# Psychological aspects of social communities

R. Lambiotte
Department of Mathematics
University of Namur, Belgium

*Multi-relational Organization of Large-scale Social Networks in an Online World*, M. Szell, R. Lambiotte and S. Thurner, PNAS, 107 13636-13641 (2010)

*The Personality of Popular Facebook Users*, D. Quercia, R. Lambiotte, M. Kosinski, D. Stillwell and J. Crowcroft, ACM CSCW (2012)

*Psychological Aspects of Social Communities*, A. Friggeri, R. Lambiotte, M. Kosinski and E. Fleury, SocialCom 2012

naxys
Namur Center for Complex Systems

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## Welcome

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**We are partners of the project**

***Sci-App: Mobile Apps for Science: http://sci-app.com/***

**we are proud to announce our iOS app *LateForGood***


**by Vsevolod Salnikov**

### NEXT NAXYS SEMINARS

**Phillipe Rodrigues Sampaio (naXys, University of Namur)**
*"Constrained derivative-free optimization"*

**Wednesday the 17th December 13h00** (*Attention this is not the usual day*)

Conference room 2nd floor, Dep. Mathematics.

Info T. Carletti Tél : +32 81724903

**Abstract.** (here)

### EDT MATH & COMPLEX

networks and medical imaging

**Thursday 29th and Friday 30th November** 2012, room E25 2nd floor Department of Mathematics.

Dynamical systems - Networks - Optimization

Biology - Social systems -Economics

Interuniversity Attraction Poles
Phase VII/19
2012 - 2017

"Dynamical systems, control and optimization"
DYSCO

Belgian Science Policy Office
belspo

# Computational social science

Small-scale questionnaire-based approaches

Fingerprints of individuals in electronic media (offline: mobile phone, or online: email, Facebook, etc.)
+ Large-scale experiments in online media

Possibility to analyse the dynamics and organisation of large-scale social systems

D. Lazer, A. Pentland, L. Adamic, S. Aral, A.-L. Barabási, D. Brewer, N. Christakis, N. Contractor, J. Fowler, M. Gutmann, T. Jebara, G. King, M. Macy, D. Roy, M. Van Alstyne, Science 323, 721-724 (2009).

# Computational social science

Small-scale questionnaire-based approaches

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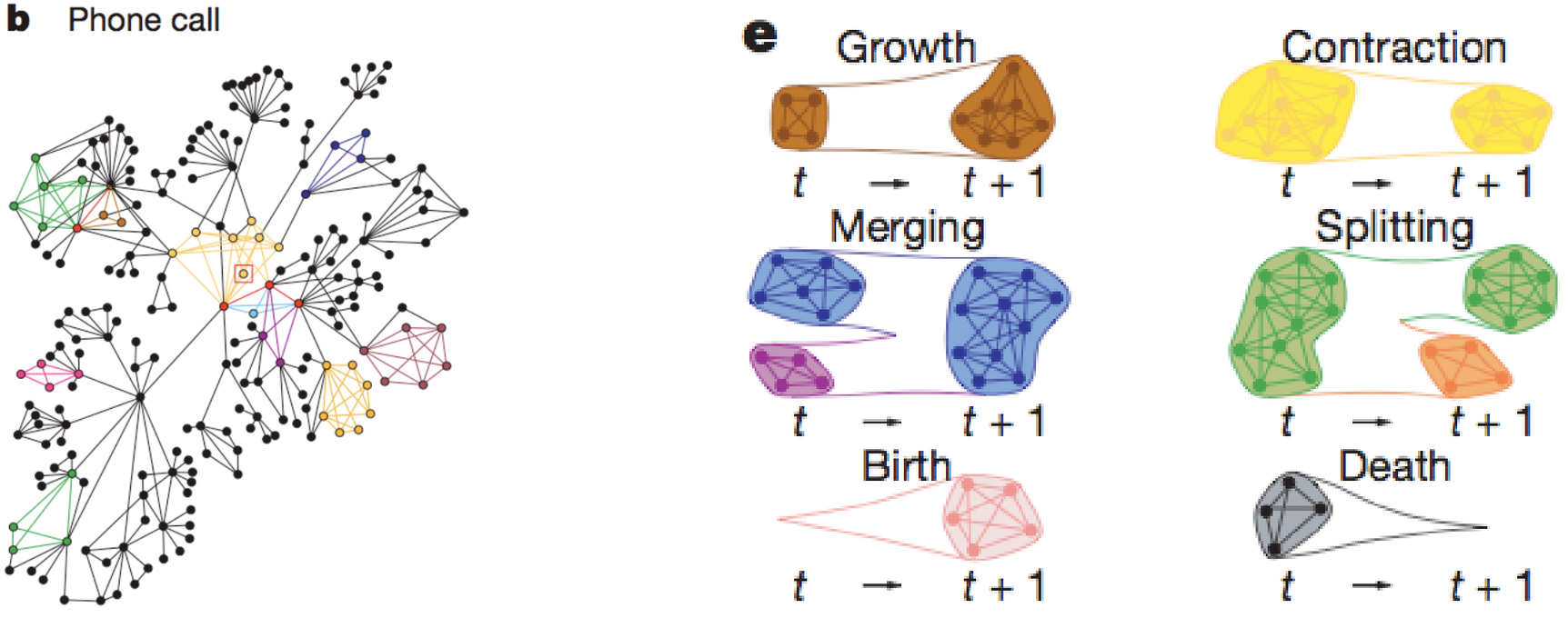
Fingerprints of individuals in electronic media (mobile phone, email, Facebook, etc.)

Longitudinal data-sets: quantification of the time evolution of social interactions




