Proceedings of the International Conference on Web and Social Media (ICWSM-2017)

Cultural Diffusion and Trends in Facebook Photographs

Quanzeng You[1], Dario Garcia-Garcia[2], Manohar Paluri[2], Jiebo Luo[1], **Jungseock Joo[3]**

Rochester Univ[1] Facebook[2] UCLA[3]

“Culture”

- Lifestyles commonly shared by members of a society or community at a certain time.

- Food, fashion, sports, hobbies, music, …
  - What we eat, what we wear, what we do, ...

- Distinct cultures exist.
  - Western vs. Eastern
  - They can be diffused to another culture.

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Diffusion of Culture

Chinese Food

P.F. CHANG'S
CHINA BISTRO

PANDA EXPRESS
GOURMET CHINESE FOOD ®

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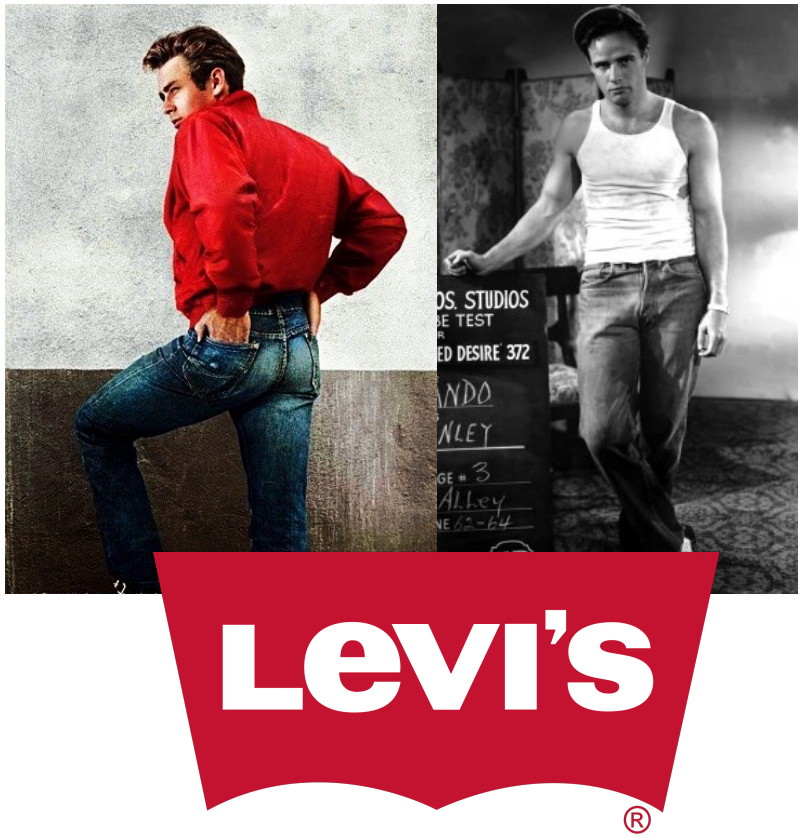
How is culture diffused?

- Culture travels with **people** (conquerors, immigrants, workers, travelers)

- Also by **media**
  - Hollywood movies spreading American pop culture to the world – by "***seeing***"



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Role of **Social Media** in Cultural Diffusion

- Can culture be diffused via social ties in online social networks?

- Can cultural preferences and lifestyles of a user be diffused to another user – by **photographs**?

Why Photographs?

- Rich information about user lifestyles.

- Often, it is a unique modality for some information
  - Other cues (text, tags, minutiae, check-ins) may not state everything in photographs.

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Our Approach

- Automatically infer cultural activities or lifestyles from user photographs using deep learning.

- Then examine:
  1. Social correlation: whether tied individuals post more similar photographs

  2. Social influence: whether the similarity is due to influence (diffusion) or homophily (inherent similarity)

Cultural Concepts in Photographs

- 11 categories
- 920 visual concepts
  - Objects, events, activities, places, photographic style
- Some region-specific cultures (American Football); but covers a wide range of general human lifestyles (bicycle, dog, beer)

Category	Concepts
Sports	baseball, basketball, climbing, football, golf, ski, soccer, swimming, tennis . . .
Animals	bear, bird, bug, cat, cow, crocodile, deer, dog, horse, spider, tiger . . .
Clothes	backpack, bikini, boots, dress, hat, heels, sunglasses, ties, . . .
Food	avocado, bagel, banana, beer, blueberry, icecream, pizza, salad, sushi . . .
Furniture	bookshelf, bed, chair, kitchen, table,. . .
Music	accordion, cello, flute, guitar, piano,. . .
Plants	flower, grass, trees, bush, . . .
Structures	bridge, house, chimney, monument, skyscraper, . . .
Places	Big Ben, Colosseum, Eiffel tower, Louvre, Opera House . . .
Scene	beach, closeup, fireworks, nature, night, selfie, sky, sunset, water,. . .
Vehicles	bicycle, boat, bus, car, train, . . .

