GENEVA GRADUATE INSTITUTE

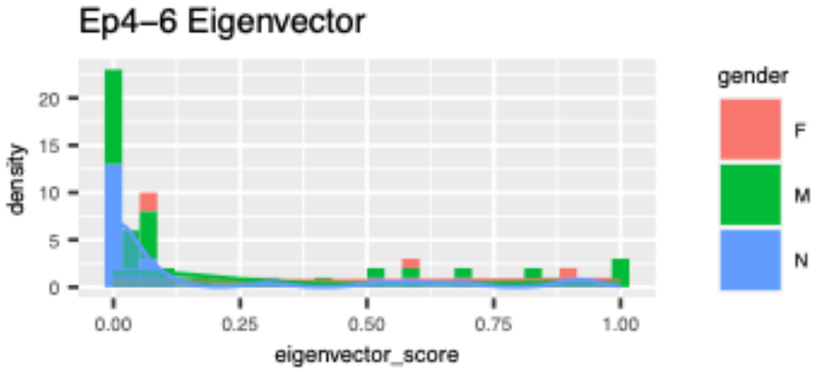
INSTITUT DE HAUTES ÉTUDES INTERNATIONALES ET DU DÉVELOPPEMENT

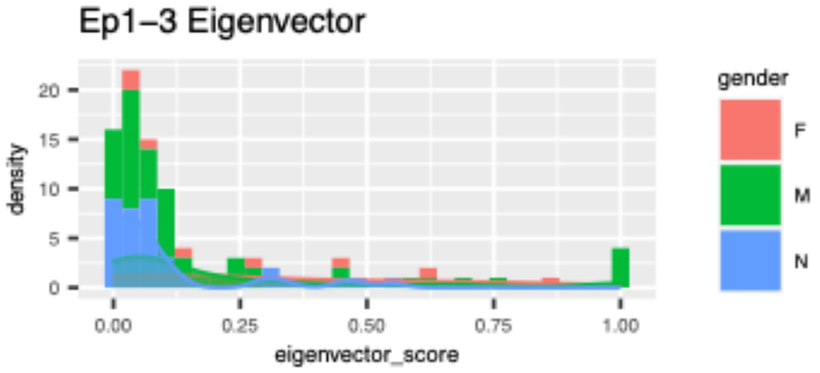
GRADUATE INSTITUTE OF INTERNATIONAL AND DEVELOPMENT STUDIES

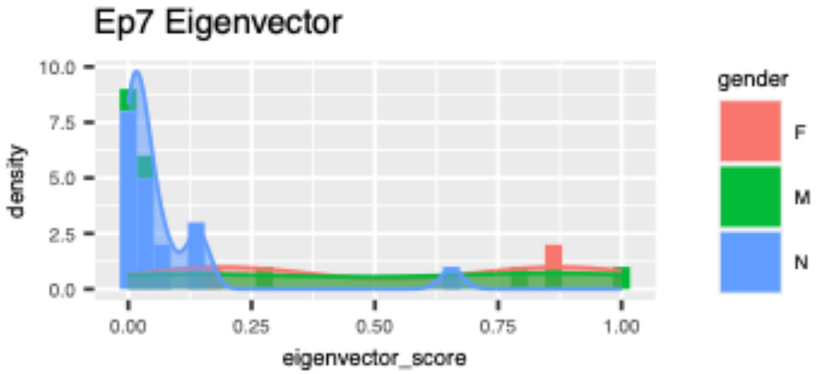
Review

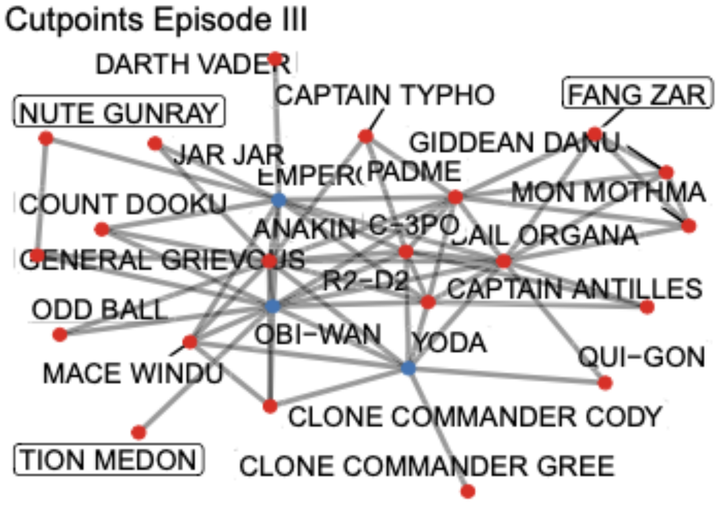
