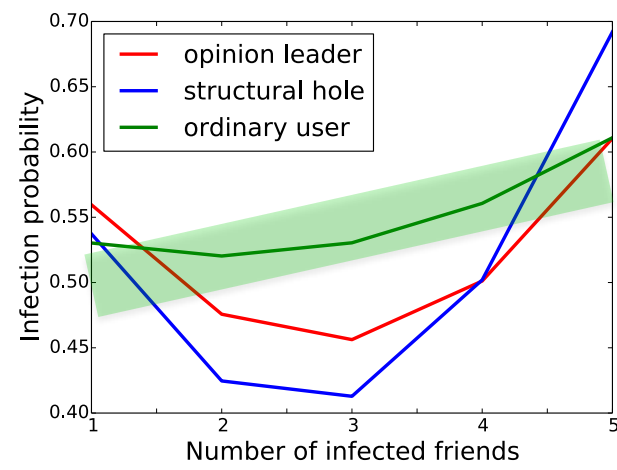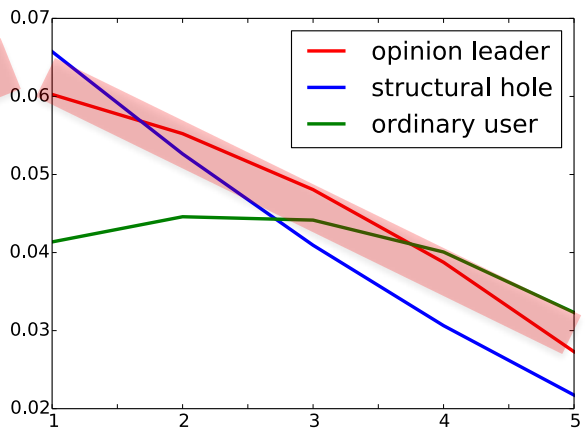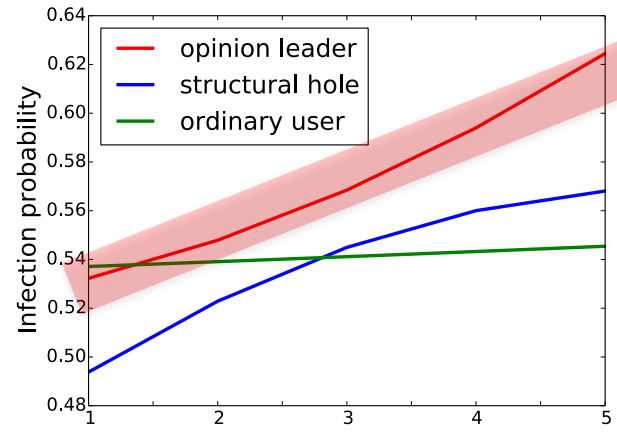
Fear

Happy

Fear

X: number of friends with different social roles.

Y: probability being a certain emotion.

