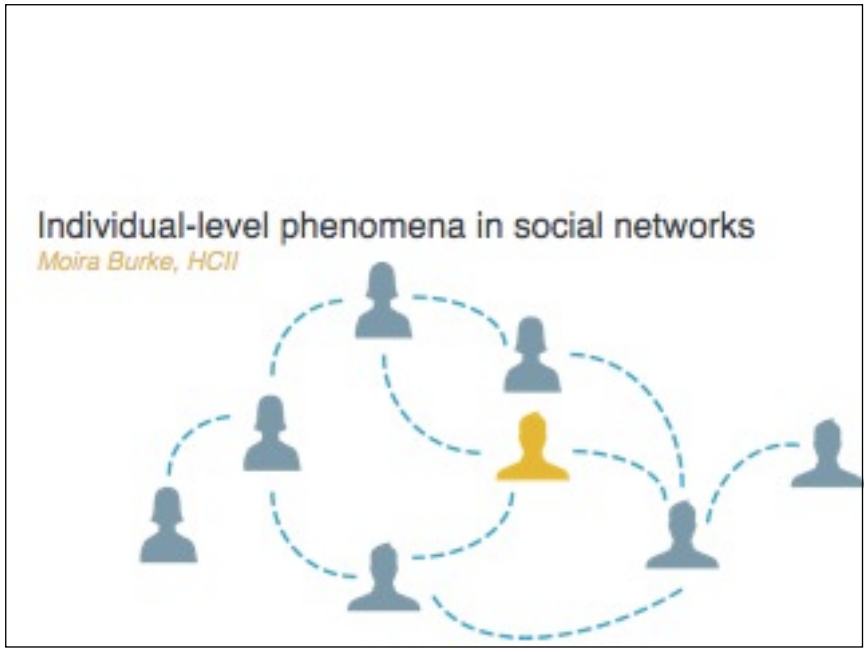
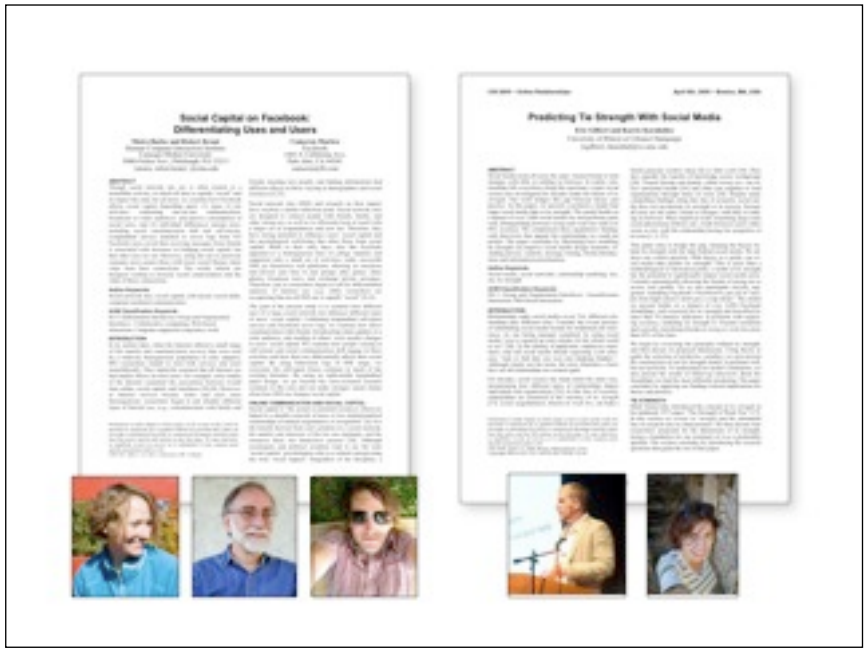


1

Rather than looking at network-level effects, like diffusion, information cascades, or small-world phenomena, I study individual-level effects, like how a particular person's happiness is affected by their (network) neighbors.



2

Two papers -- illustrate two very different methodologies for studying Facebook.

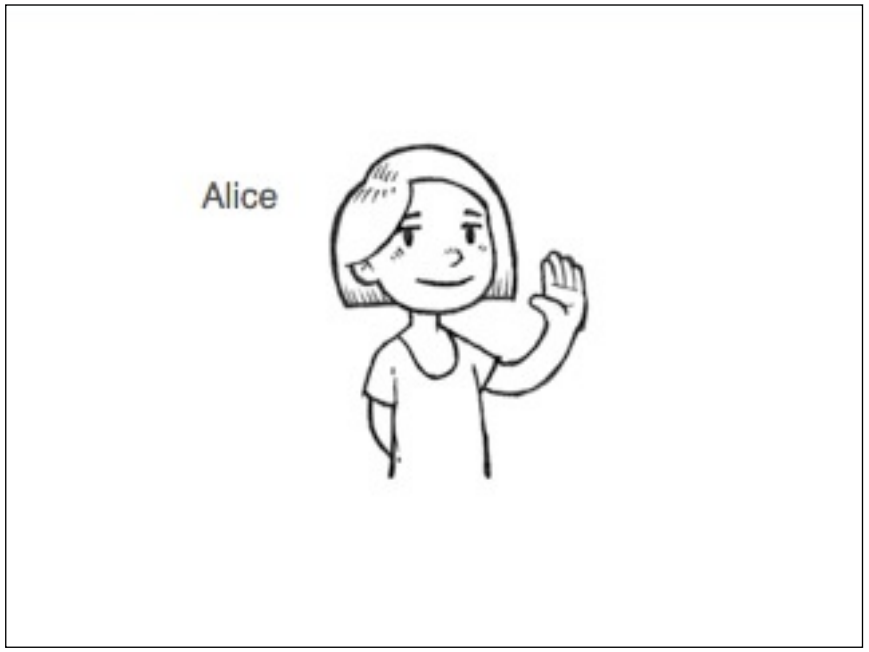
Outline

- Background: Is the Internet good or bad for friendships?
- Paper 1: Social capital on Facebook
- Paper 2: Measuring tie strength
- Combining the two approaches

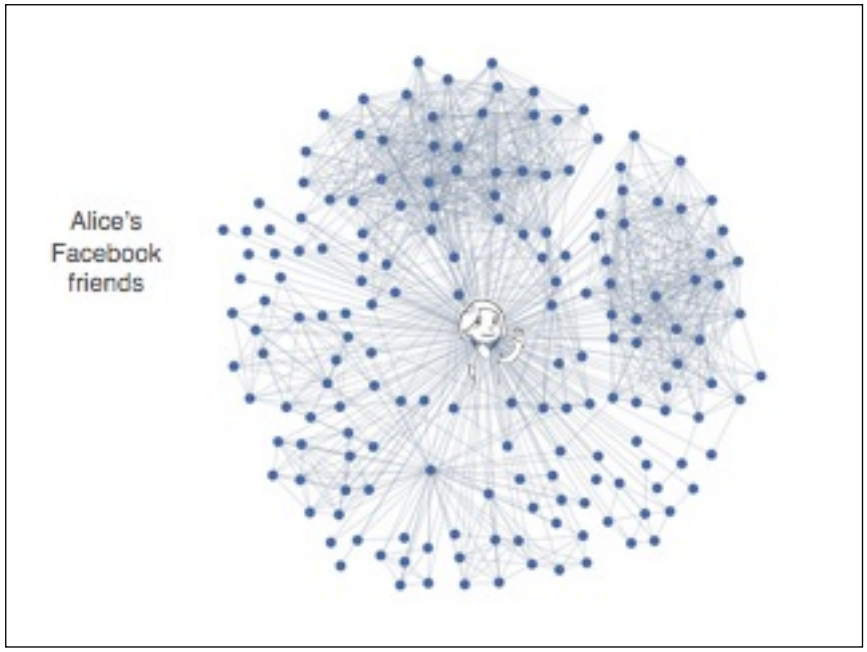
Facebook facts

- How many active users of Facebook?
- What % are active on any given day?
- How much time do they spend on the site per day?
- How many friends do they have?

Let's have some Facebook facts . . .
The average Facebook user is one of more than half a billion people using the site in the world today. Half of those, 1/4 billion, are active on any given day. According to Pew, 3/4 of Americans under 30 use



Alice. You might remember her from Ian's proposal. She's 25, lives in Pittsburgh, and has about 170 friends on the site.