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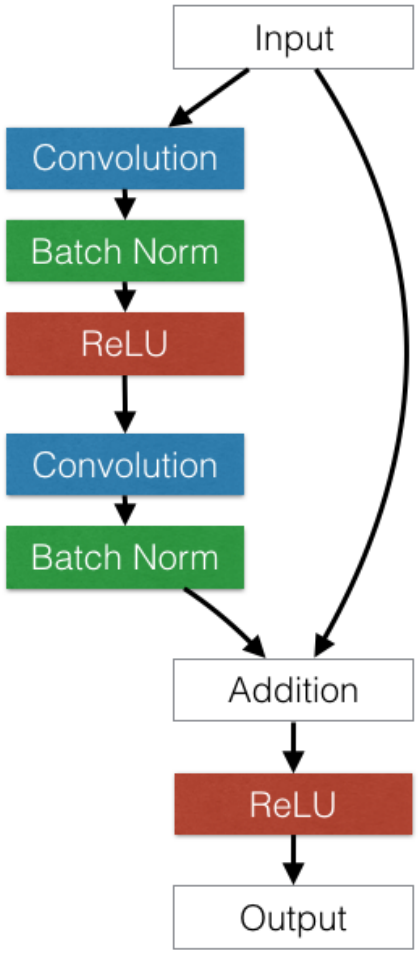
Automated classification by a CNN

- Residual Net 50-layer (He et al. 2016)
- 920 independent binary classifications
- Hard-negative and positive example and annotations collection by active learning
- Torch



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Automated classification by a CNN

Food 0.98
Restaurant 0.89
Noodles 0.85
Beef 0.73
Table 0.48

Ski 0.86
Snow 0.85
Mountain 0.81

Ocean 0.97
Wave 0.91
Surfing 0.84
Sky 0.70

Motorcycle 0.92
Wheel car 0.73
Helmet 0.6
Tree 0.54

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Automated classification by a CNN

Category	# of Concepts	Avg AUC	Avg ratio of positives
Sports	64	0.972	1.93×10^{-4}
Animals	108	0.982	3.14×10^{-4}
Clothes	88	0.882	1.71×10^{-3}
Food	107	0.979	2.56×10^{-4}
Furniture	38	0.942	5.52×10^{-4}
Music	16	0.983	1.30×10^{-4}
Plants	33	0.954	2.36×10^{-3}
Structures	17	0.973	8.33×10^{-4}
Places	73	1.000	6.03×10^{-6}
Scenes	113	0.923	1.41×10^{-3}
Vehicles	53	0.978	6.55×10^{-4}

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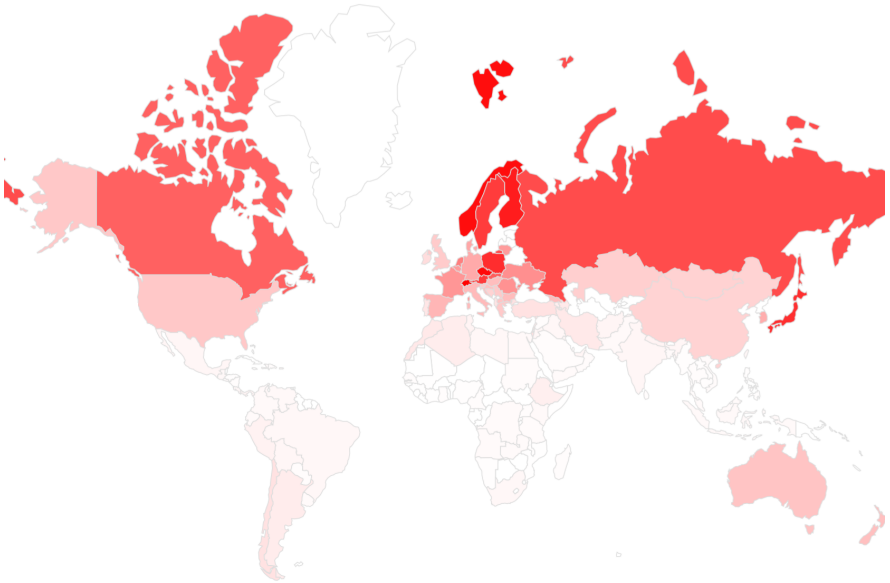
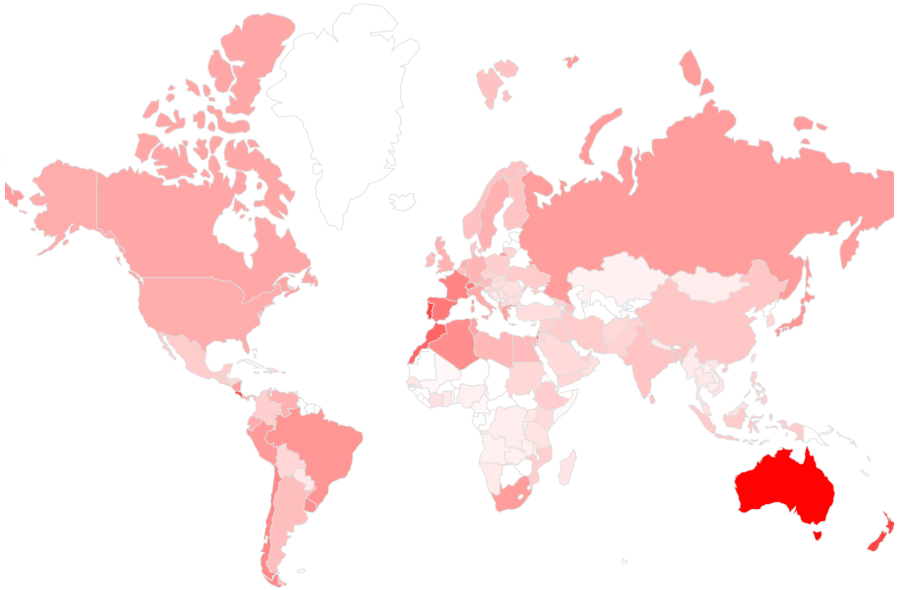
What's popular – Sports