G. Palla, A.-L. Barabási, T. Vicsek, Nature 446:7136, 664-667 (2007)

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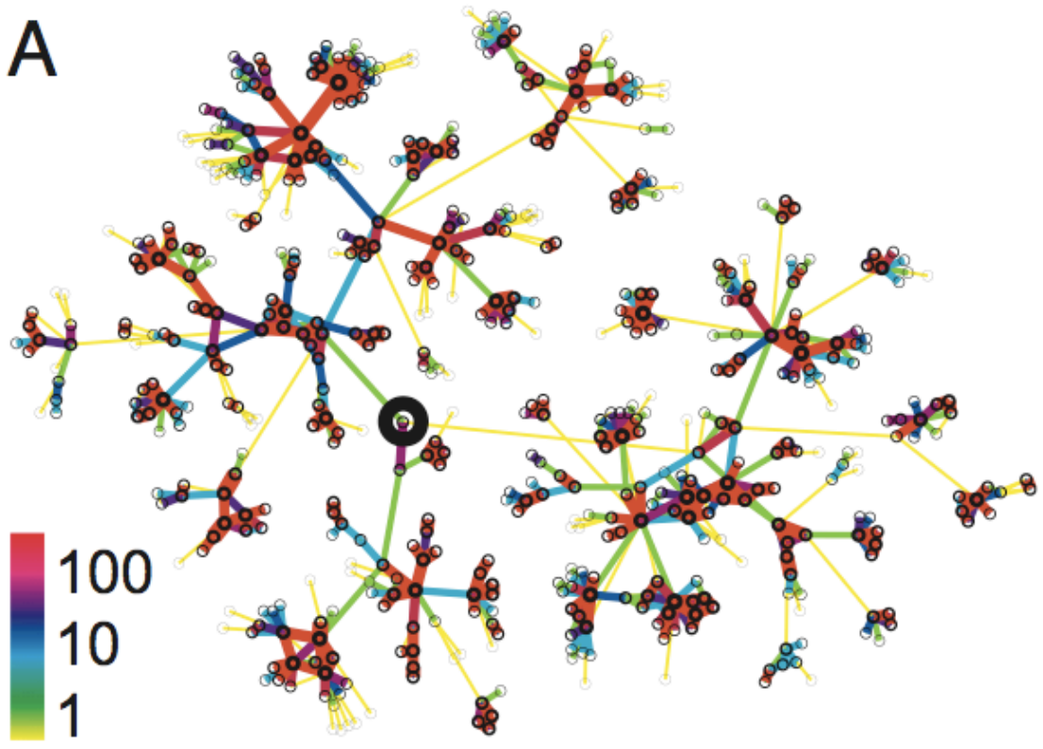
Weighted networks as a measure of the intensity of a tie




J.-P. Onnela, J. Saramaki, J. Hyvonen, G. Szabo, D. Lazer, K. Kaski, J. Kertesz, A.-L. Barabási, PNAS 104 (18), 7332-7336 (2007).

# Computational social science

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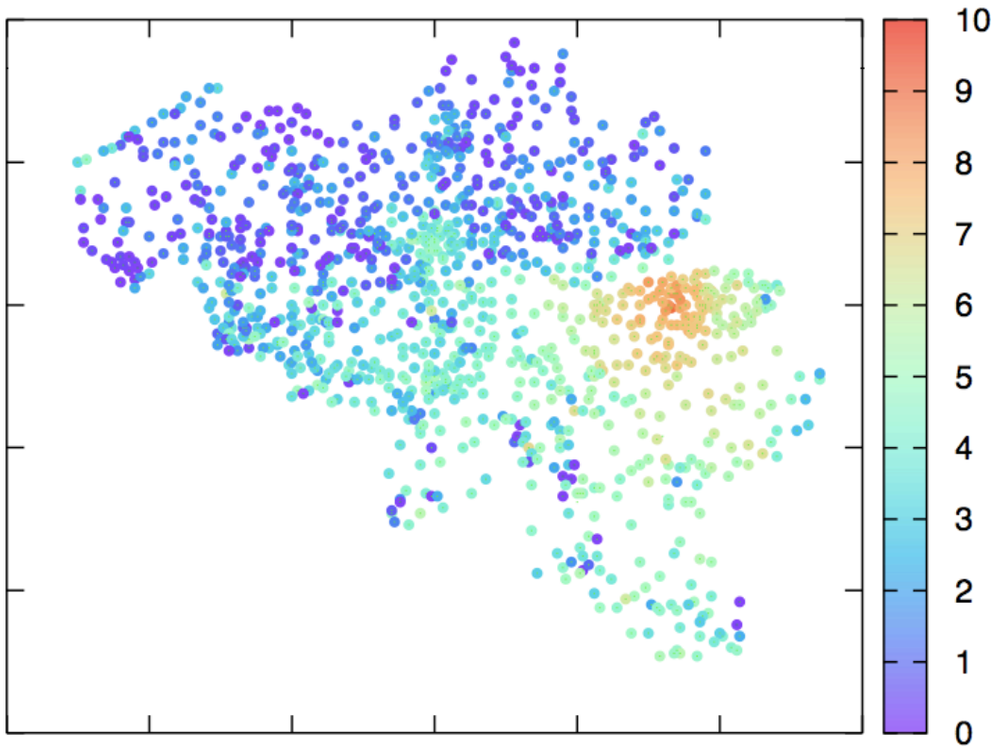
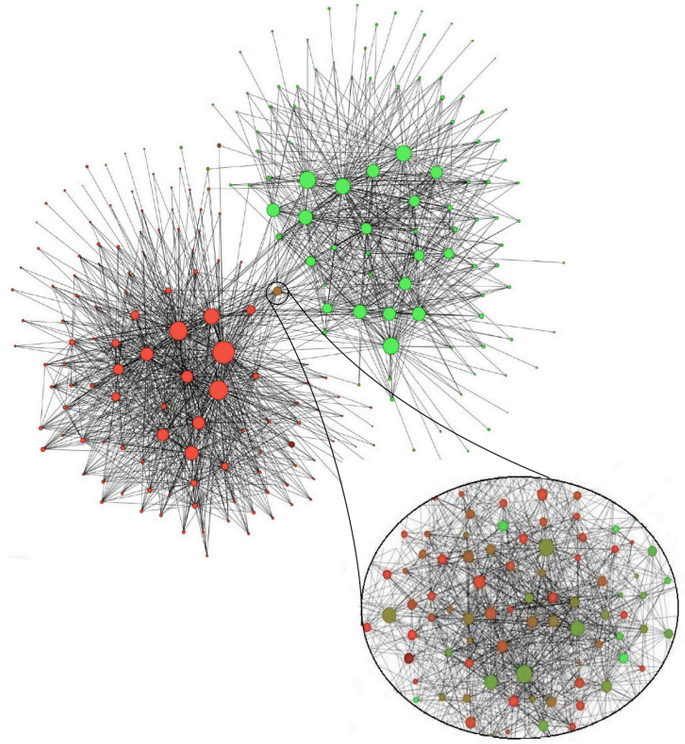
Node attributes: homophily and focus constraint



R. Lambiotte, V.D. Blondel, C. de Kerchove, E. Huens, C. Prieur, Z. Smoreda and P. Van Dooren, Physica A, 387 (2008) 5317
V.D. Blondel, J.-L. Guillaume, R. Lambiotte and E. Lefebvre, J. Stat. Mech., (2008) P10008

# Computational social science

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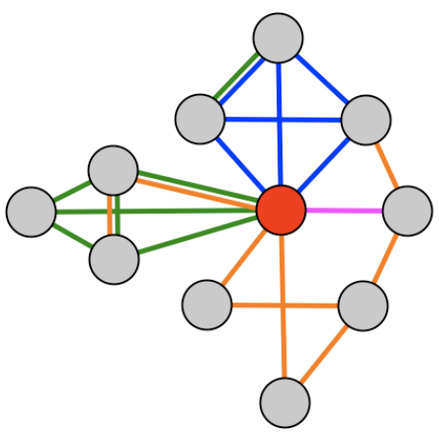
Fingerprints of individuals in electronic media (offline: mobile phone, or online: email, Facebook, etc.)
+ Large-scale experiments in online media

Possibility to analyse the dynamics and organisation of large-scale social systems

**... but still a caricature of real-life social systems**

Nature of the social relations?