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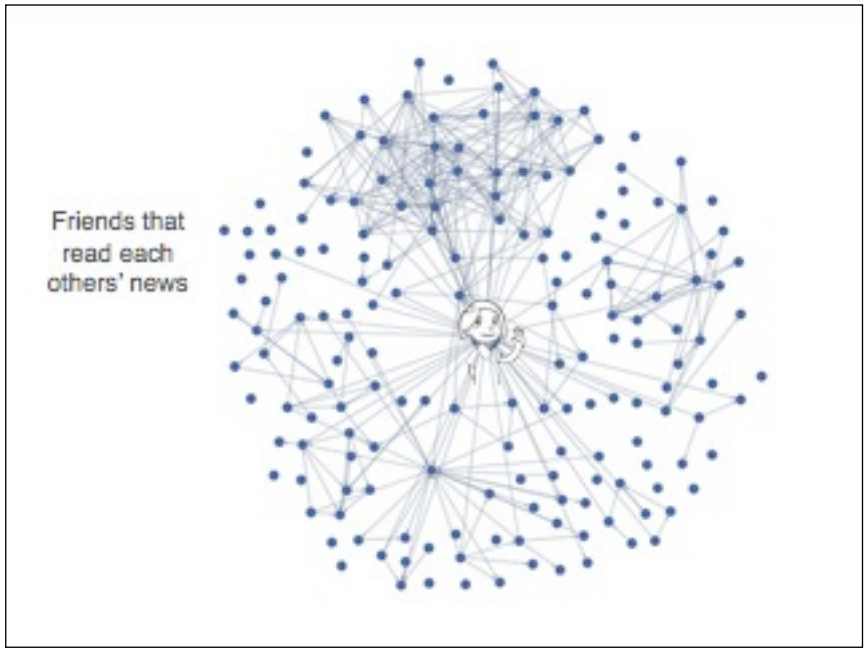
At the top, close-knit group of friends from work. At the right, you can see another close-knit group of friends from college. Now, of these 170 friends, she really only keeps in touch with 25. . .



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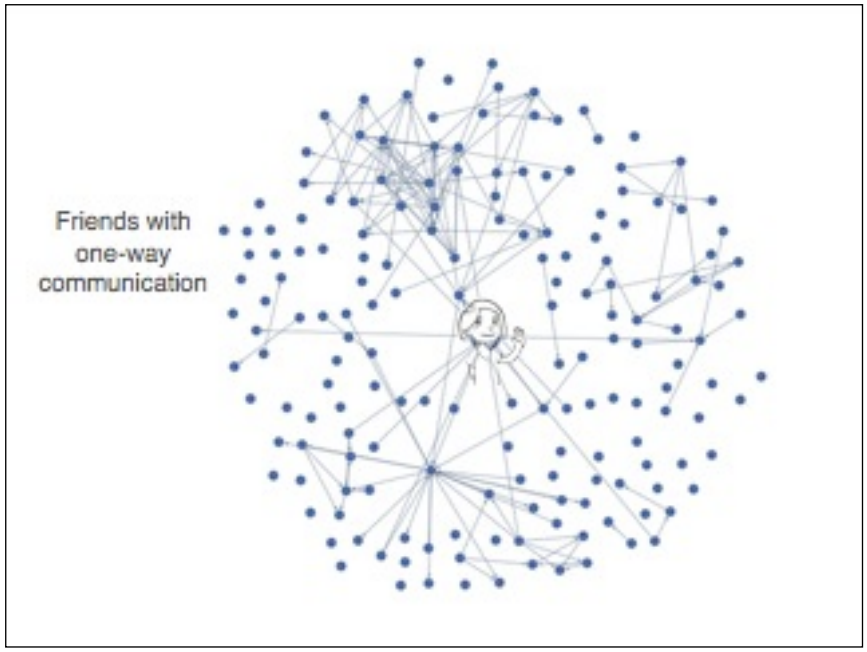
She reads their stories in her newsfeed, looks at their photos.



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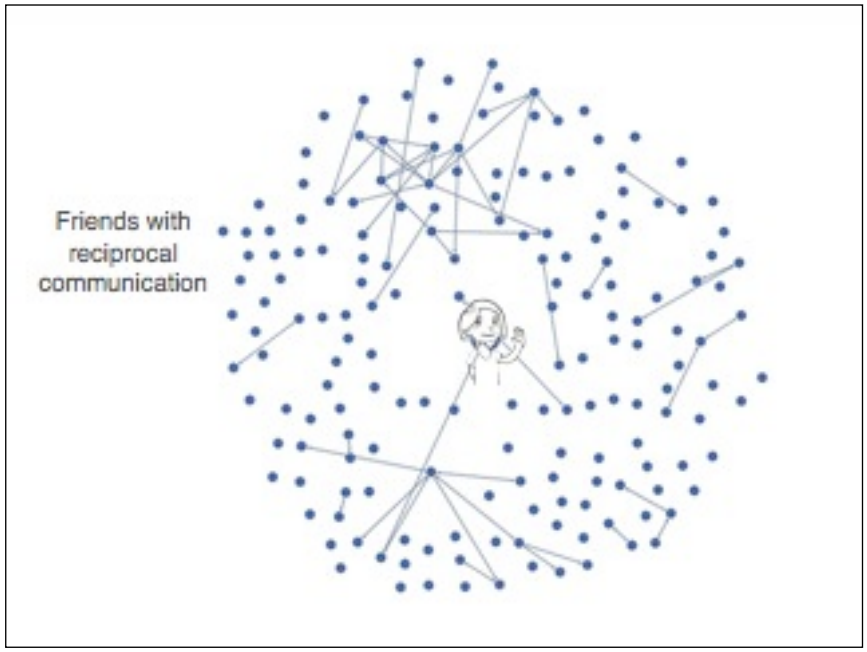
And sends messages to about 10 of them on a regular basis.



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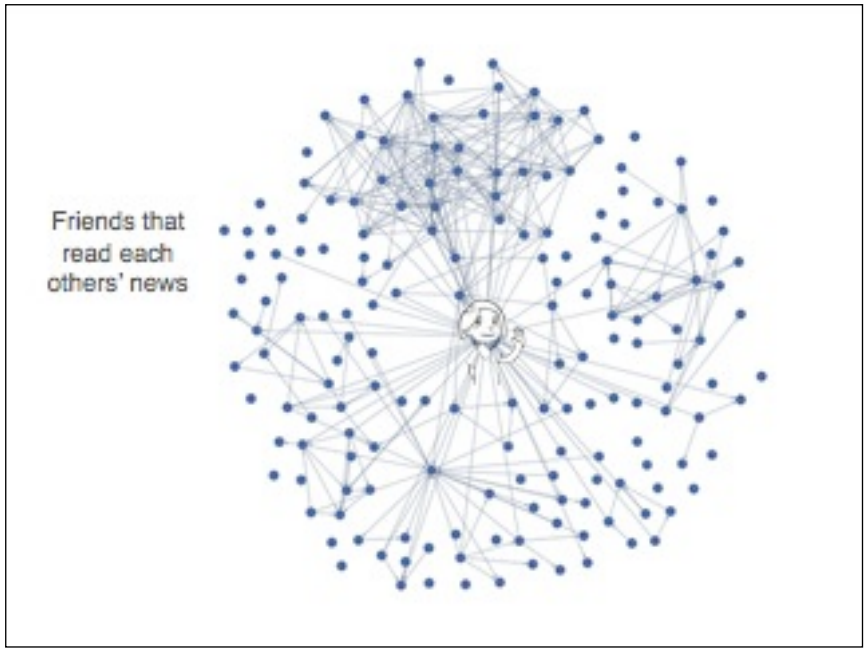
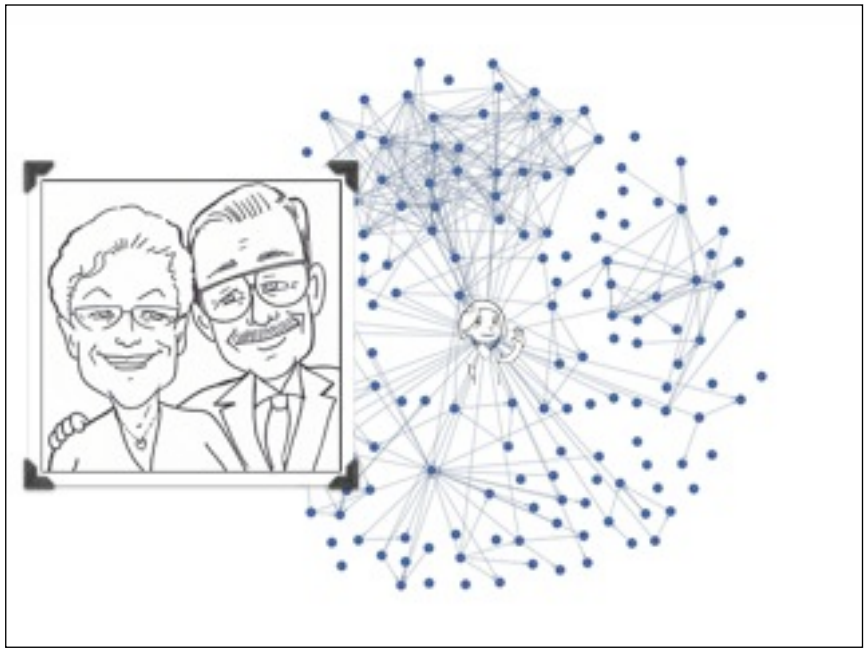
Of those, only a few write back. She has reciprocal exchanges with three people on a regular basis. Now let's go back to that group whose news she follows. . .



11

Alice spends a lot of time reading news about these friends. Maybe 8 hours per week. And they're really not her closest friends . . . people she cares about and is interested in.