Snowboarding



Surfing

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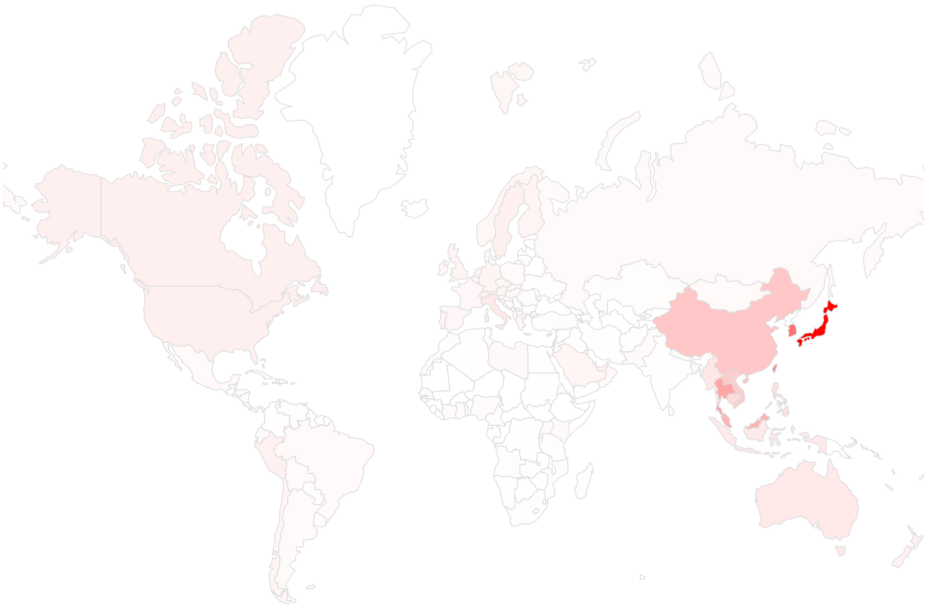
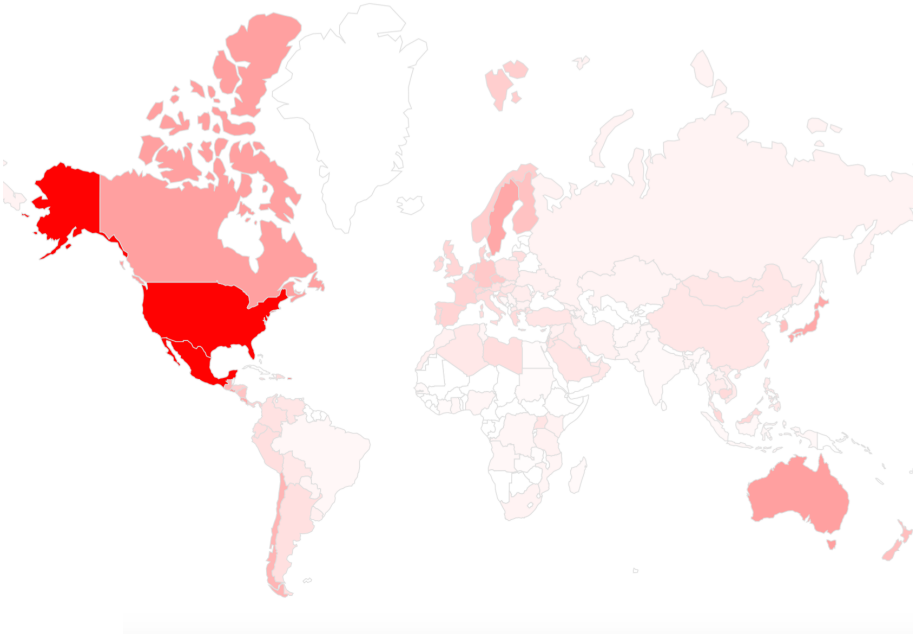
What's popular – Food