Poor understanding of the nature of the agents

Despite our knowledge of some attributes, what about their personnality?
Possibility to capture their intrinsic differences? Their tendency to react differently to the same cause?

# Plethora of new services

Interweaving the social and the physical world
Offering more and more refined data about individuals and their interactions

myrimis
Real-life locations on earth

facebook

Gowalla

bliin YourLIVE!

skobbler

SOCIALIGHT

PLAZES
Right Plaze, Right People, Right Time

LIGHTPOLE

ipoki

blummi!.com
... rave your day.

DOPPLR

loopt

foursquare

twitter

Rummble

wenear

groovr

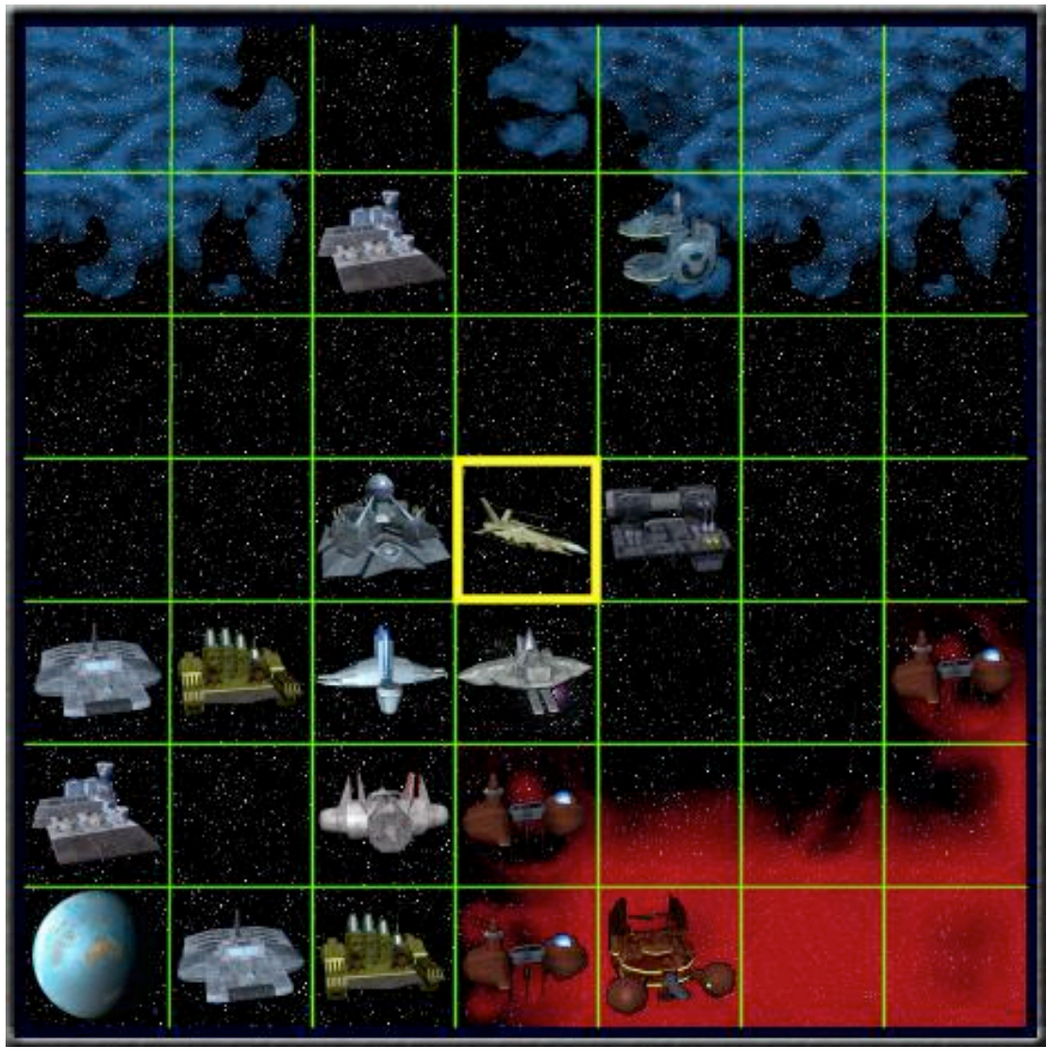
Microsoft Vine

# Nature of social relations: Massive Online Games

Players are immersed in a virtual world where they experience an *alternative* life with a variety of possible social interactions among players.

Motivation: establish friendships, gain respect and status in the virtual community.