James Hollway

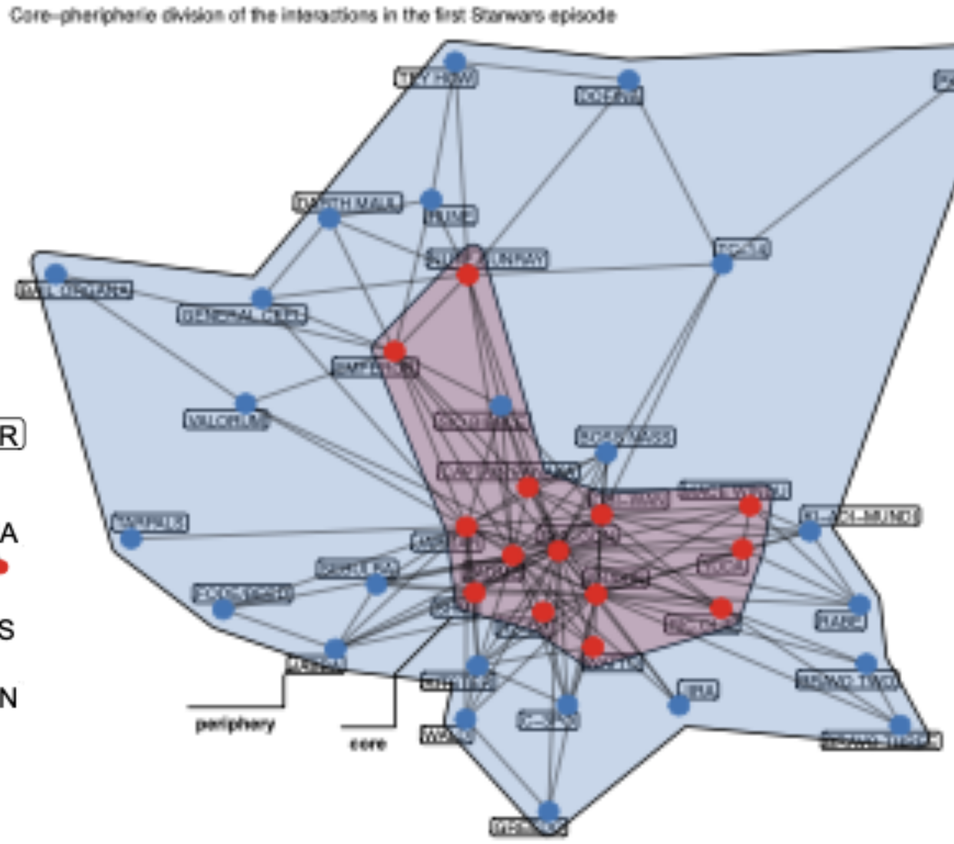
Examples

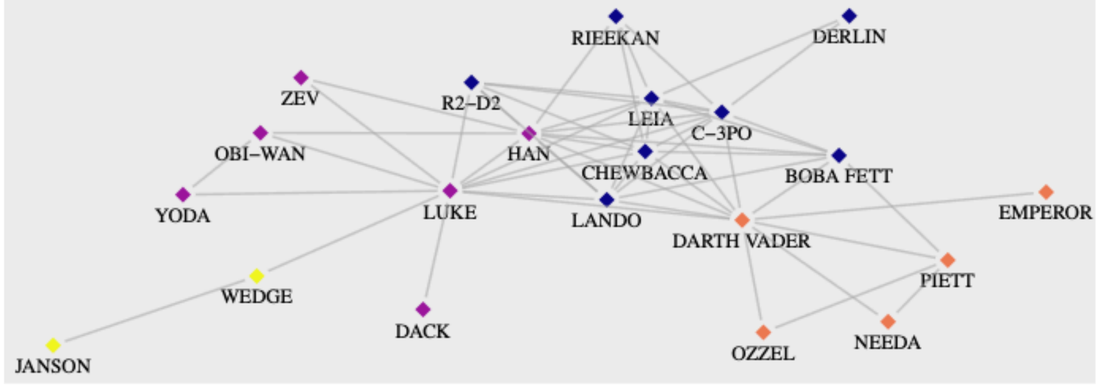

Ep4–6 Eigenvector
density
eigenvector_score
0.00
0.25
0.50
0.75
1.00
0
5
10
15
20
gender
F
M
N


Ep1–3 Eigenvector
density
eigenvector_score
0.00
0.25
0.50
0.75
1.00
0
5
10
15
20
gender
F
M
N