Opinion leaders are more influential on positive emotions
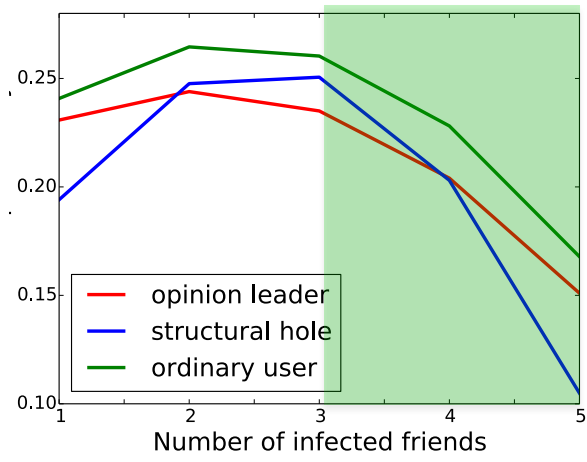
Ordinary users are more influential on negative emotions
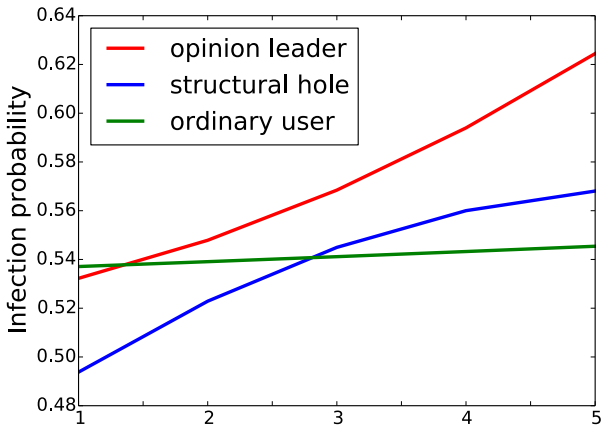
Q2: Social Role
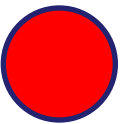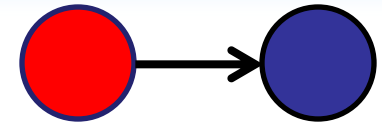
Happy   **Fear**
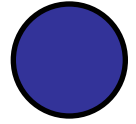
Happy

Fear
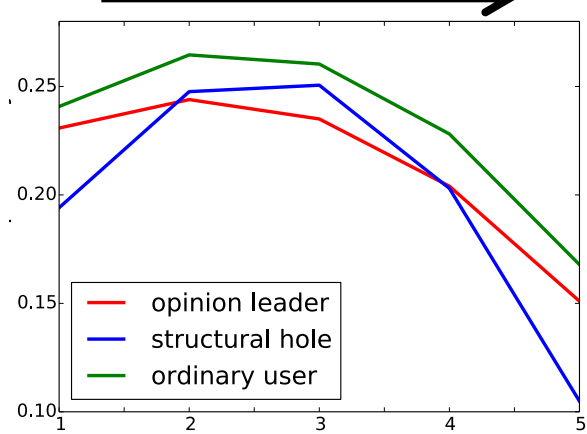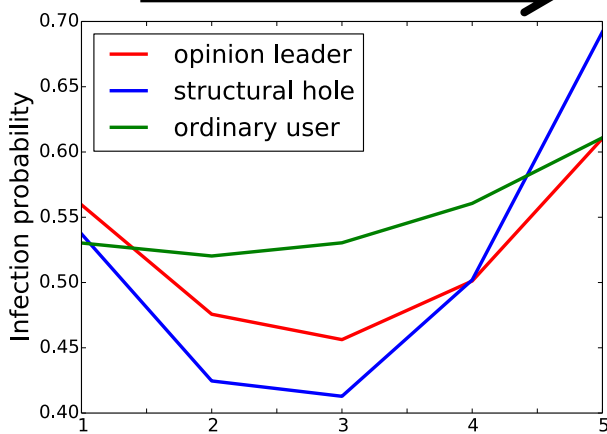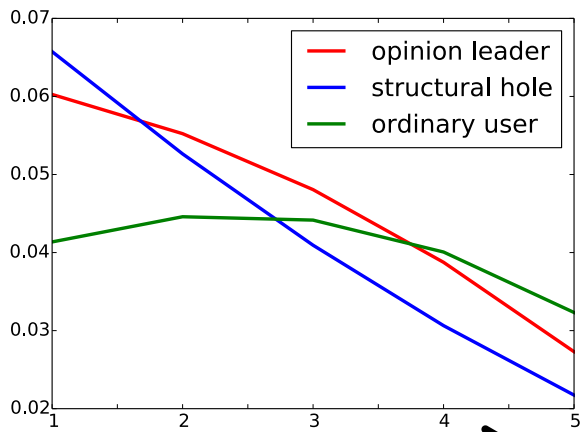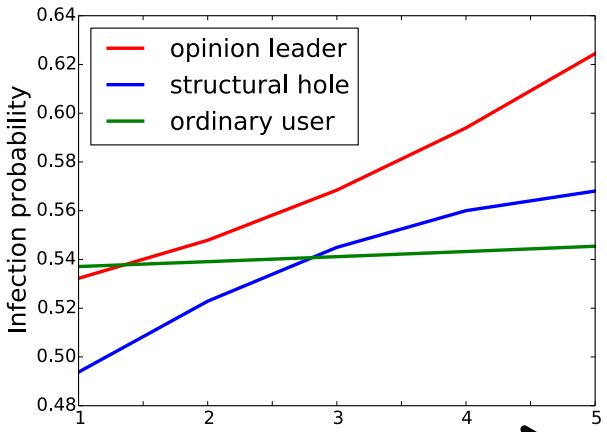
X: number of friends with different social roles.