All information about all actions taken by all players is stored in log-files



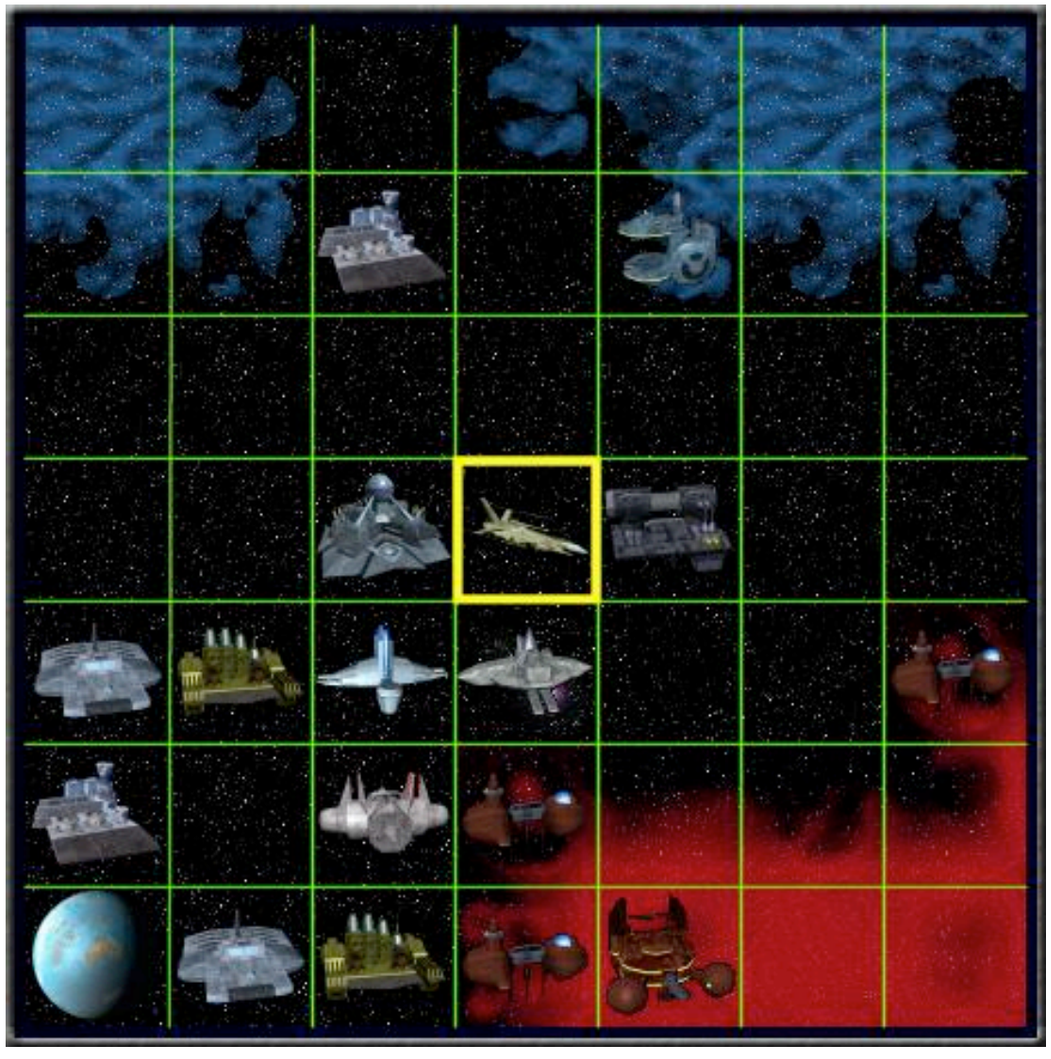
*Multi-relational Organization of Large-scale Social Networks in an Online World*, M. Szell, R. Lambiotte and S. Thurner, PNAS, 107 13636-13641 (2010)

# Massive Online Games

Pardus.at: Massive multiplayer browser game
330,000 registered, 13,000 active players
Played since 2004 (Free, optional 5$/ month)

Open-ended game (no winner)
Players self-organise within groups and subgroups, claim territories, decide to go to war, etc., completely on their own account.

Economic life: Trade, production
Social life: Chats, forums, private messages
Exploratory life: explore of an unknown universe



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# Massive Online Games

Multiplexity: 6 types of directed, one-to-one interactions

Communication network: personal messages (similar to email)

Trade network: exchange of money for commodity

Friendship network: players can mark others as friends. Only the marker and the marked player know this information

Attack network: attacks performed by one player on the spaceshift of another player

Bounty network: money promised for the destruction of a certain player

Enmity network: players can mark others as friends. Only the marker and the marked player know this information

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Attack network: attacks performed by one player on the spaceshift of another player

Bounty network: money promised for the destruction of a certain player

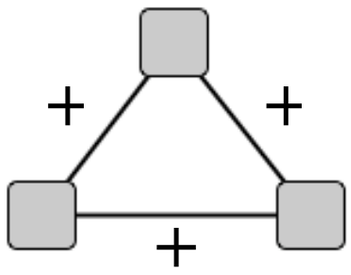
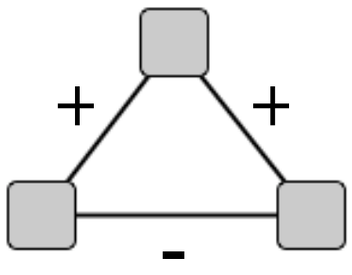
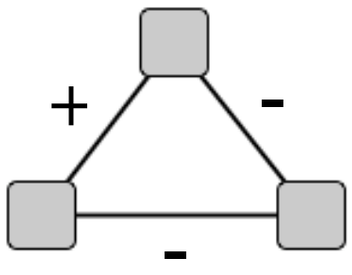
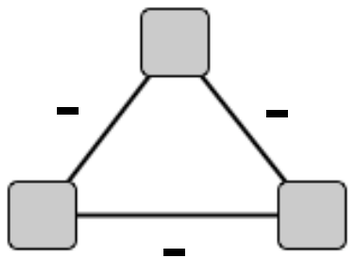
Enmity network: players can mark others as enemies. Only the marker and the marked player know this information


Static networks: Friendship and enmity networks are taken as snapshots at the last available day. All other networks are aggregated over time. For simplicity, we use unweighted, directed networks.
Undirected networks are also constructed: a link exist between i and j if there exists at least one directional edge between those nodes

# Empirical verification of structural balance

Some configurations of signed motifs are socially and psychologically more likely than others

Unbalanced triads are sources of stress and therefore tend to be avoided by actors when they adapt their personal relationships

| |  |  |  |  |
|---|---|---|---|---|
| Strong formulation of balance | B | U | B | U |
| Weak formulation of balance | B | U | B | B |
| $N_\Delta$ | 26,329 | 4,428 | 39,519 | 8,032 |
| $N_{\Delta,r}$ | 10,608 | 30,145 | 28,545 | 9,009 |
| $z$ | 71 | -112 | 47 | -5 |

Cartwright (after Heider)

Davis

*Predicting positive and negative links in online social networks*, J. Leskovec, D. Huttenlocher, J. Kleinberg, ACM WWW Int Conf on World Wide Web (2010)

*Multi-relational Organization of Large-scale Social Networks in an Online World*, M. Szell, R. Lambiotte and S. Thurner, PNAS, 107 13636-13641 (2010)

# Computational social science

... is often blind to the diversity in the personality of individuals

In data such as facebook, individuals are characterized by variables such as their age, sex, physical location, etc.
First step toward a characterization fo the heterogeneity across users.

Is it possible to use facebook to measure the personality of users and to understand its influence on their social behaviour?

# Measures of personality

The five-factor model of personality, or the big five, is the most comprehensive, reliable and useful set of personality concepts. The idea is that an individual can be associated with 5 scores that correspond to 5 main personality traits.