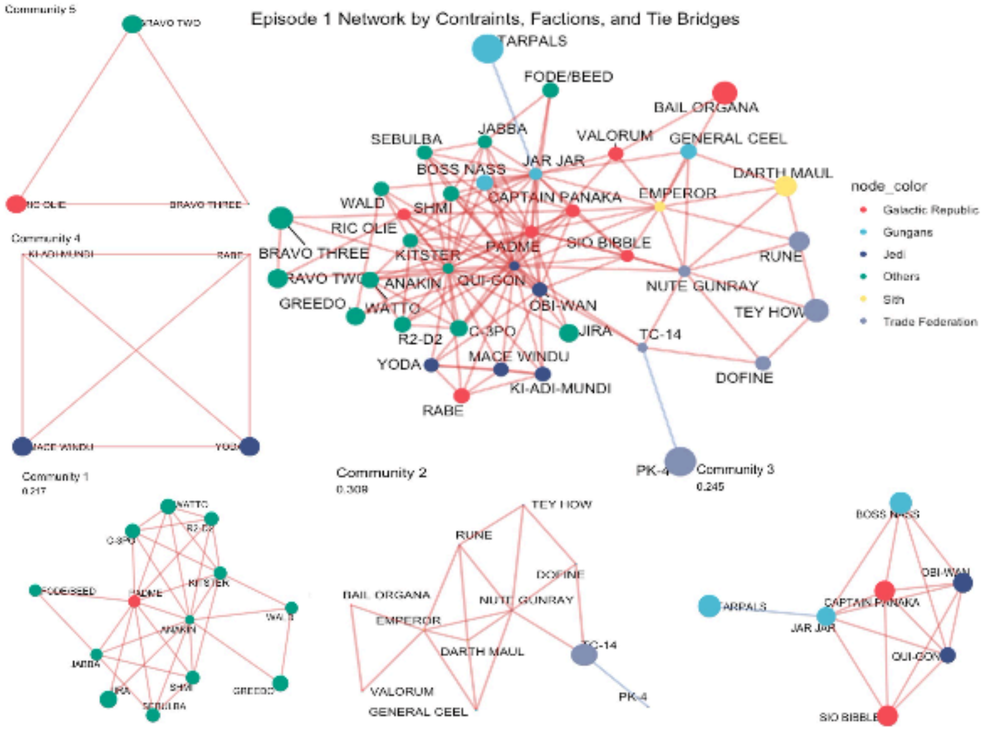

Ep7 Eigenvector
density
eigenvector_score
0.00
0.25
0.50
0.75
1.00
0.0
2.5
5.0
7.5
10.0
gender
F
M
N

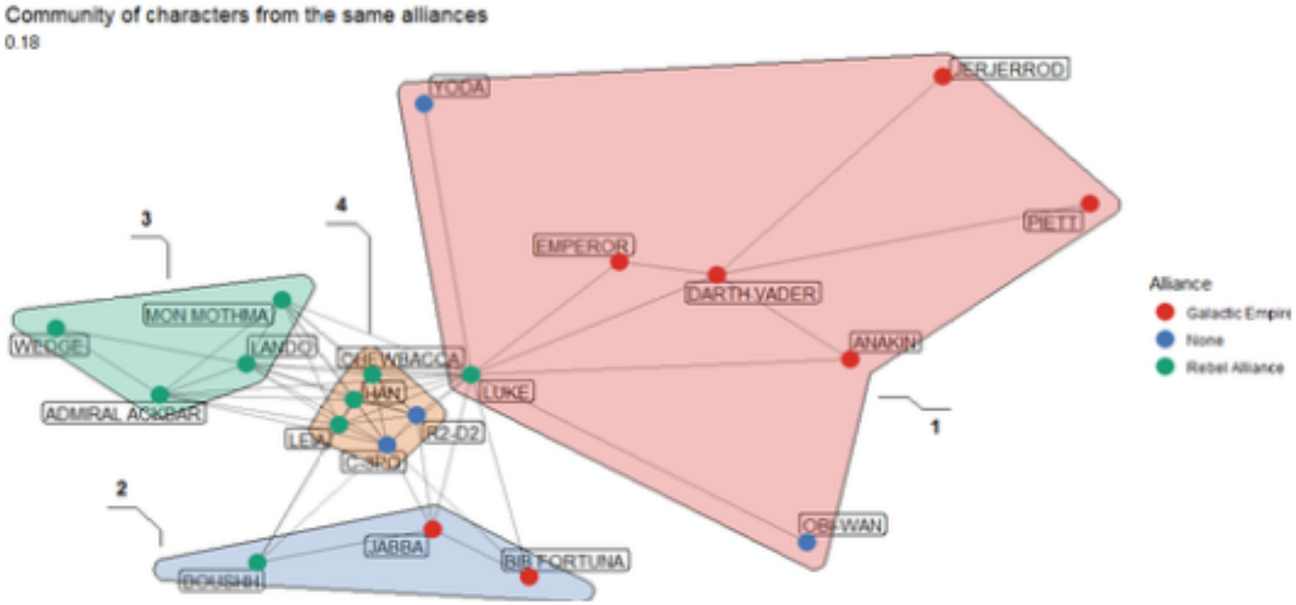

Cutpoints Episode III
DARTH VADER
CAPTAIN TYPHO
FANG ZAR
NUTE GUNRAY
GIDDEAN DANU
JAR JAR
EMPER(
PADME
MON MOTHMA
COUNT DOOKU
ANAKIN
C-3PO
AIL ORGANA
GENERAL GRIEVOUS
R2-D2
CAPTAIN ANTILLES
ODD BALL
OBI-WAN
YODA
QUI-GON
MACE WINDU
CLONE COMMANDER CODY
TION MEDON
CLONE COMMANDER GREE


Core–pheripherie division of the interactions in the first Starwars episode
periphery
core


Community Detection: Edge betweenness
Modularity 0.246
RIEEKAN
DERLIN
ZEV
R2–D2
LEIA
C–3PO
OBI–WAN
HAN
CHEWBACCA
BOBA FETT
YODA
LUKE
LANDO
EMPEROR
DARTH VADER
PIETT
WEDGE
DACK
OZZEL
NEEDA
JANSON