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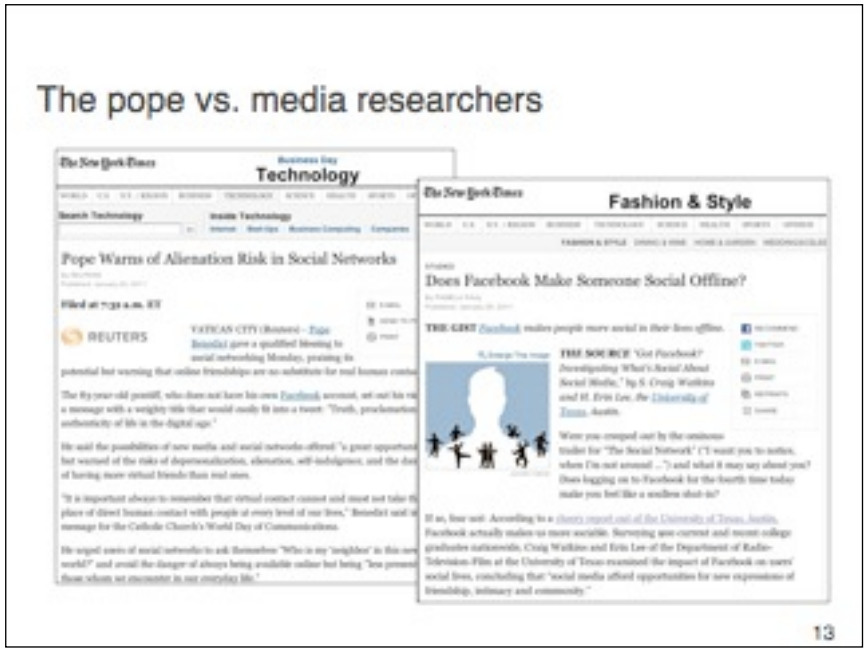
But one thing you might wonder is whether that displaces time, say, spent talking to her parents on the phone. Or having friends over for dinner.

One of the major questions of the Facebook age is whether online social networking is



13

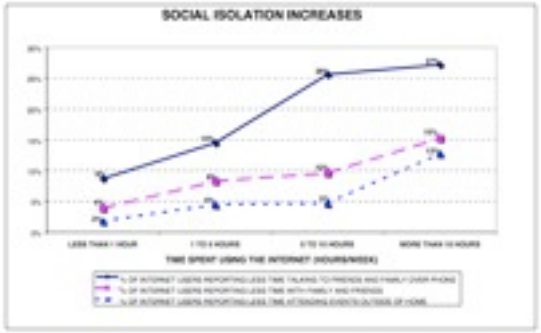
Even the pope weighed in last week, warning that virtual contact can supplant “real” friends.

14

So overall, how does social media use improve relationships? When you look more broadly at the internet in general, research tends to fall into two camps, that actually contradict each other . . .

Technology *displaces* social interaction

Heavy internet users have fewer face-to-face visits with family, friends, neighbors and greater depression, loneliness (Boase et al., 2006, Nie & Erbing, 2000; Shklovski, et al., 2004; Kraut, et al., 1998; Bessière, et al., 2006)



Source: Nie & Erbing, 2000

15

15

There are studies that find that time online displaces time spent interacting with close friends in person, and that heavy internet users are more depressed and lonely. Here's a chart from Stanford in 2000 showing that the more time people spend online, the less they talk to

Technology *augments* social interaction

- Frequent internet users have higher bridging social capital: more likely to confide in different race or discuss politics with someone from a different party. (Hampton, et al., 2009)
- Heavy Facebook users have higher civic trust and participation, with gains greatest for those with low self-esteem (Valenzuela et al., 2009; Ellison et al., 2007; Steinfeld et al., 2008)
- Teens who use IM heavily spend more time offline with friends and have higher bonding social capital. (Valkenburg & Peter, 2007)
- Closest relationships involve many communication channels, online and off. (Haythornthwaite, 2005)

16

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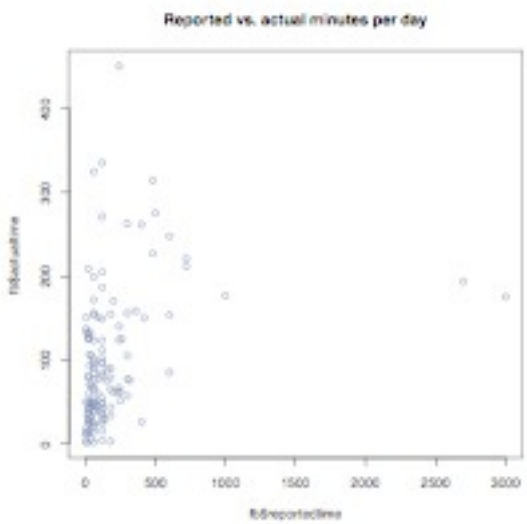
But really, many of the same researchers using different methodologies come to completely different conclusions.

Reasons for contradictory findings

17

Self-reports of time online
Undifferentiated time online
Cross-sectional
Lack of individual differences
Change in social media

17



Burke, Marlow, Lento CHI 2010

18

The majority rely only on self-reports of time online . . .

This is what the web looked like in 2000. Web was about entertainment and information seeking.

19

What is looks like now. Biggest changes include mobile, not tethered to desktop. And with Web 2.0, social is woven into every site. Restaurant reviews and health advice from strangers. Facebook's "like" button all over the web. Your grandma is on Flickr.

20

Reasons for contradictory findings

Self-reports of time online

Undifferentiated time online

Cross-sectional

Lack of individual differences

Change in social media

21

Self-reports of time online

Undifferentiated time online

Cross-sectional

21

Social networking sites, in particular have taken off.

Facebook is the 2nd most popular website in the world after Google. **Three-quarters of American adults under the age of 30 have account.**

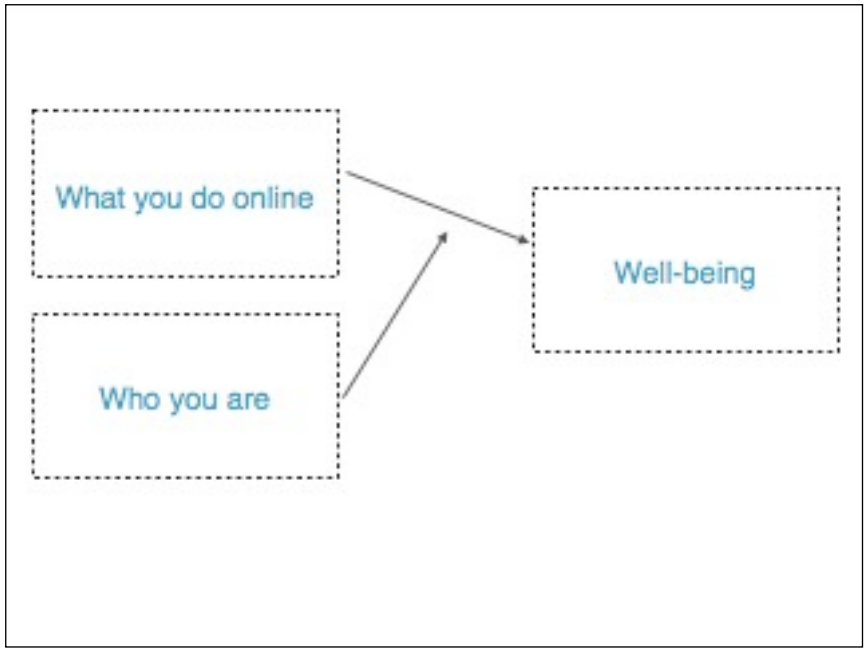
22

Social Capital on Facebook:
Differentiating Uses and Users
Predicting Tie Strength With Social Media
Not all time online is the same.
Not all people are the same.
Not all ties are the same.