Personality traits predict a number of real-world behaviors. They, for example, are strong predictors of how marriages turn out: if one of the partner is high in Neuroticism, then divorce is more likely.

| Dimension | High scorers | Low scorers |
|---|---|---|
| **O**penness | Imaginative | Conventional |
| **C**onscientiousness | Organized | Spontaneous |
| **E**xtraversion | Outgoing | Solitary |
| **A**greeableness | Trusting | Competitive |
| **N**euroticism | Prone to stress and worry | Emotionally stable |

**Table 1: The big five personality dimensions.**

*The Revised NEO Personality Inventory*, P. Costa and R. Mccrae, SAGE Publications (2005)

# Influence of OCEAN on sociometric popularity

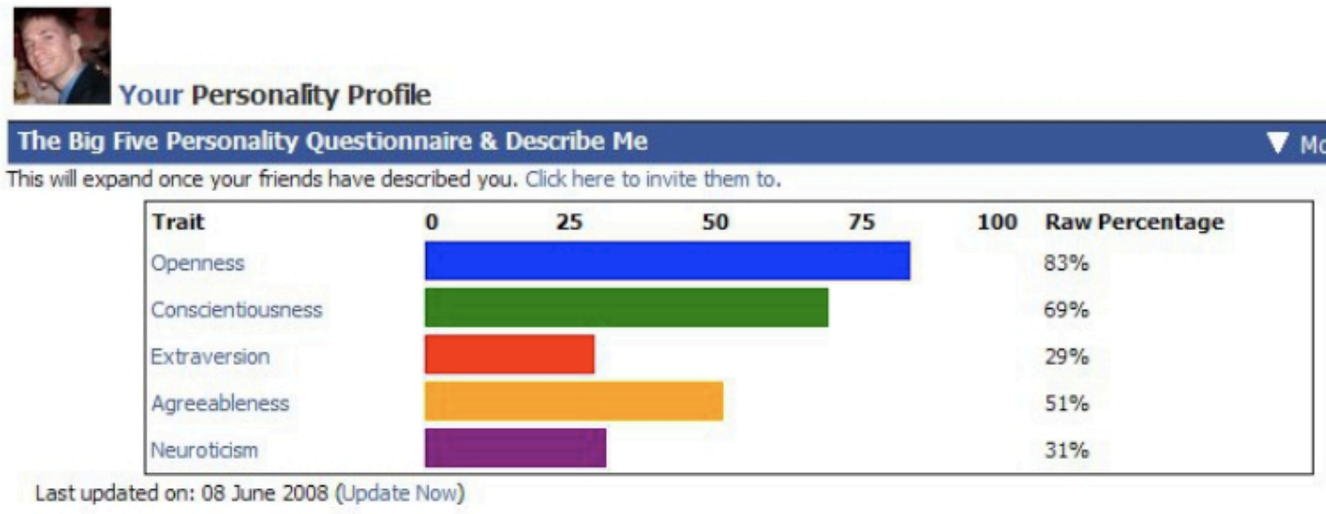
Numerous studies:
- The trait of Extraversion is the strongest predictor for the number of real-world friends. Extraversion has been shown to be consistently associated with structural measures of social support, including network size and contact with network members.
- Neuroticism has been associated with negative social interactions.
- Findings for the traits of Agreeableness, Conscientiousness and Openness are inconsistent.

But usual limitations of questionnaire-based studies: very small (poor statistics), biased samples (WEIRD, White, Educated, Industrialized, Rich, and Democratic)

*The Revised NEO Personality Inventory*, P. Costa and R. Mccrae, SAGE Publications (2005)

# Measuring OCEAN at a large-scale: myPersonality

- Facebook application: 5.5 million users
- Users can opt in and give their consent to share their profile information (40%)
- Right incentives: subjects are not paid nor receive college credits. myPersonality users are solely motivated by the prospect of receiving reliable feedback and test results that accurately describe their personalities.
- Unreliable results are removed. Numerous validity tests




- myPersonality is able to obtain test results that are more reliable than those in pen-and-paper studies.
- myPersonality users are far less biased than those studies' subjects for gender, age, and geography.
- VERY large scale data

# Influence of OCEAN on sociometric popularity

200k users with between 30 and 1000 Facebook friends and between 18 and 54.

Significant factors for predicting *log(k)*: linear regression

$$\log(k_i) = \alpha + \sum_{l=1}^{5} \beta_l R_{l;i} + \beta_S S_i + \beta_A A_i + \epsilon_i$$

| **Variables** | $\beta$ | **t-test** | $\beta$ | **t-test** |
|---|---|---|---|---|
| Openness | -0.031 | -12.6 | - | - |
| Conscientiousness | 0.004 | 1.5 | - | - |
| Extraversion | 0.174 | **79.7** | 0.171 | 79.8 |
| Agreeableness | 0.013 | 5.1 | - | - |
| Neuroticism | 0.005 | 2 | 0 | 0 |
| Sex | 0.005 | 1.4 | - | - |
| Age | -0.015 | **-64.5** | -0.014 | -64.7 |

# Psychology and ego-networks

Ego-network of person *John*: friends of *John* and connections between them (*John* does not belong to his ego-network).

Number of friends = size of the ego-network

=> Extraversion affects the size of ego-networks, but what about its shape?

In the social science, long tradition in analysing and theorising ego-networks, e.g. their connection to social capital: dense ego-networks favor trust and facilitate information flow // open ego-networks indicate bridging capital as individuals bridge structural holes between disconnected others.