Sushi



Taco

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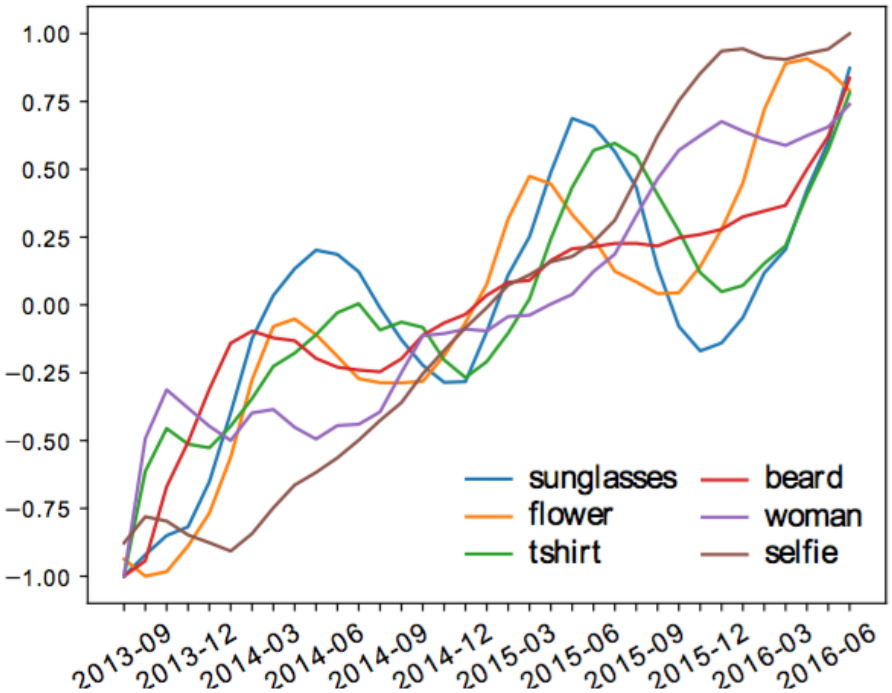
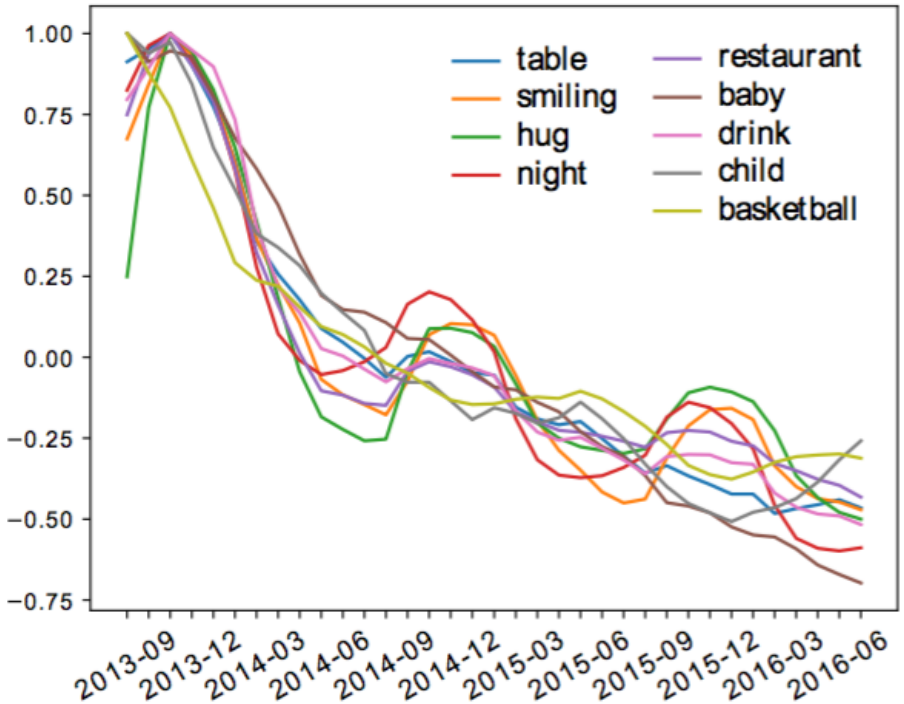
Trends





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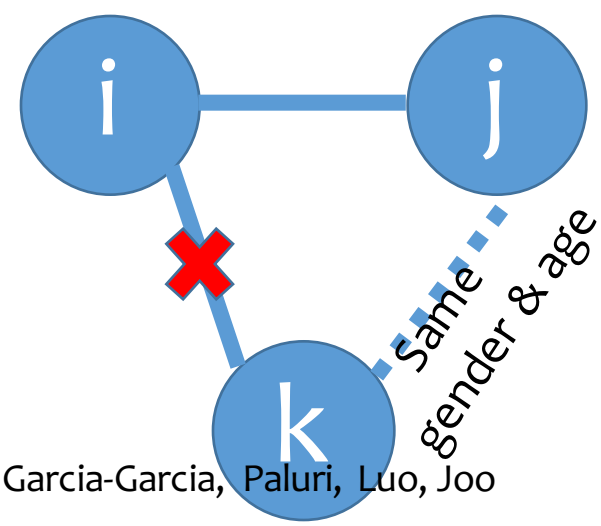
Social Correlation