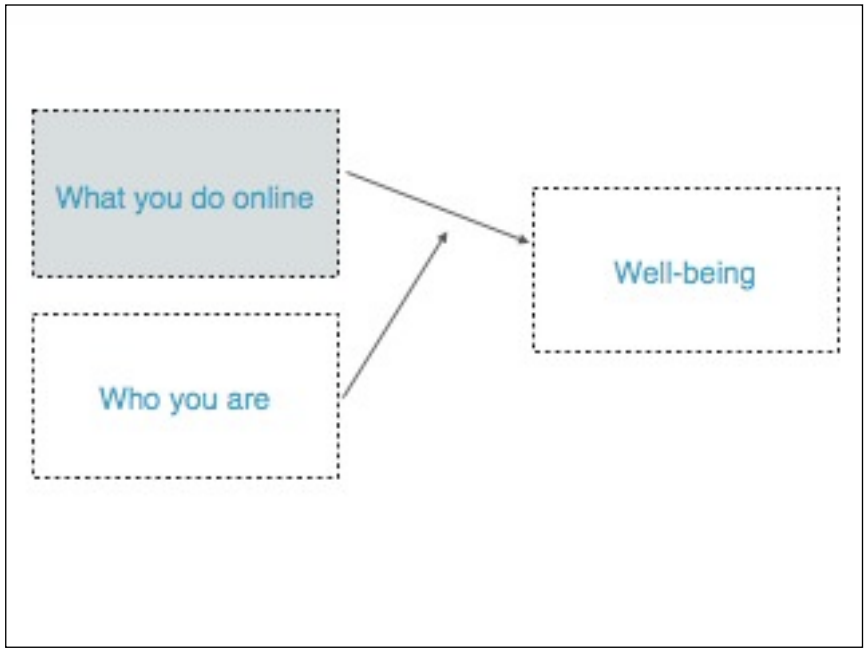
23

Social capital on Facebook
Differentiating uses and users

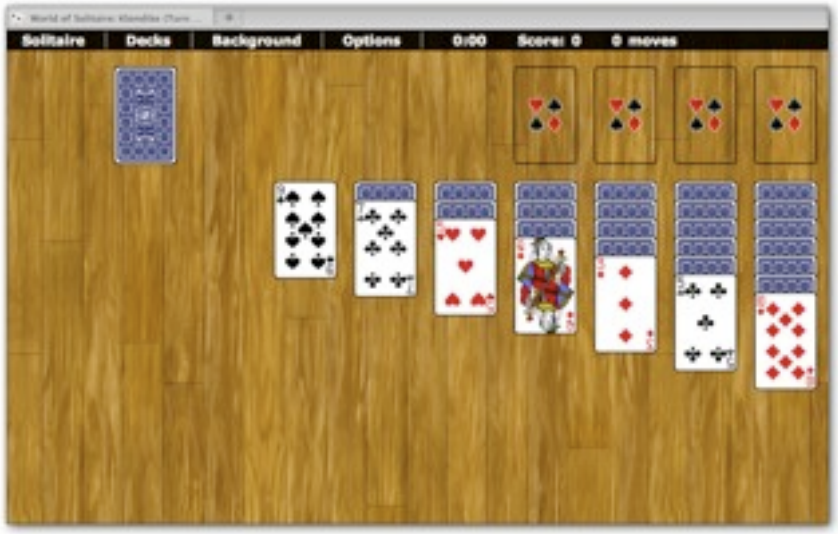
24


What you do online
Who you are
Well-being

25


What you do online
Who you are
Well-being

26



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28

Social networking sites are, by their very nature, the kind of technology that should reduce the isolation Putnam warned about. But even Facebook has different degrees of social-ness. You can think of three degrees:

Kinds of Facebook activities

Directed communication: personal, one-on-one interactions

29

29

Kinds of Facebook activities

Passive consumption: inbound social news, photos, profiles

30

30

Kinds of Facebook activities

Broadcasting: outbound status updates, photos, links shared

31

31

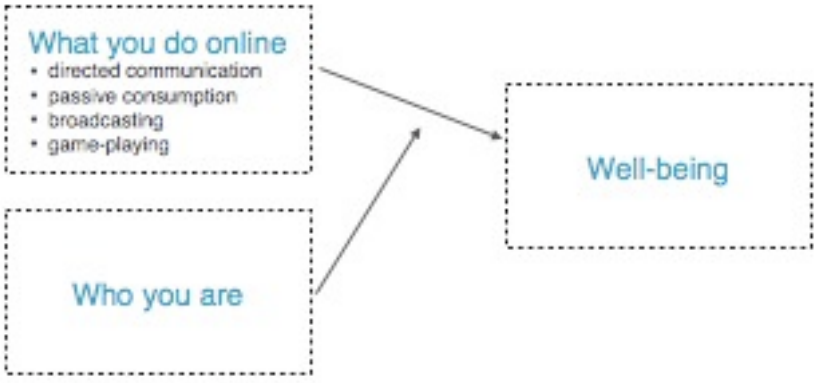
Kinds of Facebook activities

Games, quizzes

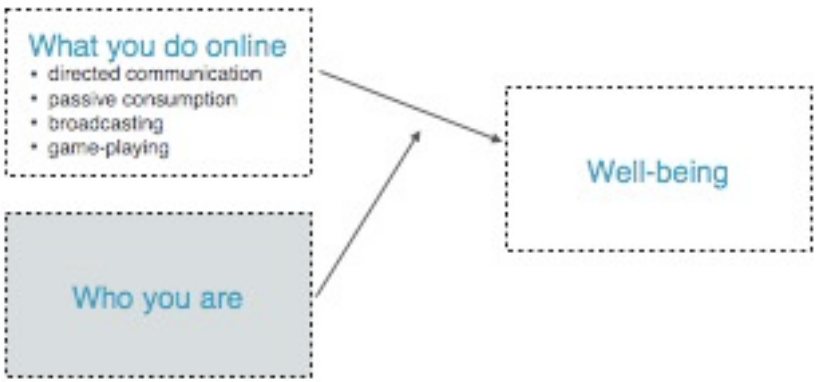
32

32

Less social activities (games, quizzes).


What you do online
• directed communication
• passive consumption
• broadcasting
• game-playing
Who you are
Well-being

33


What you do online
• directed communication
• passive consumption
• broadcasting
• game-playing
Who you are
Well-being

34

Self-esteem

Overall evaluation or appraisal of own worth.

How much do you agree or disagree with the following statements?
(5pt Likert scale: 1 = Strongly disagree to 5 = strongly agree)

1. I feel that I am a person of worth, at least on an equal plane with others.
2. I feel that I have a number of good qualities.
3. All in all, I am inclined to feel that I am a failure.
4. I am able to do things as well as most other people.
5. I feel I do not have much to be proud of.

(Rosenberg, 1989)

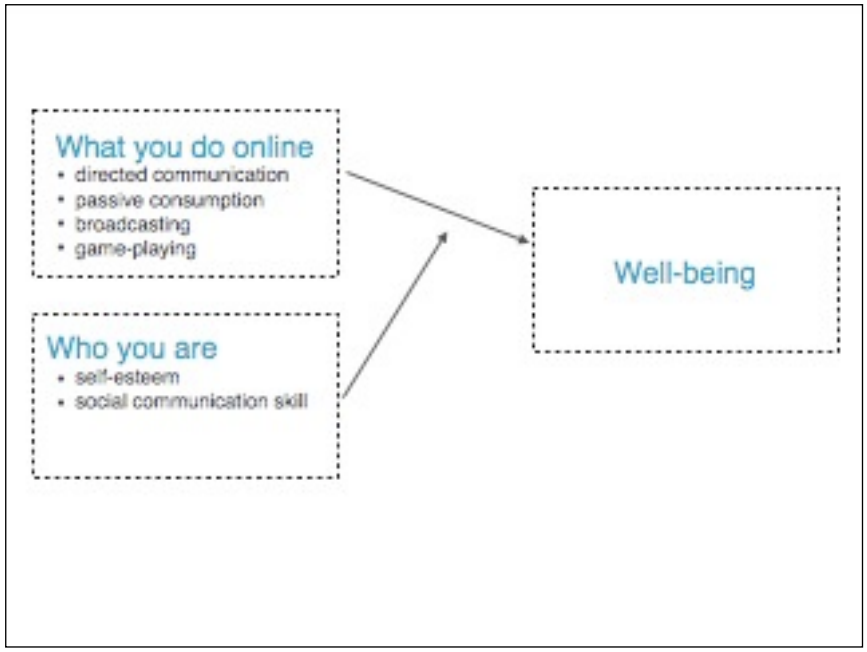
Social communication skill

Comfort and skill communicating face-to-face and on the phone

How much do you agree or disagree with the following statements?
10pt additive scale, 1pt per "agree" or "strongly agree" response

1. I enjoy social chitchat.
2. I frequently find that I don't know how to keep a conversation going.
3. I find it easy to 'read between the lines' when someone is talking to me.
4. I know how to tell if someone listening to me is getting bored.
5. When I talk on the phone, I'm not sure when it's my turn to speak.

(Baron-Cohen et al., 2001)



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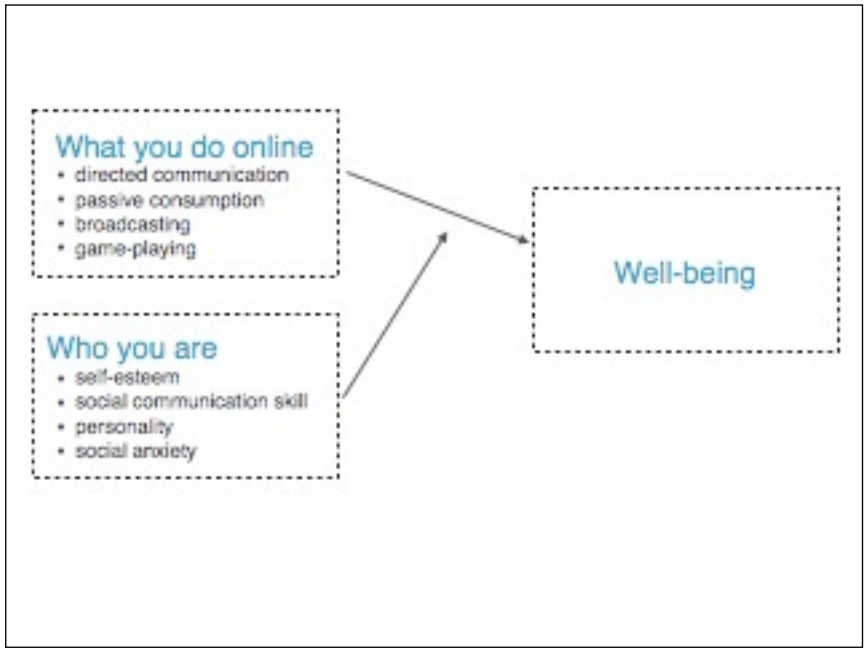

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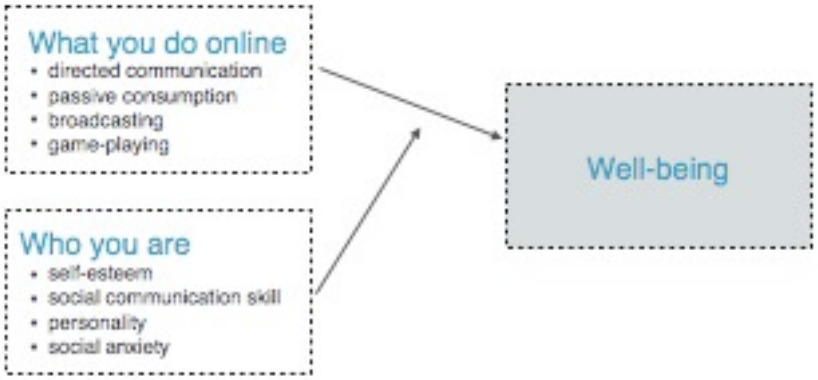
And you can imagine many other individual differences in users.