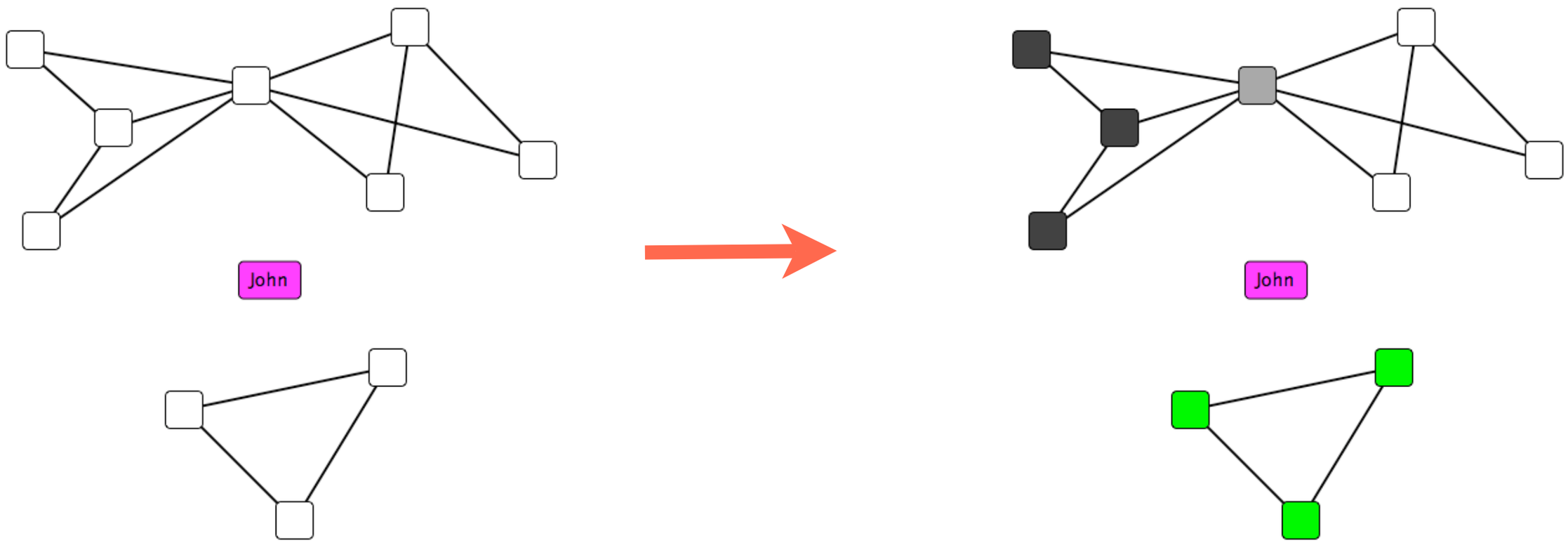
~ 50k users with number of friends comprised between 50 and 2000

PS: Local network analysis because of our very incomplete knowledge of the whole Facebook network (thousands vs billions)

*Psychological Aspects of Social Communities*, A. Friggeri, R. Lambiotte, M. Kosinski and E. Fleury, SocialCom (2012)

# From friends to communities

Organisation fo the ego-network into overlapping communities



# From friends to communities

Hundreds of methods to uncover communities, overlapping or not

We applied the so-called *C*$^3$ method where the quality of a community is defined by its *social cohesion*

$$\mathcal{C}(S) = \underbrace{\frac{\text{△}(S)}{\binom{|S|}{3}}}_{\text{transitivity}} \times \underbrace{\frac{\text{△}(S)}{\text{△}(S) + \text{⛀}(S)}}_{\text{isolation}}$$

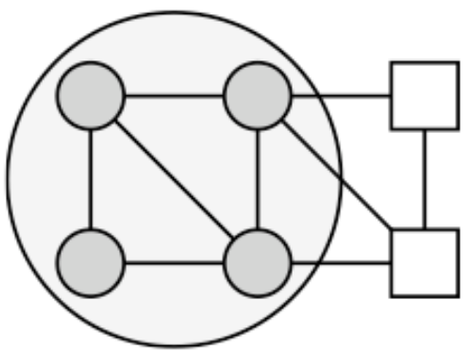


Fig. 3. In this example, the set of circle nodes contains 4 nodes, features 2 inbound triangles and only 1 outbound triangles, leading to a cohesion $\mathcal{C} = \frac{1}{3}$.

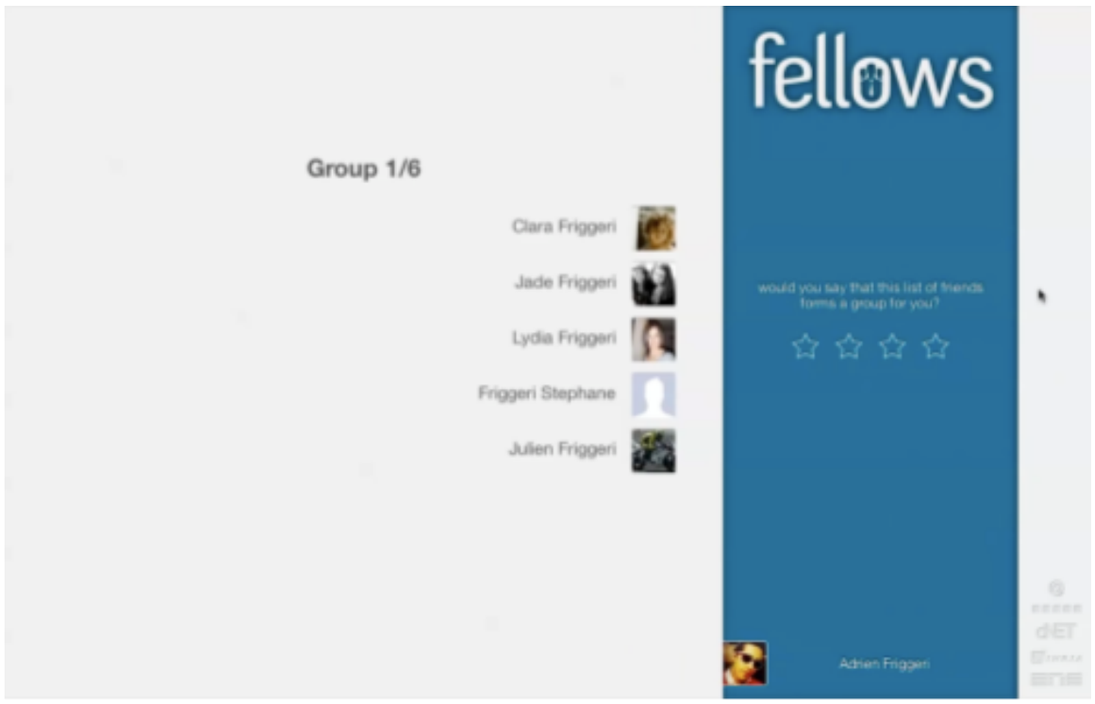
*Triangles to Capture Social Cohesion*, A. Friggeri, G. Chelius and E. Fleury, SocialCom (2011)