Extra credit





Merci Yichen Shen and Tiphaine Aeby, and all those who added extra coding

Obtaining data

- Plenty of network data around…
  - Return to lecture 2 slides, see also Moodle/Slack
  - Look at data from packages, replication material for published work, or from databases of network data
  - Can use data you might be collecting already for your dissertation (if 2nd year), but not *necessary* that the data is novel
  - You can leverage/develop more expertise if it's something you are interested in substantively, but there can be something freeing in analysing data you have no particular stakes in
  - What is most important is that you can demonstrate your network theory, analysis, and modelling skills

Obtaining data

- Some (important) recommendations:
  - Data does not need to be ‘real’ (can be fictional), but needs to have some content/meaning
  - Small to medium networks (<1000 nodes) will be easier to visualise and analyse
  - Make sure that you are choosing a network with one or more related other networks or nodal attributes that might explain how the network is formed/changed or patterns of behaviour/adoption across the network
  - Doesn’t matter if the network data has been analysed before, so long as it is a new analysis (conversely, doesn’t matter if it’s the same analysis as previous work, so long as it is an application to different data)

Influence vs Selection

- Diffusion models are about *influence* across a (usually unchanging) network structure
  - So you are probably asking some kind of question about how to promote or hinder the diffusion process (or potentially what explains an observed diffusion process)
  - You will want cross-sectional network data, potentially with an observed diffusion process
- e.g. SAOMs are about *selection* in/creating/changing a network structure
  - So you are probably asking some kind of question about why the network structure has changed in the way that it has
  - You will want network data with two or more waves (longitudinal data; could be collapsed network event data, but this can get tricky…)

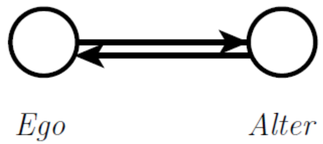
Diffusion

- If you have *an observed diffusion* process…
  - Plot this diffusion process over the network
  - Describe this diffusion process (new functions…)
  - Theorise what might be responsible for this diffusion
  - Test whether structure or attributes are significant explanations

- If you have *no observed diffusion* process…
  - Simulate a diffusion process (many times) over the network with a range of sensible parameters, e.g. thresholds, recovery, etc.
  - Describe this diffusion process
  - Theorise what might change this diffusion process (a seeding strategy, a vaccination strategy, tying thresholds to an attribute, changes to the network structure)
  - Explore how simulations based on these changes change the results

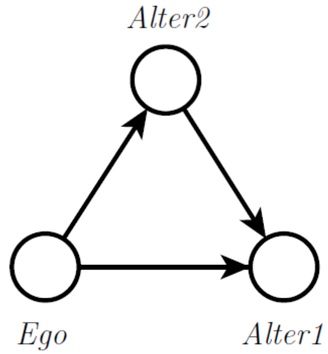
Theoretical considerations

- What is the content of the network?
  - Friendship, professional cooperation, professional advice, emotional support, trade agreements, conflict/attach
- What mechanisms should we expect?
  - Mutuality/reciprocity
  - Transitive closure/clustering
  - Preferential attachment
  - Homophily



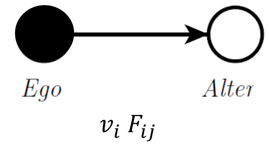
$F_{ij}F_{ji}$

reciprocity (recip)



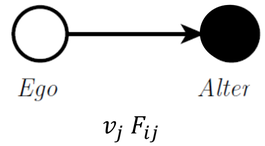
$\sum_h F_{ij}F_{ih}F_{hj}$

transitive triplets (transTrip)



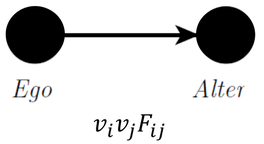
$v_i\, F_{ij}$

ego's attribute (egoX)



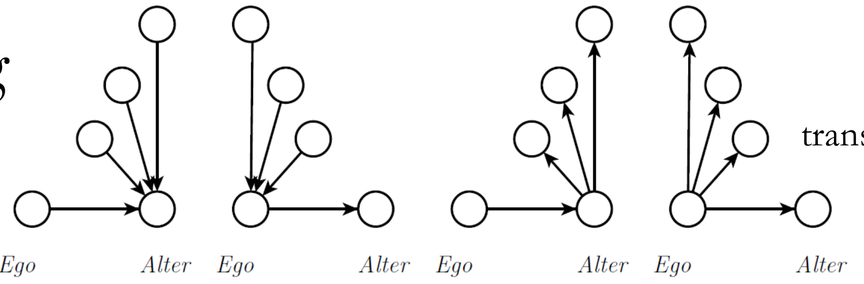
$v_j\, F_{ij}$

alter's attribute (altX)