Y: probability being a certain emotion.

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

Q3: Model
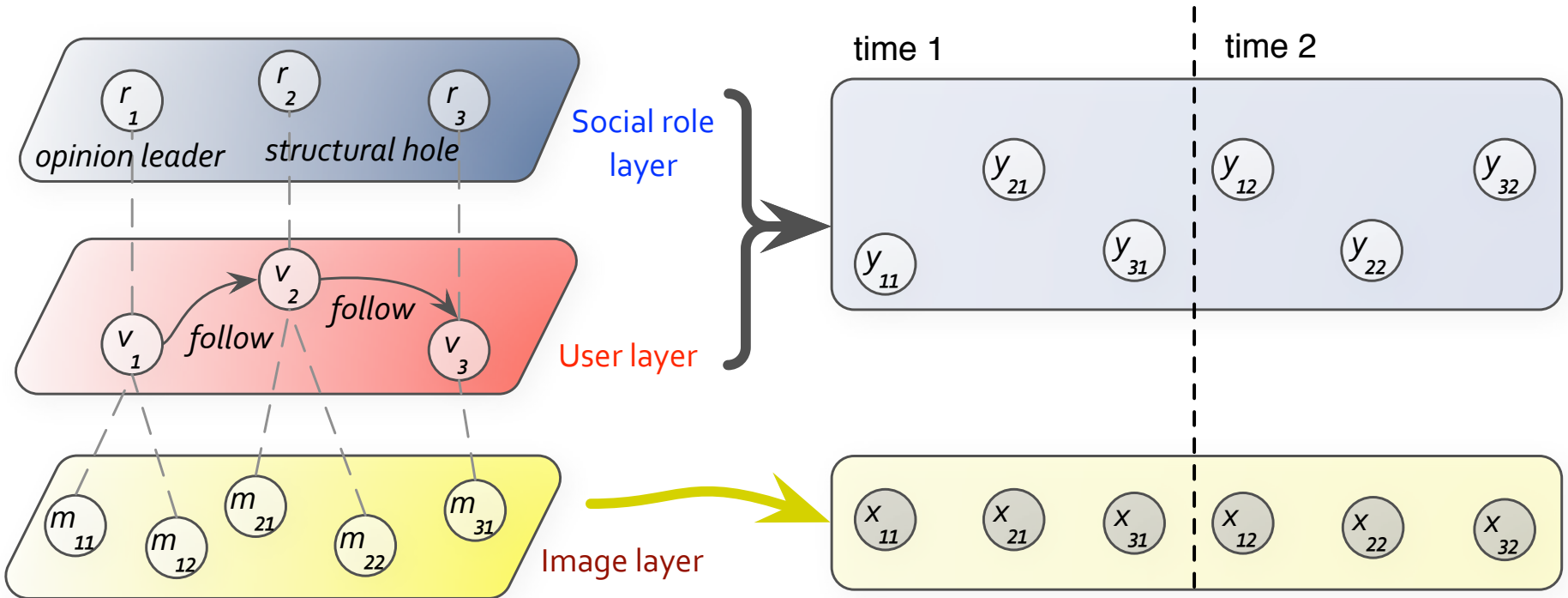
(a) An example of the problem

(b) Social Role-Aware Contagion Model