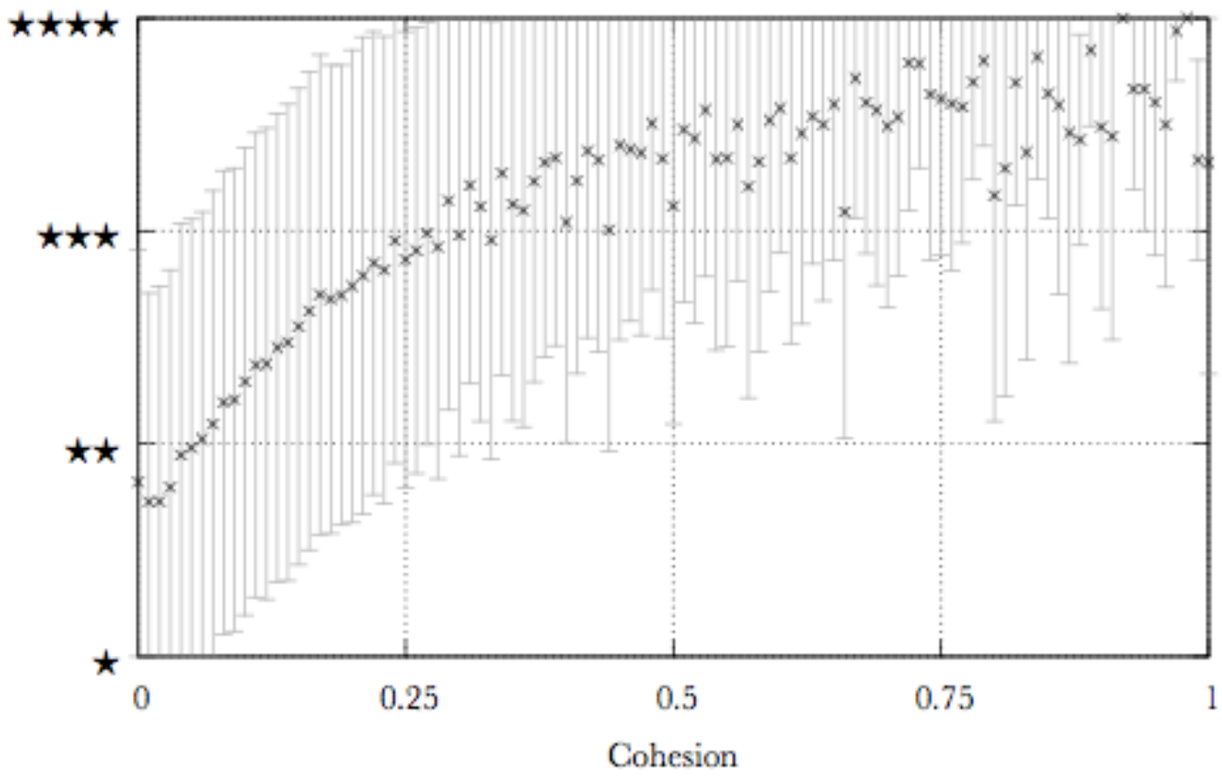
# From friends to communities

Hundreds of methods to uncover communities, overlapping or not

We applied the so-called $C^3$ method where the quality of a community is defined by its *social cohesion*

Dedicated to, and tested on ego-networks.
Validated on a large-scale experiment on Facebook (*Fellows*): algorithmic communities strongly correlated to the users' perception of the quality of social communities.

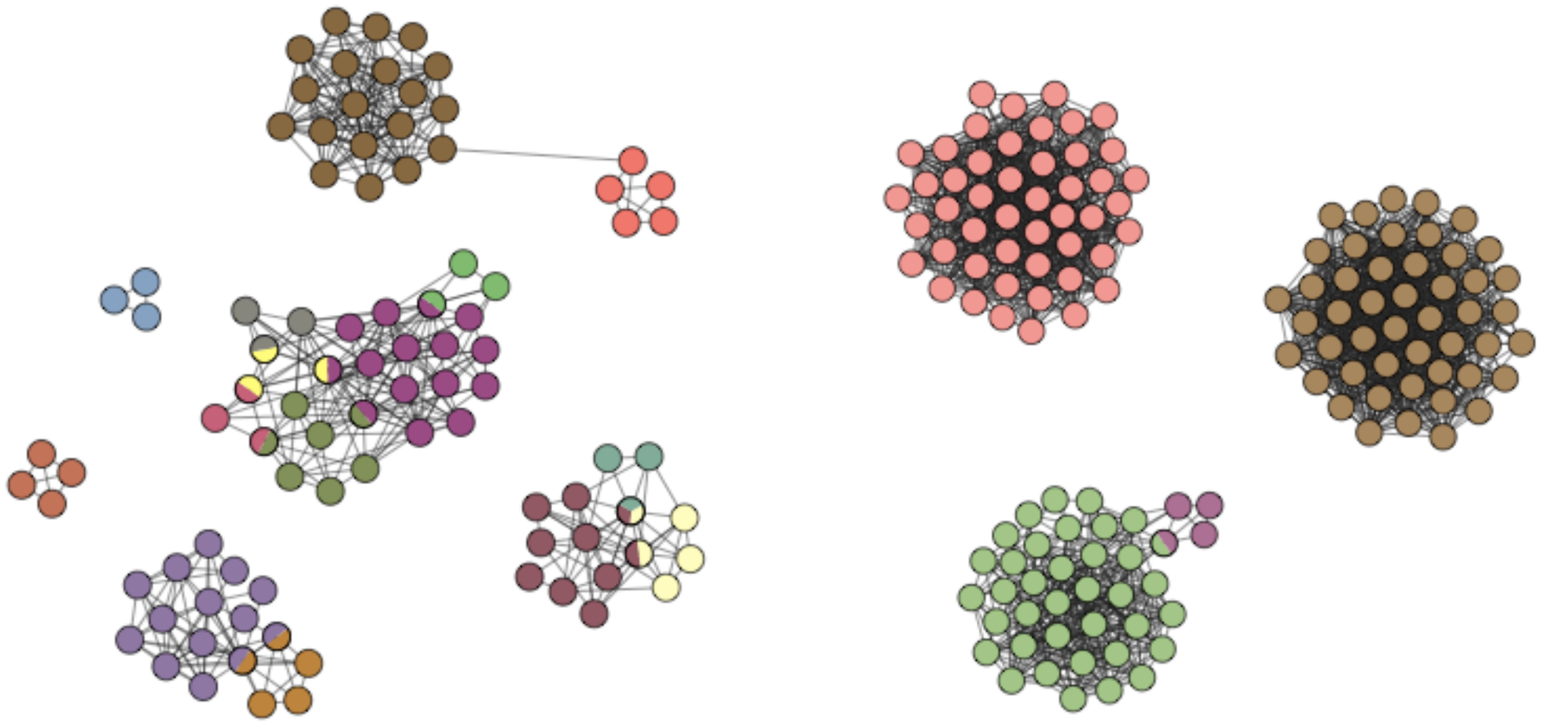



*Triangles to Capture Social Cohesion*, A. Friggeri, G. Chelius and E. Fleury, SocialCom (2011)

# Extraversion and the organisation of ego-networks

Introverts tend to have less, larger communities: they *hide* into large communities.
Extroverts exhibit a higher overlap of the communities: they act as *bridges* between communities
No significant difference in the average value of cohesion.