$v_i v_j F_{ij}$

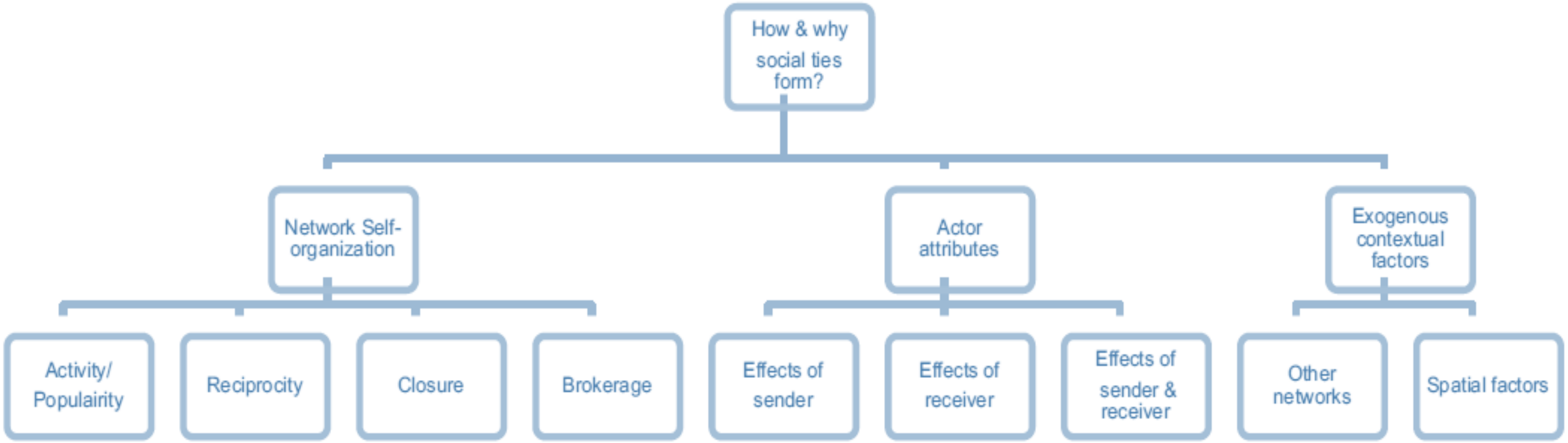
interaction (egoXaltX)



$F_{ij}\sum_h F_{hj}$ $F_{ij}\sum_h F_{hi}$ $F_{ij}\sum_h F_{jh}$ $F_{ij}\sum_h F_{ih}$

indegree-popularity *(inPop)* indegree-activity *(inAct)* outdegree-popularity *(outPop)* outdegree activity *(outAct)*

Theoretical explanations of tie formation



Robins & Lusher 2012, p. 23

How to select the right effects?

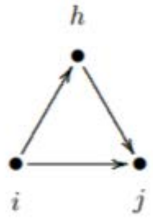
Structural effects

Structural effects are the effects depending on the network only. The following list also contains some elementary effects (see Section 5.1.1). The type of the elementary effects in RSiena still is `eval`, indicating that its parameter is applied both for creating new ties and for maintaining existing ties.

1. *out-degree effect* or *density effect* (`density`), defined by the out-degree
   $s_{i1}^{\text{net}}(x) = x_{i+} = \sum_j x_{ij}$,
   where $x_{ij} = 1$ indicates presence of a tie from i to j while $x_{ij} = 0$ indicates absence of this tie;

2. *reciprocity effect* (`recip`), defined by the number of reciprocated ties
   $s_{i2}^{\text{net}}(x) = \sum_j x_{ij}\, x_{ji}$;

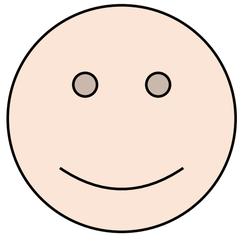
3. *transitive triplets effect* (`transTrip`), defined by the number of transitive patterns in i's relations (ordered pairs of actors (j, h) to both of whom i is tied, while also j is tied to h),
   for directed networks, $s_{i3}^{\text{net}}(x) = \sum_{j,h} x_{ij}\, x_{ih}\, x_{hj}$;
   and for non-directed networks, $s_{i3}^{\text{net}}(x) = \sum_{j<h} x_{ij}\, x_{ih}\, x_{hj}$;
   there was an error here until version 3.313, which amounted to combining the transitive triplets and transitive mediated triplets effects;



4. *transitive triplets effect type 1* (`transTrip1`), may also be called *transitive closure effect*; the elementary effect corresponding to creating or maintaining the tie $i \to j$ in the figure above; this is transitive closure in the strict sense of the term. The effect is
   $s_{i4}^{\text{el}}(x) = x_{ij} \sum_h x_{ih}\, x_{hj}$;

open SIENA MANUAL

https://www.stats.ox.ac.uk/~snijders/siena/RSiena_Manual.pdf



How to select the right effects?