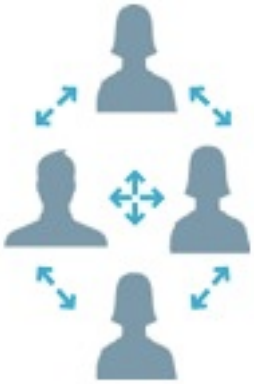
Not hard to picture how these differences affect both what you do online, and the effect it has on you. (Ask why . . . what kinds of differences might you expect based on self-esteem and



39

Bonding social capital

Emotional and tangible support from close friends



1. There are several people I trust to help solve my problems.
2. There is someone I can turn to for advice about making very important decisions.
3. There is no one that I feel comfortable talking to about intimate personal problems.
4. When I feel lonely, there are several people I can talk to.
5. If I needed an emergency loan of $500, I know someone I can turn to.

Williams, 2006

40

40

Bridging social capital

Access to new information through diverse ties

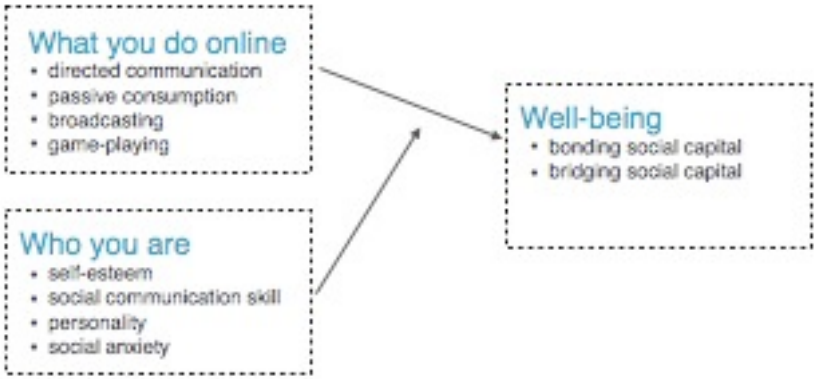
1. Interacting with people makes me interested in what people unlike me are thinking.
2. Interacting with people makes me feel like part of a larger community.
3. I come in contact with new people all the time.
4. I interact with people from different racial or ethnic backgrounds.
5. Based on the people I interact with, it is easy for me to hear about new job opportunities.

Williams, 2006

41

41

Why this is important: your closest friends tend to know the same things you do.



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43

Method

Surveys + server logs

Survey of 415 English-speaking, adult Facebook users around the world recruited through Facebook ad.

Surveyed users 8 months apart (July 2009, March 2010).

Paired responses with activity data from server logs (2 months prior to second survey).

44

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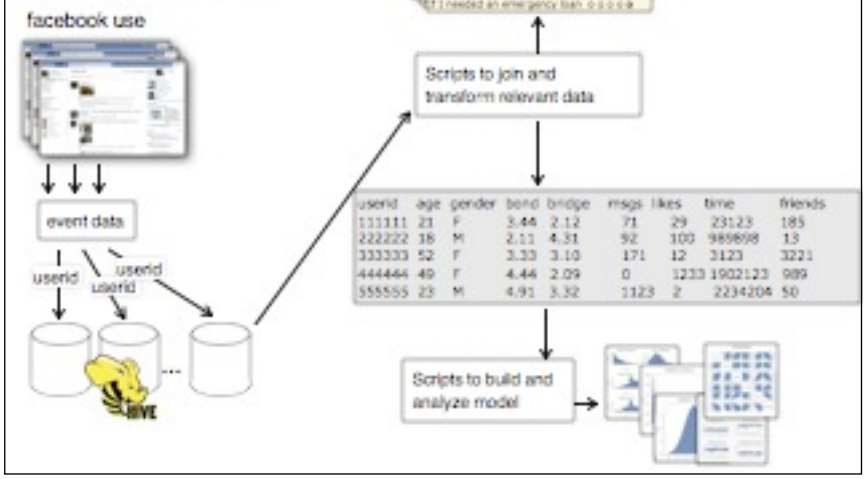
Data pipeline

Surveys + server logs



userid	age	gender	bond	bridge	msgs	likes	time	friends
111111	21	F	3.44	2.12	71	29	23123	185
222222	18	M	2.11	4.31	92	100	989898	13
333333	52	F	3.33	3.10	171	12	3123	3221
444444	49	F	4.44	2.09	0	1233	1902123	989
555555	23	M	4.91	3.32	1123	2	2234204	50

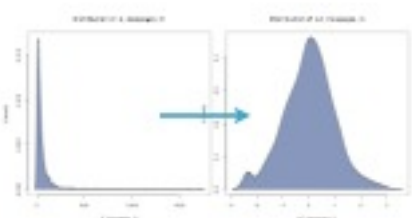
Activity data

Transformations

Logged (base 2) and standardized all activity variables

$$x' = \log_2 (x + \epsilon)$$

$$z = \frac{x' - \mu'}{\sigma'}$$



	Median	Mean	SD
Age	34.0	35.2	13.9
Gender	63% female		
Friend count	171.0	241.2	288.4
Time on site (hours/day)	1.3	1.8	1.9
Directed communication scale (in) (α = 0.90)			
Distinct friends who initiated communication	41.0	53.1	47.3
Comments received	66.0	130.2	199.7
Messages received	30.0	70.8	147.8
Wall posts received	10.0	18.3	24.8
"Likes" received	29.0	61.5	116.7
Tags in photos	5.0	14.1	29.6
Directed communication scale (out) (α = 0.88)			
Distinct friends user communicated with	56.0	72.8	62.4
Comments written	127.0	232.2	344.8
Messages sent	34.0	92.3	226.2
Wall posts written	13.0	24.4	33.0
"Likes" given	34.0	93.6	231.3
Times tagged friends in photos	1.0	25.4	77.1
Passive consumption scale (α = 0.93)			
Times reloaded feed	773.0	1281.6	1577.2
Stories clicked in feed	179.0	341.1	498.3
Friends whose feed stories user clicked	65.0	101.2	109.9
Distinct photos viewed	4.0	11.5	20.5
Distinct profiles viewed	140.0	211.5	275.6
Broadcasting scale (α = 0.63)			
Status updates	24.0	41.3	58.6
Notes written	0.0	0.2	0.6
Photos shared	3.0	7.0	15.5
Application stories posted to own wall	17.0	126.0	352.5
Other items posted to own wall	2.0	10.6	28.0

Table 1. Participant demographics and activities over two-month period and aggregate scales.

Activity data

Transformations

To avoid multicollinearity:

Combined theoretically similar variables into scales (by taking mean of component z-scores).

- Directed communication (in)
- Directed communication (out)
- Passive consumption
- Broadcasting

Good Cronbach's alpha for each scale.

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Table 1. Participant demographics and activities over two-month period and aggregate scales.

Survey data

Calculated scores from survey responses for:

Well-being measures	# items	Cronbach's alpha	Mean (½)
Bridging social capital	10	0.86	3.8
Bonding social capital	5	0.75	3.7
Individual differences measures			
Self-esteem	7	0.87	3.9
Social communication skill	10	0.63	7.9 (out of 10)

	Strongly agree	Agree	Neither	Disagree	Strongly disagree
There are several people I trust to help solve my problems.	O	O	O	O	O
There is someone I can turn to for advice about making very important decisions.	O	O	O	O	O
If I needed a very large emergency loan, I know someone I can turn to.	O	O	O	O	O
The people I interact with would be good job references for me.	O	O	O	O	O
I do not know people well enough to get them to do anything important. (R)	O	O	O	O	O

49

49

Lagged dependent variable regression

Measuring change over time

$$Y_t = \alpha Y_{t-1} + \beta_1 X_{1t} + \beta_2 X_{2t} + ... + \beta_n X_{nt} + \epsilon$$

$$\begin{aligned} Bridging_t = \alpha Bridging_{t-1} \\ +\beta_1 DirectedCommIn_t \\ +\beta_2 PasiveConsumption_t \\ +\beta_3 Broadcasting_t + \epsilon_t \end{aligned}$$

50

50

Reverse-causation model (testing whether current levels of directed communication are predicted by lagged communication and lagged bridging social capital)

Base model: time-on-site

Treating all time the same gives mediocre results

Bridging social capital

	β	SE
Intercept	3.86 ***	0.03
Bridging social capital (lagged)	0.47 ***	0.04
Age	0	0
Male	-0.17 ***	0.05
Major life changes		
Moved	0.14	0.09
Lost job	-0.34 **	0.11
Site activities		
Time on Facebook	0.05 .	0.03