(a) User A, 26 years old: high extraversion (ext $= 1.33$), 101 friends of which 91 are split across 15 communities of size varying between 3 and 19, and average cohesion $\bar{C} = 0.46$.

(b) User B, 19 years old: low extraversion (ext $= -1.21$), 145 friends of which 136 are split across 4 communities of size 4, 37, 48 and 48, and average cohesion $\bar{C} = 0.31$.

Fig. 8. Examples of two ego-networks of subjects with different psychological traits and structural features.

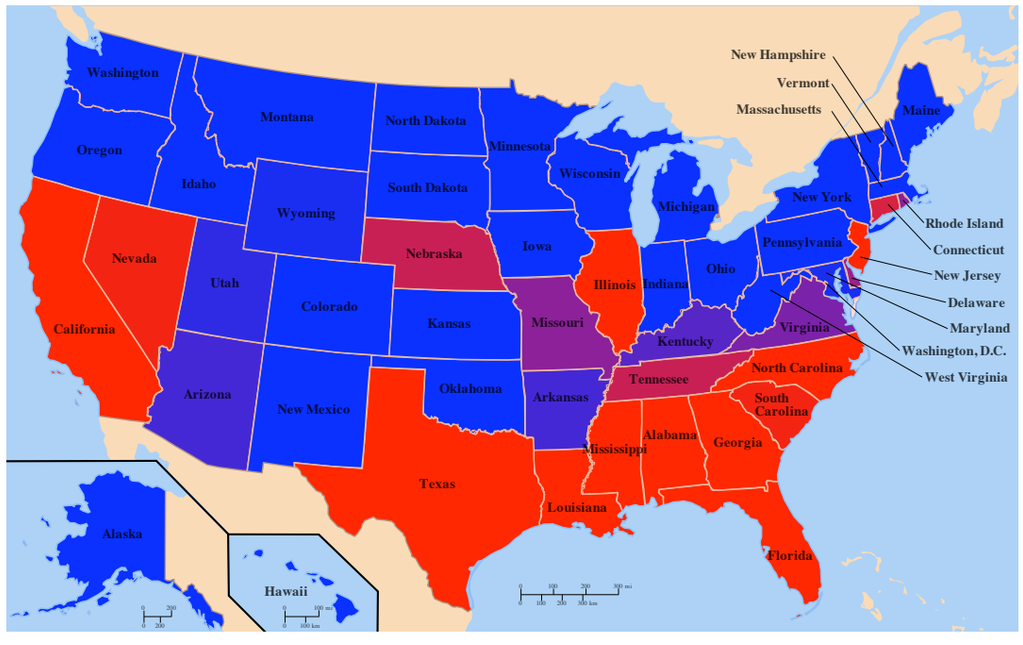
*Psychological Aspects of Social Communities*, A. Friggeri, R. Lambiotte, M. Kosinski and E. Fleury, SocialCom (2012)

# Conclusion

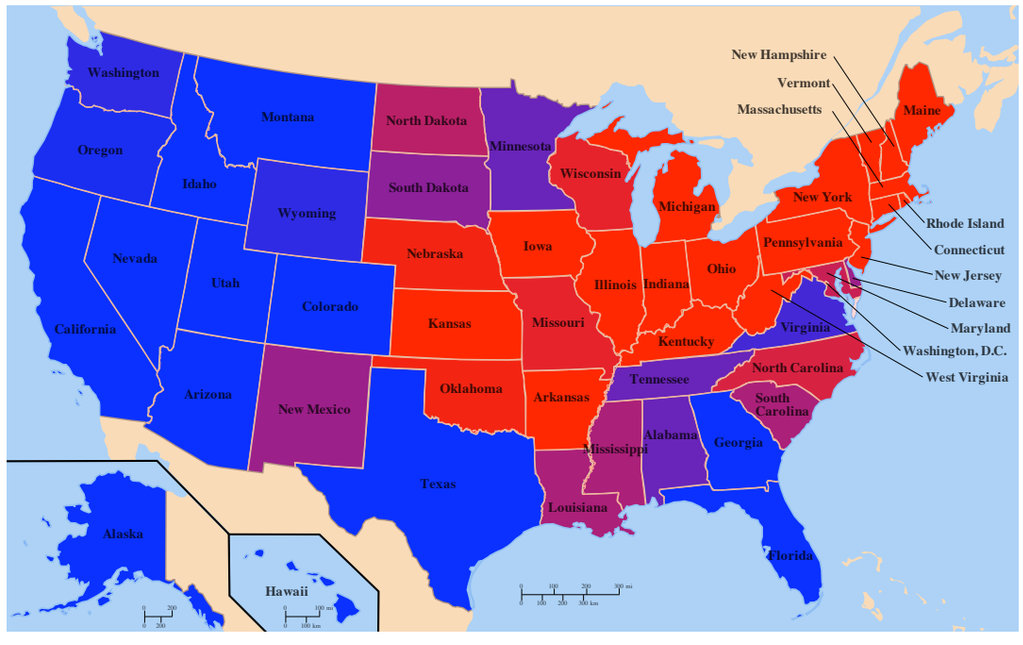
- Online games to reveal the nature of social relations and conflict dynamics

- Online experiment to survey a very large number of Facebook users with peer-reviewed personality tests, and to test the effect of personality scores on network topology

- Opens avenue for new research questions: Regional personnality differences?




“p-values” Extraversion




“p-values” Neuroticism

*Fingerprints in online media reveal the organization of social systems*, Renaud Lambiotte, Awareness (2012)

# Thanks to

M. Szell (MIT) and S. Thurner (Vienna) => Online games

E. Fleury (ENS Lyon), A. Friggeri (Facebook), and D. Quercia and M. Kosinski (Cambridge) => Personality

Mason Porter and Till Hoffman (Oxford) => Modeling of temporal networks

Tim Evans (Imperial College) => Communities

Michael Gastner (Bristol) => Mobility

Vsevolod Salnikov (UNamur) => App development

Lionel Tabourier (UNamur) => Algorithms for temporal nets

Martin Rosvall (Umea) => Communities and ranking

C. Mascolo, A. Noulas (Cambridge) and S. Scellato (Google) => Mobility