- Correlation between cultural lifestyles of tied individuals (friends)
- Are friends more likely to post photographs that exhibit similar cultural lifestyles?
- Measured by the difference of cosine similarities of CNN outputs between friend and non-friend pairs.

$$D_{\text{corr}}(T) = \frac{1}{|T|} \sum_{(v_i, v_j, v_k) \in T} \cos(x_i, x_j) - \cos(x_i, x_k).$$

- x_i : a user, x_j : a friend,
  x_k : a random non-friend user,
  of the same gender & age group as x_j



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Social Correlation

- Dataset
  - 1.3 M users
  - 250 M photographs, 2013-2016
  - Seattle area – the same location

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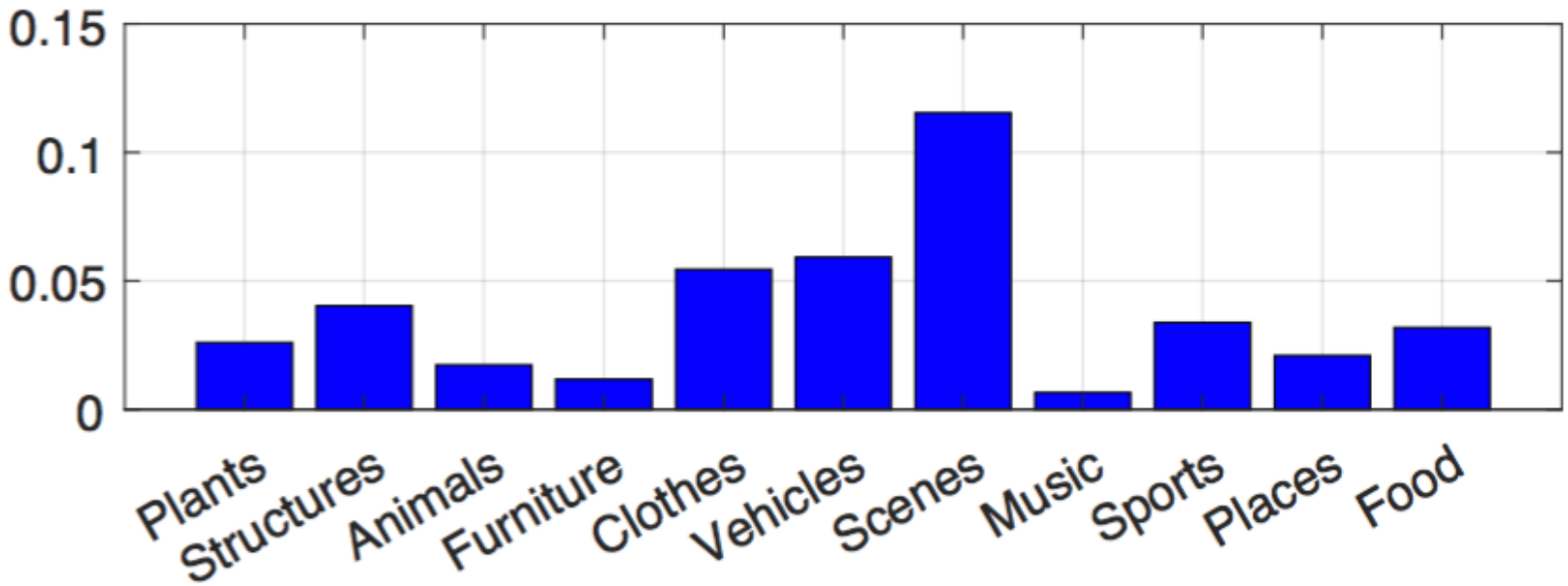
Social Correlation



- All statistically significant (p-val < 0.00001) except Music (p-val = 0.111).