*** $p < .001$ ** $p < .01$ * $p < .05$. $p < .10$

51

51

Base model: time-on-site

Treating all time the same gives mediocre results

Bridging social capital

	β	SE
Intercept	3.86 ***	0.03
Bridging social capital (lagged)	0.47 ***	0.04
Age	0	0
Male	-0.17 ***	0.05
Major life changes		
Moved	0.14	0.09
Lost job	-0.34 **	0.11
Site activities		
Time on Facebook	0.05 .	0.03

*** $p < .001$ ** $p < .01$ * $p < .05$. $p < .10$

52

52

The intercept represents an average woman receiving the mean inbound directed communication (approximately 150
comments, “likes,” wall posts, messages, and photo tags per month). She would have a

Base model: time-on-site

Treating all time the same gives mediocre results

Bridging social capital

	β	SE
Intercept	3.86 ***	0.03
Bridging social capital (lagged)	0.47 ***	0.04
Age	0	0
Male	-0.17 ***	0.05
Major life changes		
Moved	0.14	0.09
Lost job	-0.34 **	0.11
Site activities		
Time on Facebook	0.05 .	0.03

*** $p < .001$ ** $p < .01$ * $p < .05$. $p < .10$

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Treating all time the same gives mediocre results

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Site activities		
Time on Facebook	0.05 .	0.03

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Bridging social capital (lagged)	0.47 ***	0.04
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Major life changes		
Moved	0.14	0.09
Lost job	-0.34 **	0.11
Site activities		
Time on Facebook	0.05 .	0.03

*** $p < .001$ ** $p < .01$ * $p < .05$. $p < .10$

Base model: time-on-site

Treating all time the same gives mediocre results

Bridging social capital

	β	SE
Intercept	3.86 ***	0.03
Bridging social capital (lagged)	0.47 ***	0.04
Age	0	0
Male	-0.17 ***	0.05
Major life changes		
Moved	0.14	0.09
Lost job	-0.34 **	0.11
Site activities		
Time on Facebook	0.05 .	0.03

*** $p < .001$ ** $p < .01$ * $p < .05$. $p < .10$

Main effects: Facebook activities

Bridging social capital

	β	SE
Intercept	3.86 ***	0.03
Bridging social capital (lagged)	0.45 ***	0.04
Age	0	0
Male	-0.17 **	0.06
Major life changes		
Moved	0.14	0.09
Lost job	-0.32 **	0.11
Site activities		
Time on Facebook	-0.05	0.04
Directed communication (in)	0.14 **	0.05
Passive consumption	0.05	0.04
Broadcasting	-0.02	0.06

*** $p < .001$ ** $p < .01$ * $p < .05$. $p < .10$

57

For every doubling of that inbound communication, her bridging social capital would increase by .14 points. This is comparable to the social capital increase felt by people who moved to a new city between

Interaction effects: Activities x communication skill

Bridging social capital

	β	SE
Intercept	3.85 ***	0.03
Bridging social capital (lagged)	0.41 ***	0.04
Age	0	0
Male	-0.14 **	0.05
Major life changes		
Moved	0.12	0.08
Lost job	-0.25 *	0.11
Site activities		
Time on Facebook	-0.04	0.04
Directed communication (in)	0.12 **	0.05
Passive consumption	0.04	0.04
Broadcasting	0.01	0.06
Individual differences		
Communication skill	0.08 **	0.03
Comm skill x Directed communication (in)	-0.07 *	0.03
Comm skill x Passive consumption	-0.07 *	0.03
Comm skill x Broadcasting	0.00	0.04

*** $p < .001$ ** $p < .01$ * $p < .05$. $p < .10$

58

Interaction effects: Activities x communication skill

Bridging social capital

	β	SE
Intercept	3.85 ***	0.03
Bridging social capital (lagged)	0.41 ***	0.04
Age	0	0
Male	-0.14 **	0.05
Major life changes		
Moved	0.12	0.08
Lost job	-0.25 *	0.11
Site activities		
Time on Facebook	-0.04	0.04
Directed communication (in)	0.12 **	0.05
Passive consumption	0.04	0.04
Broadcasting	0.01	0.06
Individual differences		
Communication skill	0.08 **	0.03
Comm skill x Directed communication (in)	-0.07 *	0.03
Comm skill x Passive consumption	-0.07 *	0.03
Comm skill x Broadcasting	0.00	0.04

*** p < .001, ** p < .01, * p < .05, . p < .10

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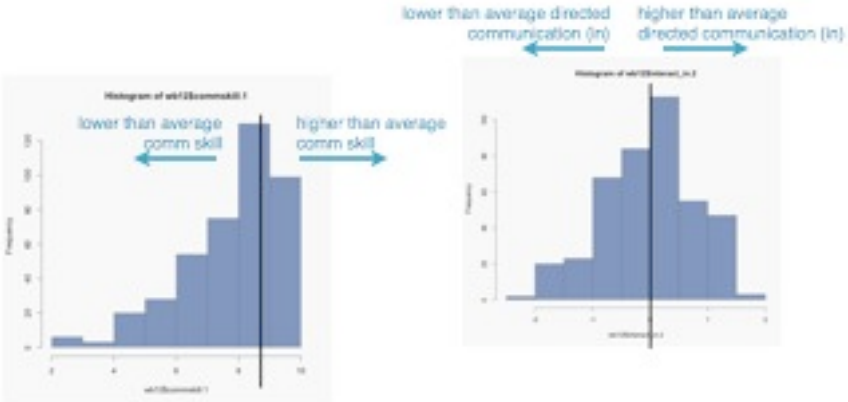
Interaction effects: Activities x communication skill

Using median splits



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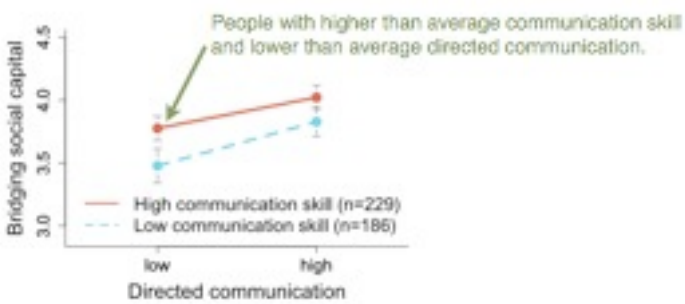
Interaction effects: Activities x communication skill

Using median splits

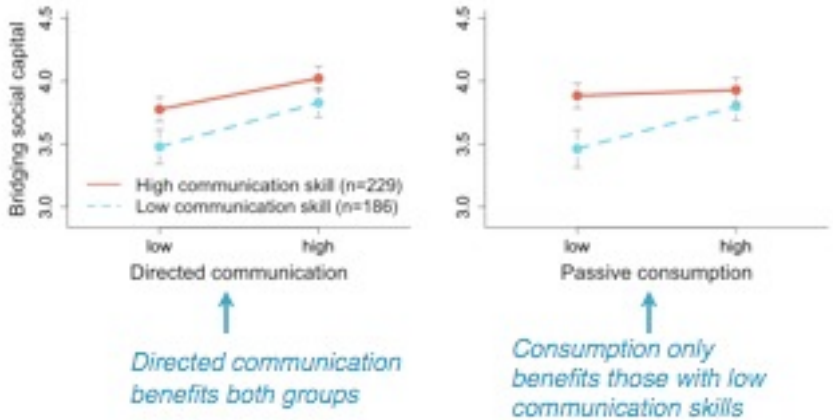
Interaction effects: Activities x communication skill

Using median splits



Interaction effects: Activities x communication skill

Using median splits



Directed communication benefits both groups

Consumption only benefits those with low communication skills

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And if you do the same chart for broadcasting, the two lines are essentially parallel and flat.

Very conservative plots (median splits)

Any differences in site activities?

Based on individual differences in communication skill / self-esteem

Generally, no. No differences in time on site, amount of passive consumption, broadcasting.

Exceptions:

	+1 SD increase is associated with:
Self esteem X number of friends	19 friends
Communication skill x number of friends	25 friends
Communication skill x outbound directed communication	150 message
Communication skill x inbound directed communication	90 messages

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Bonding social capital

Emotional and tangible support from close friends

Controlling for previous levels of bonding social capital, different Facebook activities had no effect on current bonding social capital.

Cross-sectional results show higher FB use correlated with higher bonding social capital.

65

65

Why might that be?

Summary of results

- *Receiving* personal, directed messages increases bridging social capital. *Sending* them does not.
- Passive *consumption* of social news increases bridging social capital only for those with *lower communication skill* and *lower self-esteem.*
- *Broadcasting* has no effect on bridging social capital.
- No evidence that any kind of Facebook use affects *bonding* social capital.
- Communication skill and self-esteem have little effect on what people do on Facebook (except for small differences in # of friends and # of messages sent/received)

66

66

Using causal language, but with hedge. Why results?
* Need more than just a “friend” link. To be able to receive benefits from that relationship, need to have active communication open with someone.