103. *total covariate - in - alter at distance 2* (`totInDist2`). This is defined as the sum of alters' values for the total of the covariate values of all their incoming ties, except for the possibly incoming tie from ego:

$$s^{\text{net}}_{i103}(x) = \sum_j x_{ij}(x_{+j} - x_{ij})\check{v}^{(-i)}_j \ .$$

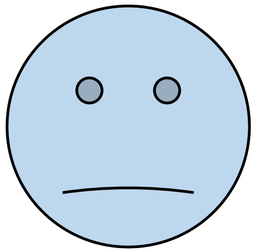
104. *ego-(in-alter-distance-2) covariate - similarity* (`simEgoInDist2`), defined as the sum of centered similarity between i and alters' covariate-in-average, for all actors j to whom i has a tie,

$$s^{\text{net}}_{i104}(x) = \sum_j x_{ij}\left(\text{sim}(\acute{v})_{ij} - \widehat{\text{sim}^v}\right) \ ,$$

where the similarity scores $\text{sim}(\acute{v})_{ij}$ are defined as

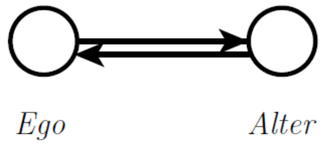
$$\text{sim}(\acute{v})_{ij} = \frac{\Delta - |v_i - \check{v}^{(-i)}_j|}{\Delta} \ ,$$

while $\check{v}^{(-i)}_j$ is as in the definition of `altInDist2`, $\Delta = \max_{ij}|v_i - v_j|$ is the observed range of the *original* covariate v, and $\widehat{\text{sim}^v}$ is as above (see `simDist2`).
Note that for ego (i) the own value is used and for alter (j) the alters' covariate-average (these are alter's alters!), so that this effect is about a comparison between i and the out-neighbourhoods of the j's.



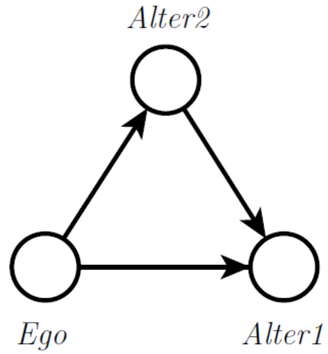
Theoretical considerations

- What is the content of the network?
  - Friendship, professional cooperation, professional advice, emotional support, trade agreements, conflict/attach
- What mechanisms should we expect?
  - Mutuality/reciprocity
  - Transitive closure/clustering
  - Preferential attachment
  - Homophily



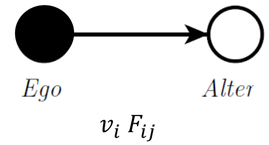
$F_{ij}F_{ji}$

reciprocity (recip)



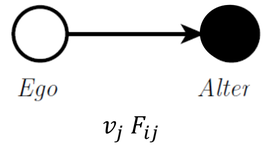
$\sum_h F_{ij}F_{ih}F_{hj}$

transitive triplets (transTrip)



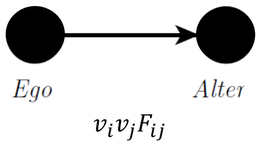
$v_i F_{ij}$

ego's attribute (egoX)



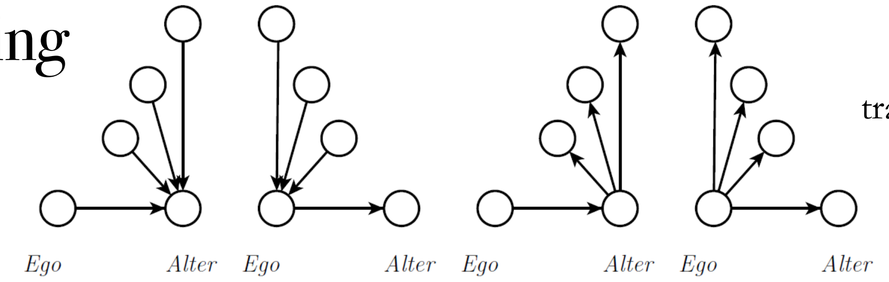
$v_j F_{ij}$

alter's attribute (altX)



$v_i v_j F_{ij}$

interaction (egoXaltX)

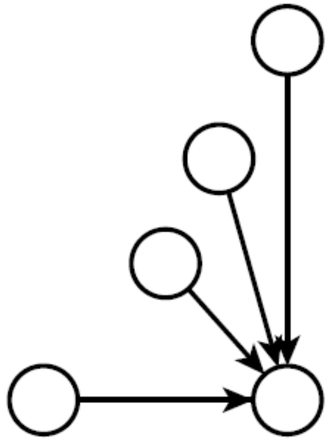


$F_{ij}\sum_h F_{hj}$ $F_{ij}\sum_h F_{hi}$ $F_{ij}\sum_h F_{jh}$ $F_{ij}\sum_h F_{ih}$

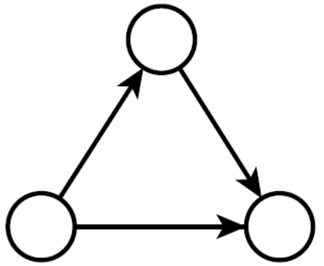
indegree-popularity *(inPop)* indegree-activity *(inAct)* outdegree-popularity *(outPop)* outdegree activity *(outAct)*

Joint parameter interpretation

- Like in all regression-type models, important to take into account (control for) important alternative explanations
- Interpretation of results: ceteris paribus
- In Siena models even more complicated…
  - Because Siena-effects are embedded in each other