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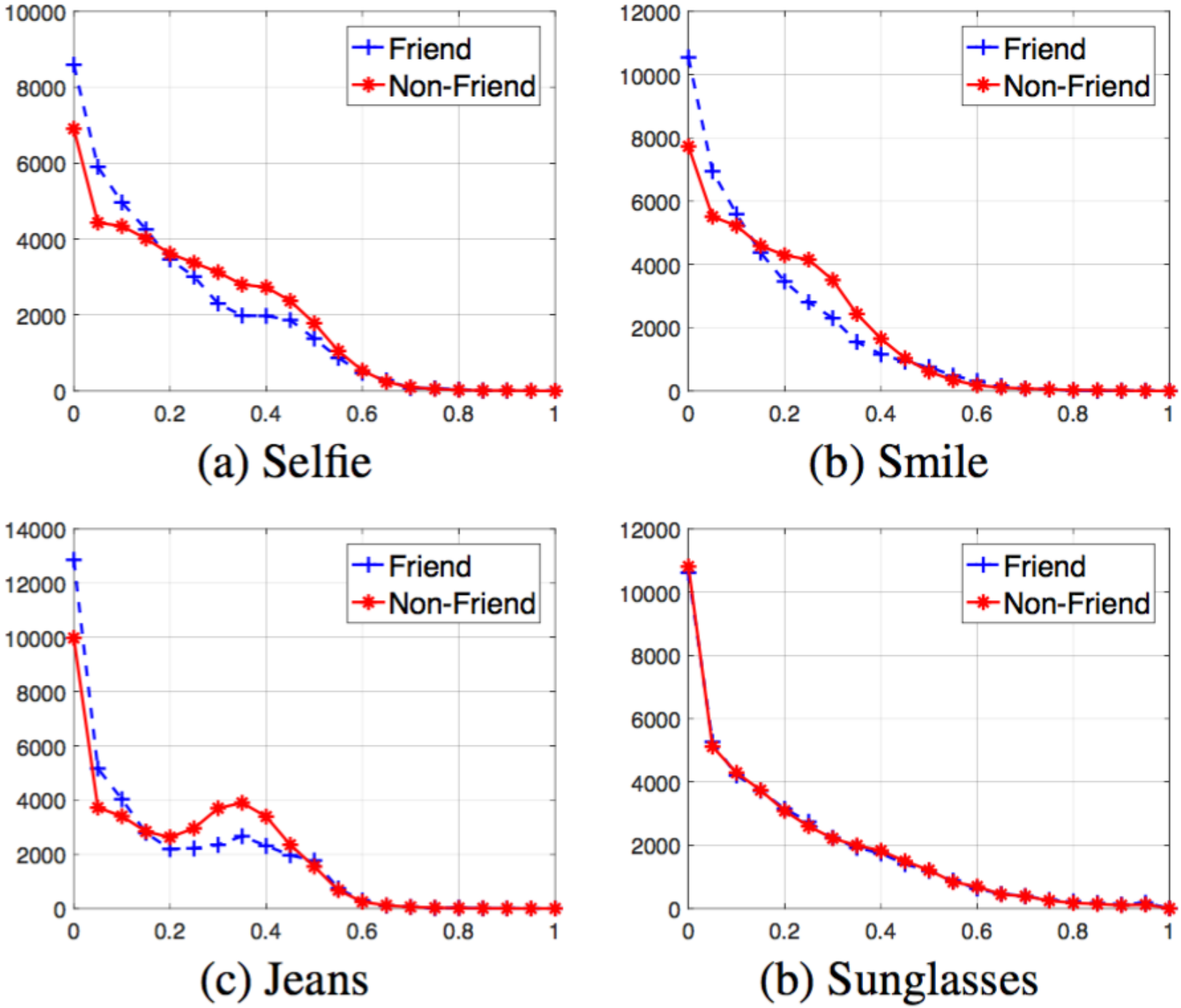

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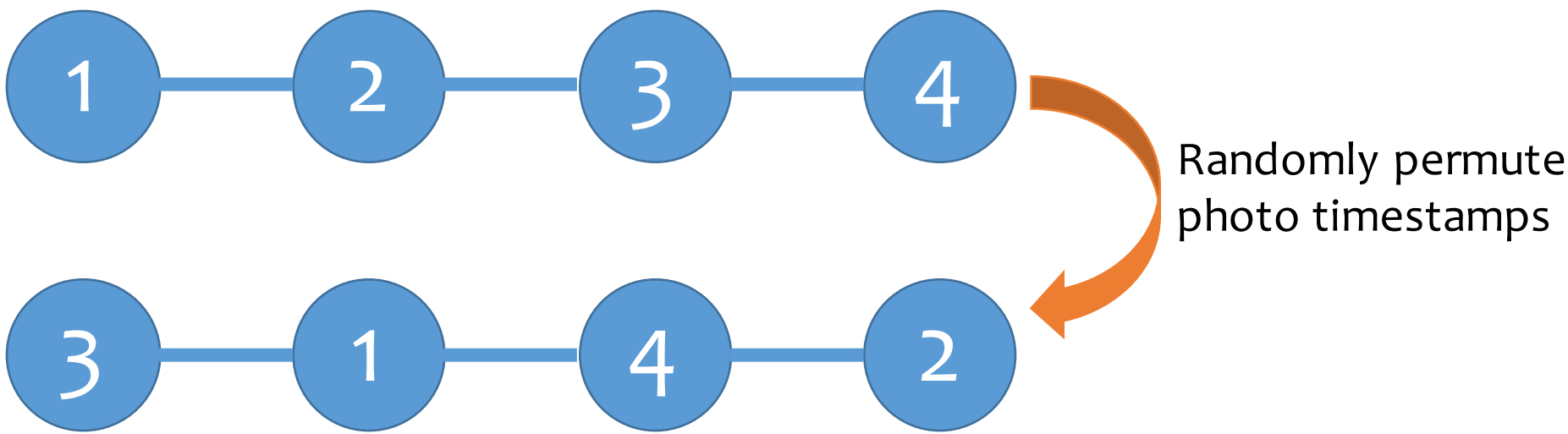
Social Influence

- Influence vs. Homophily
  - Influence: cultural lifestyles can be diffused via friendship ties.
  - Homophily: people with similar lifestyles are more likely to become friends.