Limitations

- Sample of people who responded to an ad on Facebook and were willing to take multiple rounds of a survey.
- Still not causal explanations.
- Ignoring the content of messages/posts/comments.
- Ignoring the quality of the tie (close friend? professional superior? family member?)
- Ignores underlying network structure

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– But still better than the convenience sample of undergrads commonly used.
– But ask about major life events. And using lagged model accounts for a lot of other explanations.

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Predicting tie strength with social media

Eric Gilbert and Karrie Karahalios

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TIE STRENGTH
concept & impact

The strength of a tie is a (probably linear) combination of the amount of TIME, the emotional INTENSITY, the INTIMACY (mutual confiding), and the reciprocal SERVICES which characterize the tie. — **Granovetter**

STRONG TIES are the people you really trust.

WEAK TIES, conversely, are merely acquaintances.

Slides: http://social.cs.uiuc.edu/people/gilbert/docs/gilbert-chi09-talk.pdf

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TIE STRENGTH
concept & impact

7,000+ papers cite TSOWT

firms with right mix of ties get better deals

strong ties can affect mental health

71

TIE STRENGTH
dimensions

AT WHAT POINT is a tie to be considered weak? … Do all four indicators count equally toward tie strength? — *D. Krackhardt*

GRANOVETTER'S intensity, intimacy, duration & services

WELLMAN'S emotional support

LIN'S social distance

BURT'S structural

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THE MAPPING PROBLEM

73

RESEARCH QUESTIONS

R1. The literature suggests seven dimensions of tie strength: **INTENSITY, INTIMACY, DURATION, RECIPROCAL SERVICES, STRUCTURAL, EMOTIONAL SUPPORT** and **SOCIAL DISTANCE.**

As manifested in social media, can these dimensions predict tie strength? In what combination?

R2. What are the limitations of a tie strength model based **SOLELY** on social media?

74

THE DATA
overview

2,184 assessed friendships

from **35** university students & staff

described by **70+** numeric indicators

75

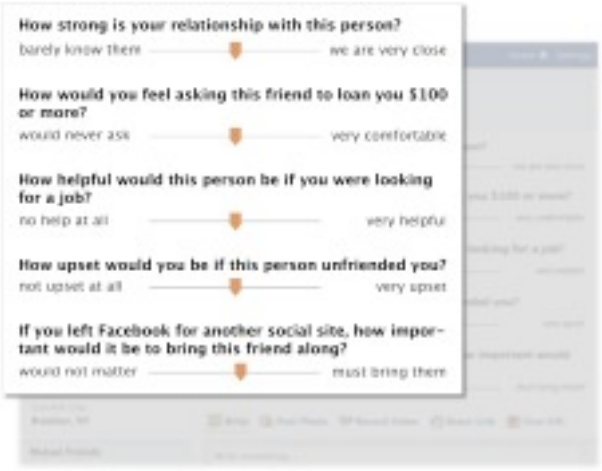
DATA COLLECTION
methodology

&

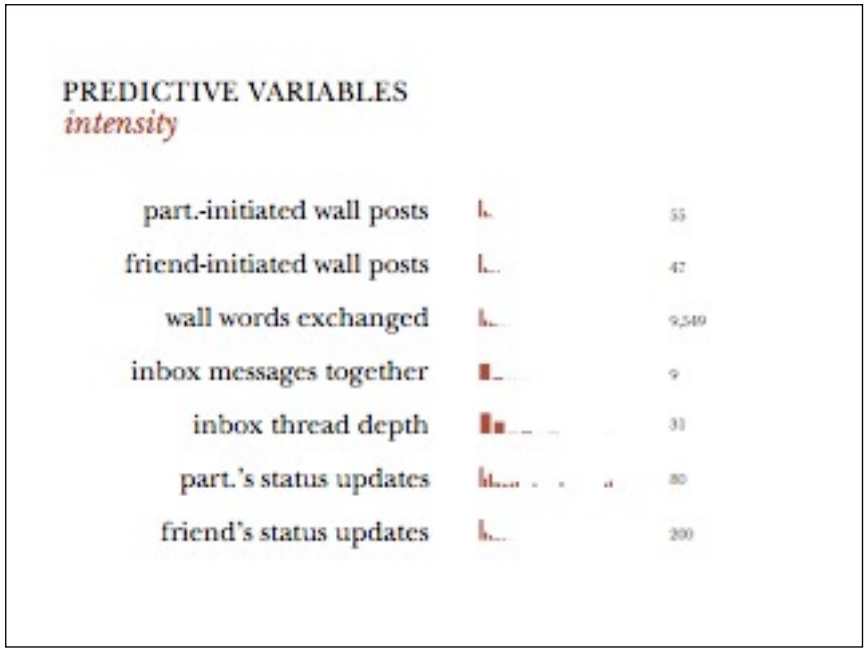
76

ASSESSING TIE STRENGTH
participant interface

ASSESSING TIE STRENGTH
participant interface



Number on the right is the max.



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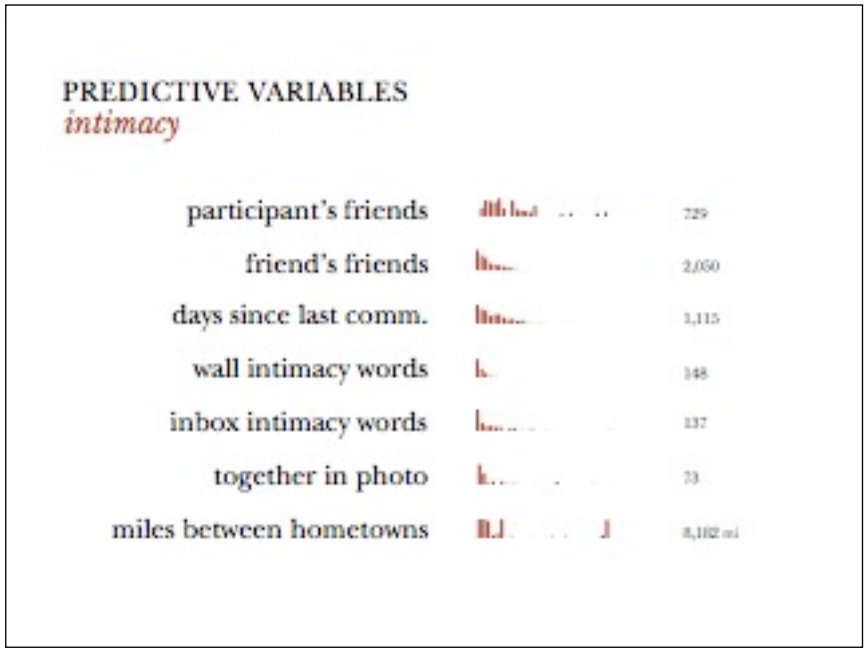

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PREDICTIVE VARIABLES
intimacy

Counted "intimacy" words using Linguistic Inquiry and Word Count (LIWC). http://www.liwc.net

Dictionaries: Family, Friends, Home, Sexual, Swears, Work, Leisure, Money, Body, Religion and Health.

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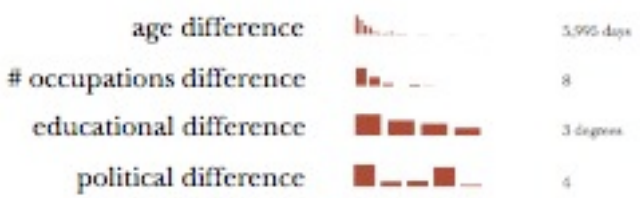
PREDICTIVE VARIABLES
social distance



82

PREDICTIVE VARIABLES
structural

mutual friends		206
groups in common		12
tf-idf of interests & about		73

83

PREDICTIVE VARIABLES
reciprocal services

links exchanged by wall		688
applications in common		18

emotional support

positive emotion words		197
negative emotion words		51

84

PREDICTIVE VARIABLES
duration

days since first comm.

85

STATISTICAL METHODS

$$s_i = \alpha + \beta R_i + \gamma D_i + N(i) + \epsilon_i$$

s_i = tie strength of ith friend

R_i = vector of 67 predictive variables

D_i = pairwise interactions between 13 variables with 90% or higher completion rate

86

s(i) is tie strength with i-th friend. Linear combination of:

- R(i) = 67 predictive variables
- D(i) = pairwise interactions between the 13 variables with a 90%+ completion rate

Note that they also log-transform all of their variables.

STATISTICAL METHODS

$$s_i = \alpha + \beta R_i + \gamma D_i + N(i) + \epsilon_i$$

$$N(i) = \lambda_0 \mu_M + \lambda_1 med_M + \sum_{k=2}^{4} \sum_{s \in M} \lambda_k (s - \mu_M)^k + \lambda_5 min_M + \lambda_6 max_M$$

$$M = \{s_j : j \text{ and } i \text{ are mutual friends}\}$$

N(i) encodes network structure. Do a bunch of calculations over your mutual friends:
- mean tie strength
- median tie strength
- min / max tie strength
- variance, kurtosis, and skew (diff from mean squared, raised to the 3rd, and 4th, respectively)

To compute, use iterative variation of OLS, starting with tie strengths of 0, and then substituting in the calculated tie strength from the previous iteration. Converges in 9 steps.