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

Q3: Model
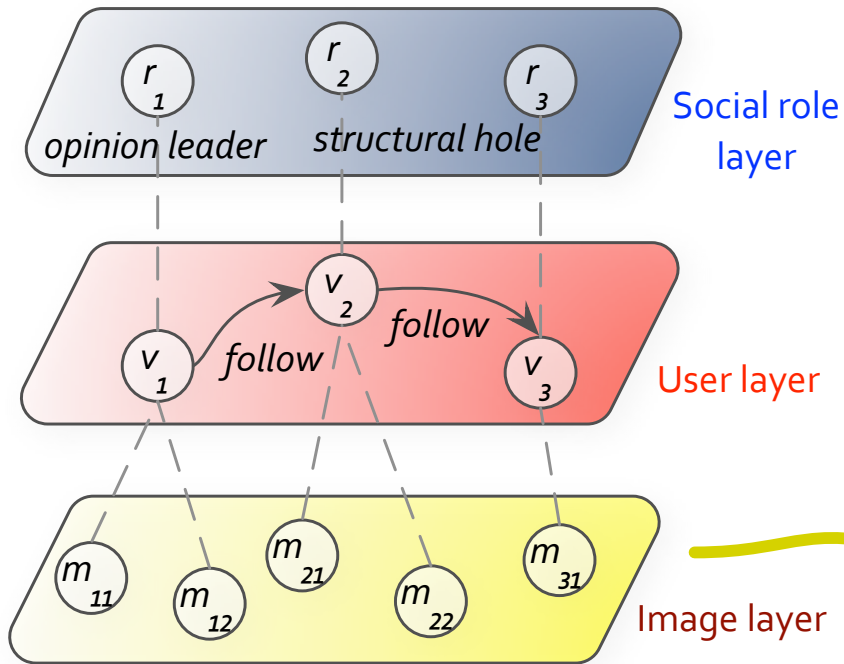
(a) An example of the problem
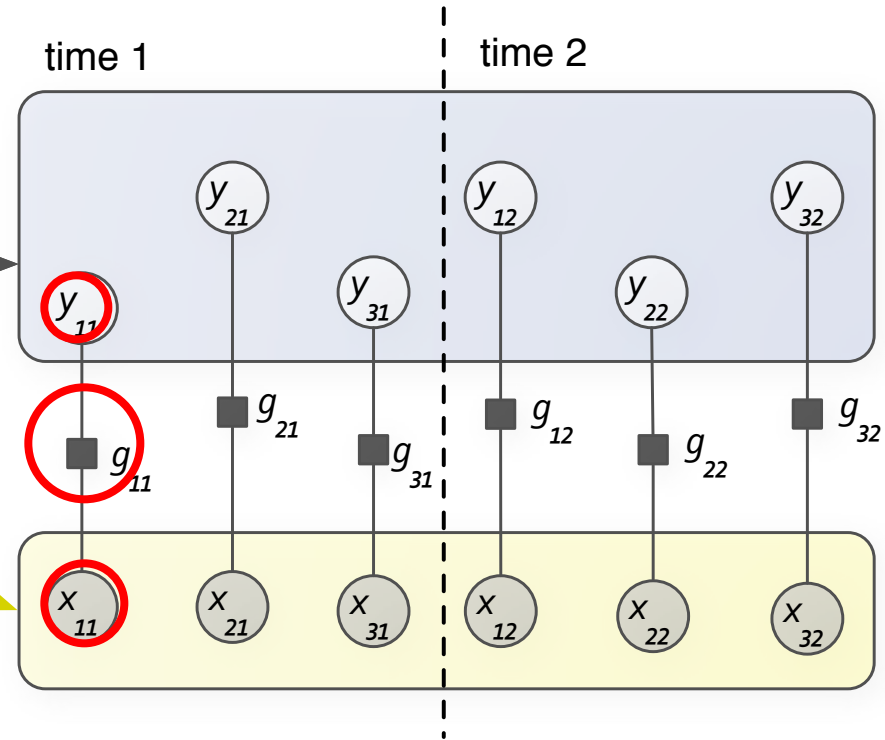
(b) Social Role-Aware Contagion Model