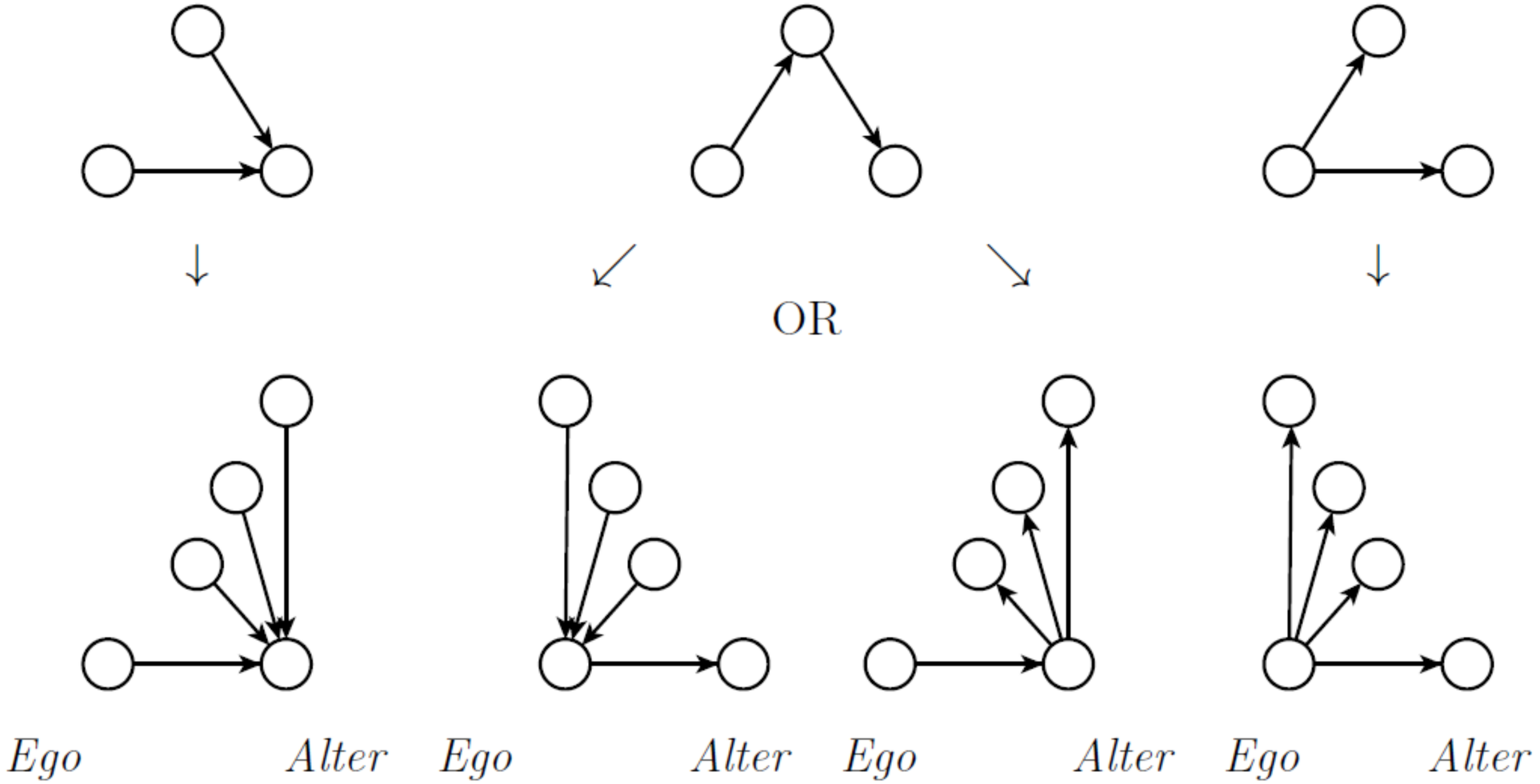


indegree-popularity *(inPop)*



transitive triplets *(transTrip)*

Joint parameter interpretation



Joint parameter interpretation

- Interpretation of effects always depends on the other effects in the model
- Sub-configurations of an effect should always be included as well
- For example: if there is a triangle, there *has to be* stars (captured by degree effects) as well
- Imagine a sociological study on the effects of giving birth when we forget to control for biological sex of the respondent, or similarly silly such example

Example: ethnic homophily in school

	Model A	
Effect name	Est	(S.E.)
Outdegree	-0.864	(0.088) ***
Ethnicity effects		
Alter is minority	-0.285	(0.123) *
Ego is minority	-0.079	(0.144)
Both minorities	-0.179	(1.033)
Structural effects		
Reciprocity		
Transitive triplets		
Trans. reciprocated triplets		
Indegree – popularity		
Outdegree – popularity		
Outdegree – activity		