- Predictive influence
  - Observational data
  - Shuffle Test (Anagnostopoulos, Kumar & Mahdian 08)
  - PME Test (Sharma & Cosley 16)

Shuffle Test

- Measure correlations before/after permuting the timestamps associated with user photographs.
- Idea – the temporal propagation of a visual concept would be aligned with the friendship ties if there was an effect of influence.



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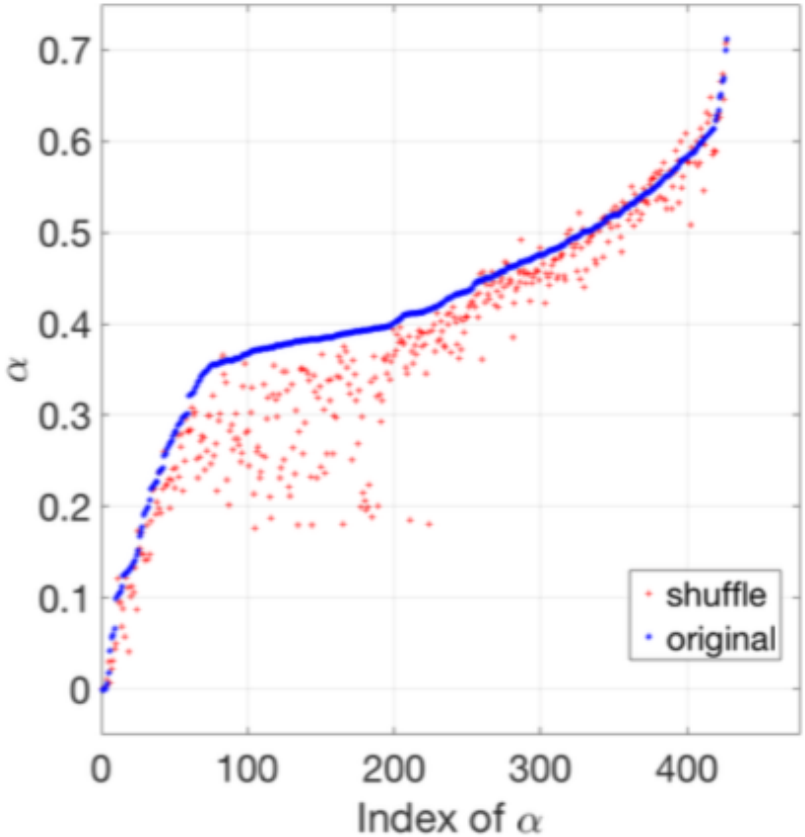
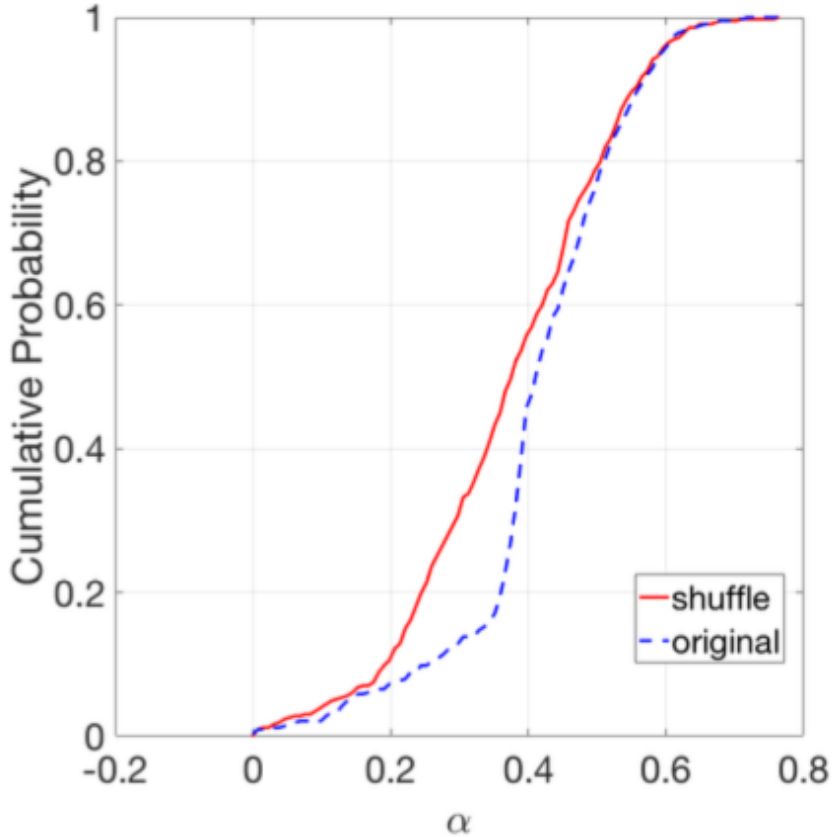
Shuffle Test