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

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

Q3: Model

$P(Y|G) = \pi\{g(.)h(.)\} \dots$
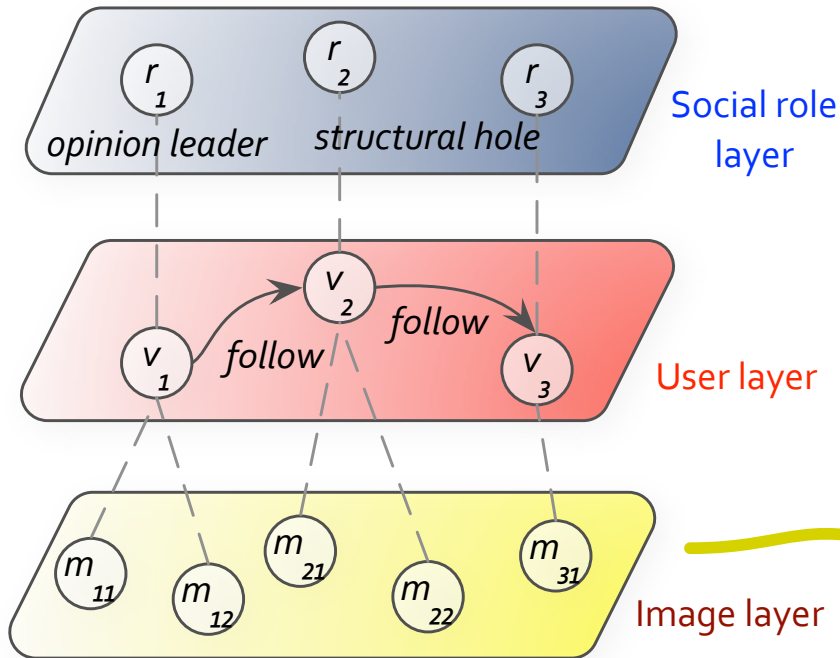
(a) An example of the problem
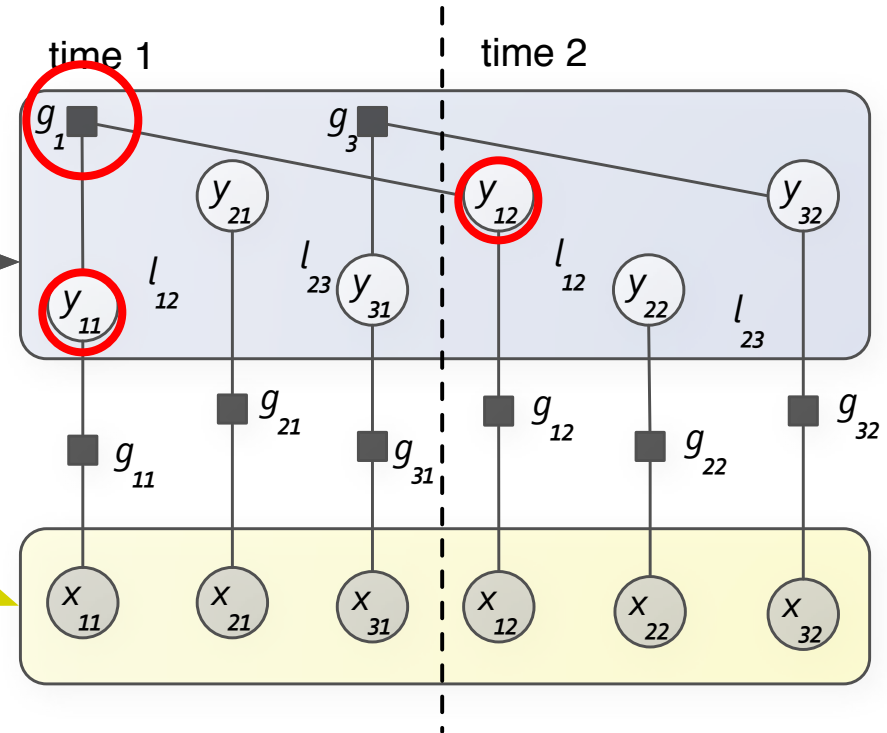
(b) Social Role-Aware Contagion Model