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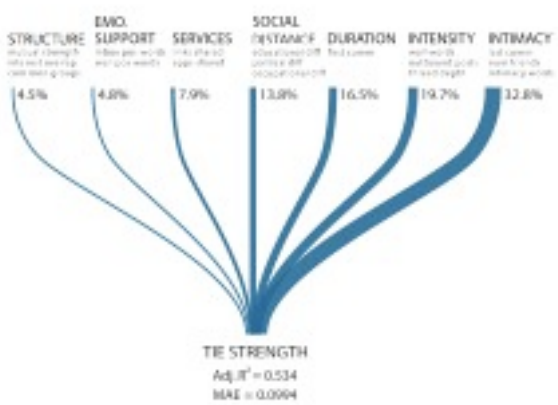
THE MODEL
structure & performance



Top three most predictive variables for each dimension. Note that on its own, the structural dimension doesn't account for much. But we'll see that it's important with interactions with other dimensions. (Individual relationships matter, but they get filtered through a friend's clique before impacting tie strength.)

MAE means that the model will predict the true value within 1/10th of it's actual value. So, if you had a 10-pt "how close" scale, the model would miss it by at most, one point.

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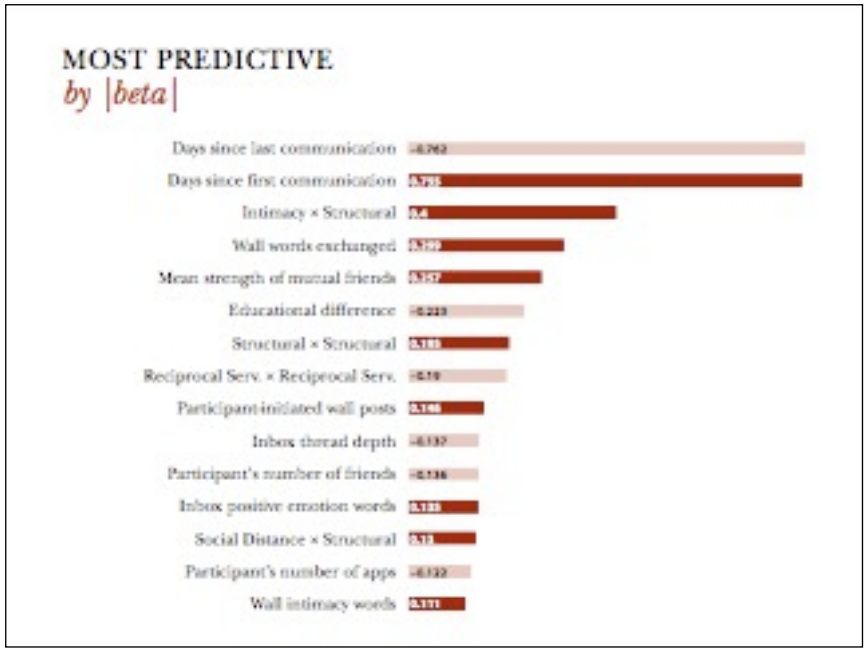
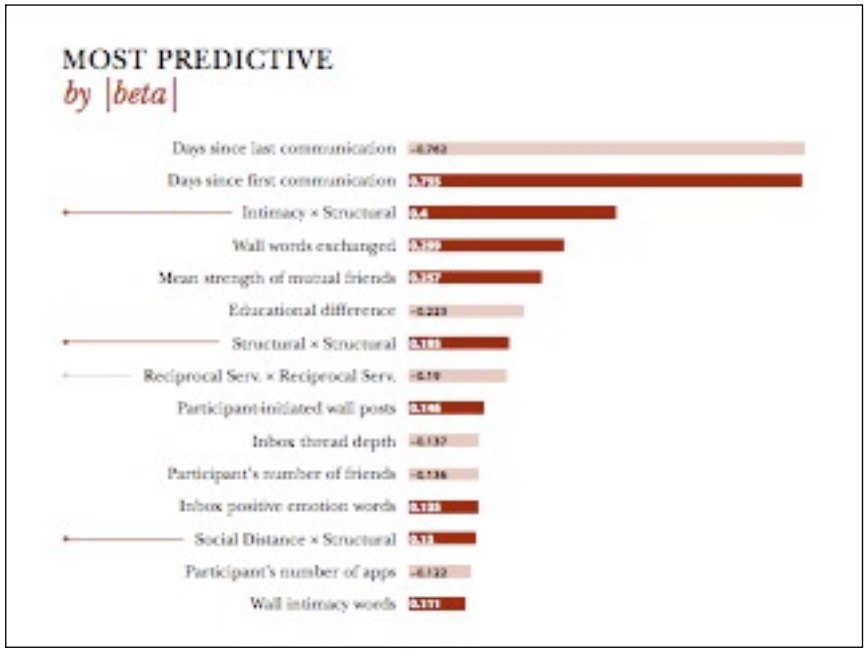


Coefficients on the first two variables are much larger than the others: it's because there are many people who you never communicate with on FB. Really, the act of communicating with someone even once has a huge relationship with tie strength.

89



Intimacy x structural: Positive main effects for intimacy and having mutual friends. But effect of intimacy is even greater when you have strong ties with mutual friends. (Nonlinear relationships.)

Structural x structural -- indicating a nonlinear relationship (e.g., whatever the main effect of having a network of mutual strong ties, the rate of predictiveness grows as tie strength grows)

Help interpreting Soc distance x Structural (backwards?) -- you can be far away socially

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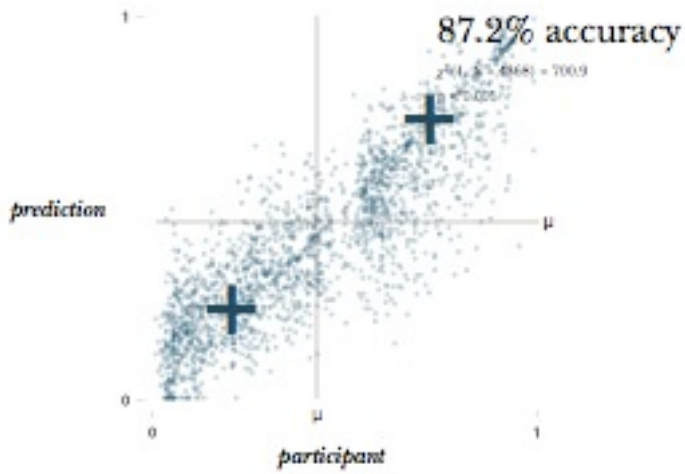
THE MODEL
details



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certainly not the only way,
perhaps not even the best way,
to segment friends

LIMITATIONS
high residuals

> *Ah yes. This friend is an old ex. We haven't really spoken to each other in about 6 years, but we ended up friending each other on Facebook when I first joined. But he's still important to me. We were best friends for seven years before we dated. So I rated it where I did (I was actually even thinking of rating it higher) because I am optimistically hoping we'll recover some of our "best friend"-ness after a while. Hasn't happened yet, though.*

error: −0.5

92

LIMITATIONS
high residuals

> *We were neighbors for a few years. I babysat her child multiple times. She comes over for parties. I'm pissed off at her right now, but it's still 0.8. ;) Her little son, now 3, also has an account on Facebook. We usually communicate with each other on Facebook* ***via her son's account****. This is our "1 mutual friend."*
>
> **error: –0.5**

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IMPLICATIONS
for theory

① Social network analyses of large-scale phenemona
② Weights on dimensions & importance of structure
③ Is there an upper bound? Do important things get left out?

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IMPLICATIONS
for practice

MODEL TIE STRENGTH TO...

① prioritize activity updates.

② broadcast especially novel information.

③ make better friend introductions.

④ build more informed privacy controls.

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CONTRIBUTIONS
of our work

A MODEL of tie strength

SPECIFIC WEIGHTS on tie strength's dimensions

THE ROLE OF STRUCTURE in modulating tie strength

96

- Ignores other communication channels
- Cannot ipsatize (normalize for participant bias)

Limitations

- Ignores other communication channels
- Cannot ipsatize (normalize for participant bias) because don't have strongest ties (random selection)
- Does not take other dimensions of relationships into account (e.g., professional colleague, high-school crush, little brother)
- Lacks "behind the scenes" data (who-friended-whom, page views)
- Typical participant selection bias (college students)

97

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Also doesn't include co-attendance at parties, one of the few indicators of offline interaction (in addition to co-tagging in photos).

Putting them together

Modeling ties and individual well-being

98

Ask people to select some of their closest friends. Means we can ipsatize their survey responses. (But ignores close ties that aren't on FB.)

99

Take the set of close friends they selected, and add a few randomly-selected ones.

100

Then ask similar questions to Gilbert & Karahalios. But this time, ask about communication offline, and the kind of tie this is (classes).

101

And then ask the typical battery of well-being questions, and individual different questions.

102

What this gets us

By combining methodologies

Models of tie strength and type:

- Improve baseline models with "behind-the-scenes" variables including page views, who friended whom, when friendship began on site
- Correlations between communication on Facebook and other channels
- Predictive features to distinguish friends who communicate through other channels but not often on FB
- Models of different classes of friends
- Features predicting changes in tie strength over time

Models of well-being:

- Three way interactions between:
  - Who you are
  - What you do online
  - Whom you do it with
- How is well-being affected by direct, one-on-one interaction with weak ties? By passively consuming news of strong ties?
- How composition of your network (how many strong/weak ties, and of what categories) relates to overall well-being

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