- Correlation between (via logistic regression)
  - # of friends who post about a visual concept and,
  - Whether the user will also post the same concept or not

Shuffle Test





- Overall, correlations were reduced after permutation: the effect of influence

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Shuffle Test

Concept	Shuffled	Original	Difference
face	0.18	0.416	0.236
person	0.185	0.411	0.226
child	0.18	0.389	0.209
smiling	0.179	0.383	0.204
table	0.179	0.381	0.202
tree	0.196	0.393	0.197
night	0.176	0.371	0.195
sky	0.2	0.395	0.195
pants	0.2	0.393	0.193
hug	0.187	0.374	0.187
shoes	0.206	0.393	0.187
plant	0.214	0.392	0.178
drink	0.21	0.374	0.164
restaurant	0.202	0.36	0.158
hat	0.221	0.379	0.158

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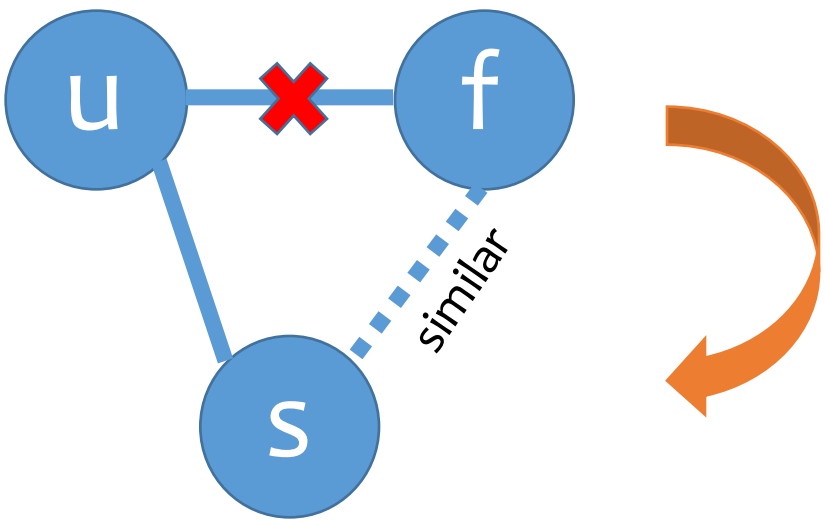
PME Test

- Preference-based Matched Estimation (Sharma & Cosley 2016)
- At time t, sample a network:



Sample a non-friend user who is similar to f

$$J(f,s) = \frac{|A_t^f \bigcap A_t^s|}{|A_t^f \bigcup A_t^s|}$$

$$N(f,s) = \frac{\left||A_t^f| - |A_t^s|\right|}{|A_t^f|}$$

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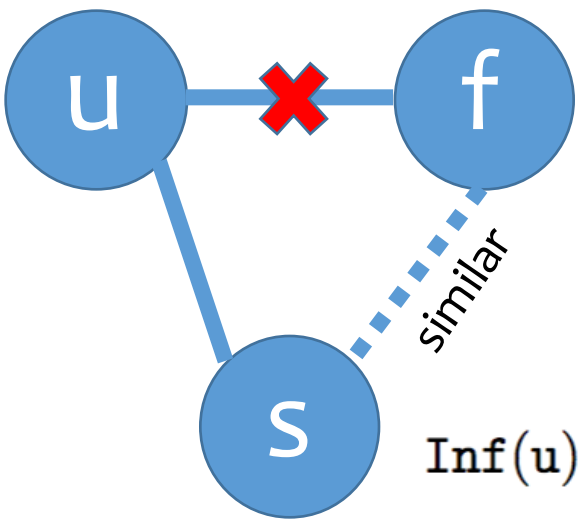
PME Test

- Preference-based Matched Estimation (Sharma & Cosley 2016)
- At time t+1, compare two similarities:



$$\mathtt{Inf}(\mathtt{u}) = \frac{\sum_{c \in A_{t+1}^{F(u)}} I(c \in A_{t+1}^{u})}{|A_{t+1}^{F(u)}|} - \frac{\sum_{c \in A_{t+1}^{S(u)}} I(c \in A_{t+1}^{u})}{|A_{t+1}^{S(u)}|}$$

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PME Test

- The original network has a higher similarity (between true friend pairs).

- Effect of influence

Influence	std	t-stat	p-value
0.07	0.09	293	$< 10^{-5}$

Discussions

- Social media can offer a channel for cultural exchanges via exposures to user content between online friends.

- Our study finds the effect of influence using photos.
  - User tagging has been reported as non-influential in other platforms: flickr (Anagnostopoulos, Kumar & Mahdian 2008), Flixster, Last.fm, Goodreads, flickr (Sharma & Cosley 2016).

Discussions

- Limitations
  - Observational study
  - Only visual analysis

- People communicate via visual means in social media. Photographs are a great channel to understand their behaviors.