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

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

Q3: Model

$$P(Y|G)=\pi\{g(.)h(.)l(.)\}$$
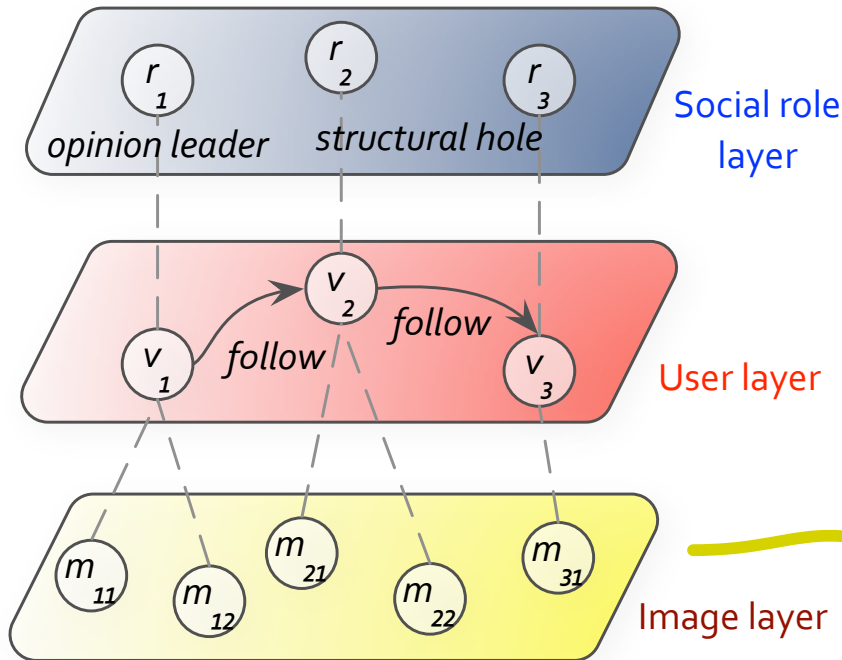
(a) An example of the problem
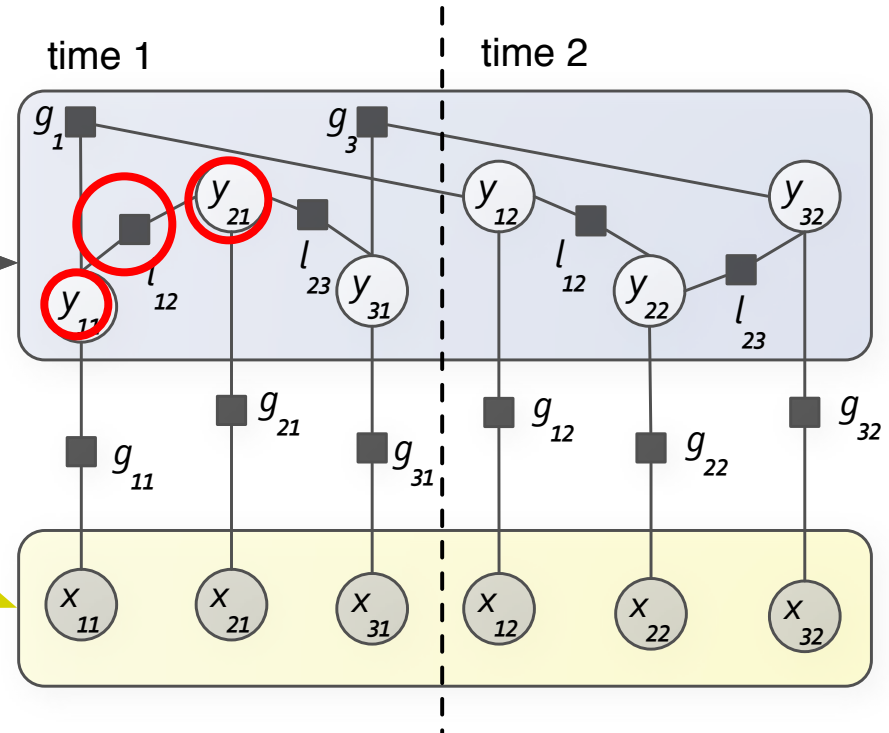
(b) Social Role-Aware Contagion Model

$l(y_{ut-1}, y_{vt})$: 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

Experimental Results

Emotion
Happiness
Surprise
Anger

Flickr dataset:

     2,060,353 images, 1,255,478 users

     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%

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	Emotion	Method	Precision	Recall	F1-score
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								

Evaluation Metrics:

Precision
Recall
F1 Measure

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
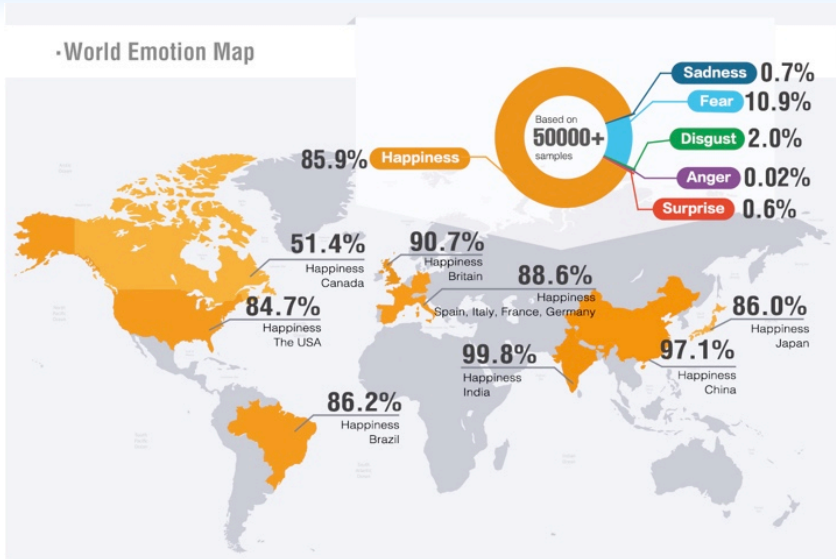
(a) Ground truth
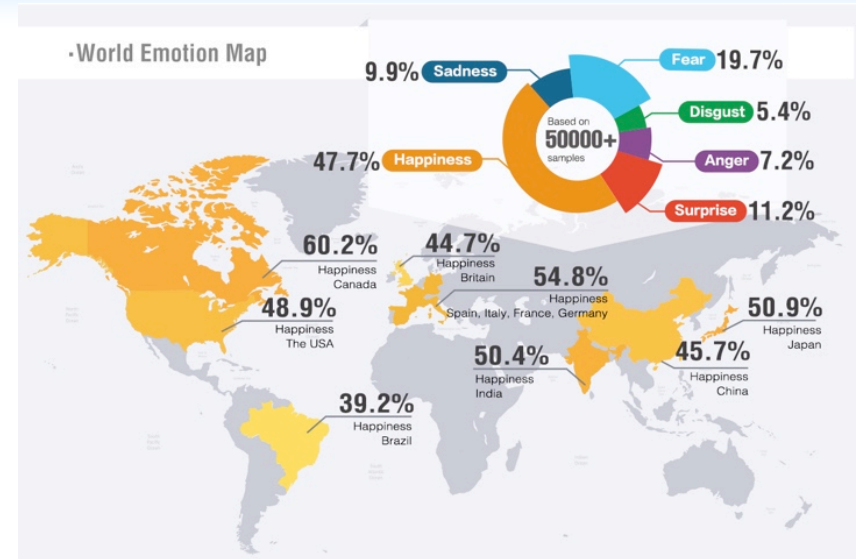
(b) Random users
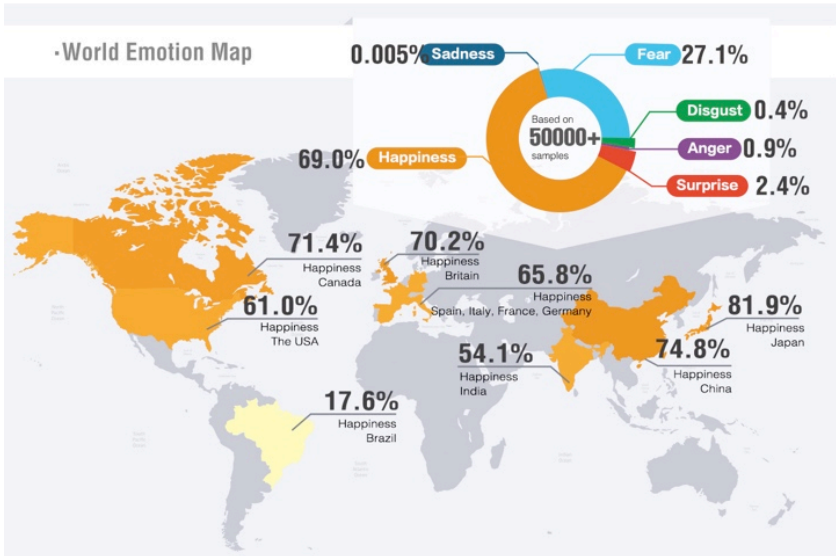
(c) Opinion leaders
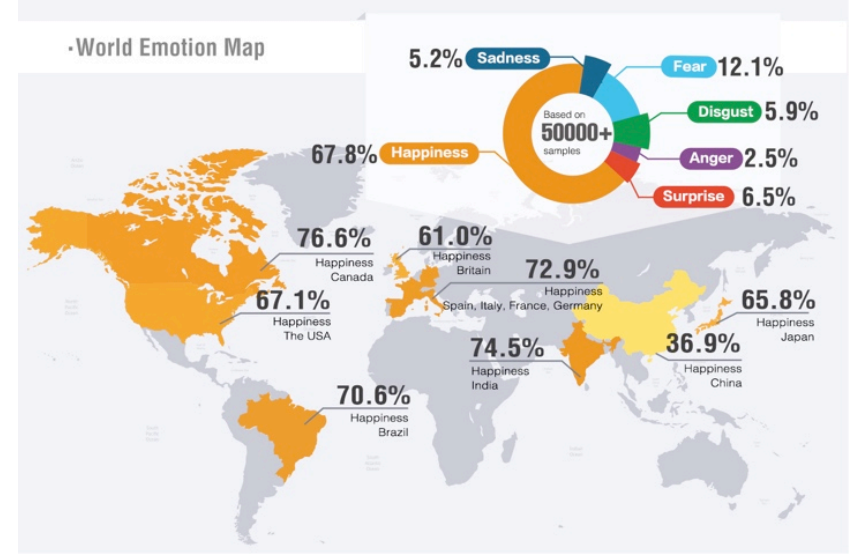
(d) Structural hole spanners

Conclusion

- We 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?
- We propose the *social role-aware contagion model* and validate it on a real social network.

THANK YOU!

Social Role-Aware Emotion Contagion in Image Social Networks

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