Example: ethnic homophily in school

	Model A		Model B	
Effect name	Est	(S.E.)	Est	(S.E.)
Outdegree	-0.864	(0.088) ***	-1.318	(0.041) ***
Ethnicity effects				
Alter is minority	-0.285	(0.123) *	-0.270	(0.118) *
Ego is minority	-0.079	(0.144)	0.069	(0.130)
Both minorities	-0.179	(1.033)	0.026	(0.601)
Structural effects				
Reciprocity			1.444	(0.109) ***
Transitive triplets				
Trans. reciprocated triplets				
Indegree – popularity				
Outdegree – popularity				
Outdegree – activity				

Example: ethnic homophily in school

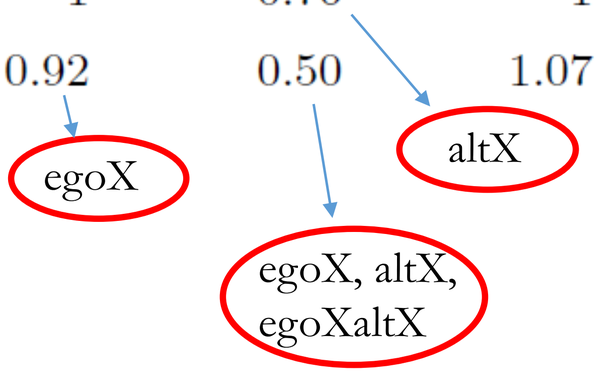
	Model A		Model B		Model C	
Effect name	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)
Outdegree	-0.864	(0.088) ***	-1.318	(0.041) ***	-2.038	(0.088) ***
Ethnicity effects						
Alter is minority	-0.285	(0.123) *	-0.270	(0.118) *	-0.186	(0.122)
Ego is minority	-0.079	(0.144)	0.069	(0.130)	0.072	(0.109)
Both minorities	-0.179	(1.033)	0.026	(0.601)	-0.153	(0.773)
Structural effects						
Reciprocity			1.444	(0.109) ***	1.931	(0.143) ***
Transitive triplets					0.403	(0.030) ***
Trans. reciprocated triplets					-0.422	(0.057) ***
Indegree – popularity						
Outdegree – popularity						
Outdegree – activity						

Example: ethnic homophily in school

	Model A		Model B		Model C		Model D	
Effect name	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)	Est	(S.E.)
Outdegree	-0.864	(0.088) ***	-1.318	(0.041) ***	-2.038	(0.088) ***	-1.446	(0.152) ***
Ethnicity effects								
Alter is minority	-0.285	(0.123) *	-0.270	(0.118) *	-0.186	(0.122)	-0.070	(0.111)
Ego is minority	-0.079	(0.144)	0.069	(0.130)	0.072	(0.109)	0.107	(0.116)
Both minorities	-0.179	(1.033)	0.026	(0.601)	-0.153	(0.773)	-0.113	(0.603)
Structural effects								
Reciprocity			1.444	(0.109) ***	1.931	(0.143) ***	2.218	(0.136) ***
Transitive triplets					0.403	(0.030) ***	0.429	(0.035) ***
Trans. reciprocated triplets					-0.422	(0.057) ***	-0.242	(0.057) ***
Indegree – popularity							0.009	(0.021)
Outdegree – popularity							-0.169	(0.020) ***
Outdegree – activity							-0.005	(0.006)

Joint test

		Model A		Model B		Model C		Model D	
		Alter		Alter		Alter		Alter	
		Majority	Minority	Majority	Minority	Majority	Minority	Majority	Minority
Ego	Majority	1	0.76 *	1	0.76 *	1	0.83	1	0.93
	Minority	0.92	0.50	1.07	0.72	1.07	1.00	1.11	0.79



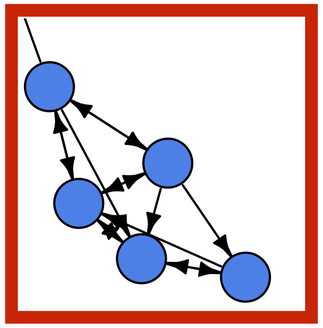
See ?Wald.Rsiena

How to find a good model specification

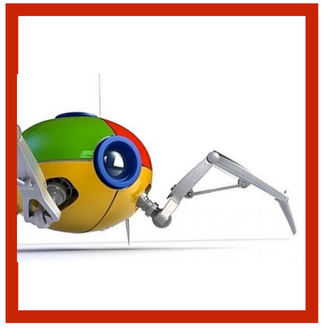
- Think about the content of the network, e.g. friendship
- Think about theoretical expectations, e.g. reciprocity, transitive closure, preferential attachment
- However theoretical expectations can be expressed in slightly different ways (check the manual!)
- To examine our research question (e.g. is there ethnic homophily in school?) we have to capture the network structure well…
- There can be multiple (theoretically meaningful) effects to choose from
- There can be effects that ought to be added to adequately capture the network structure
- To see how well our structure is represented see GOF.

History

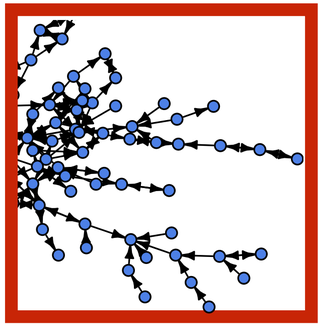
Definitions



Vocabulary

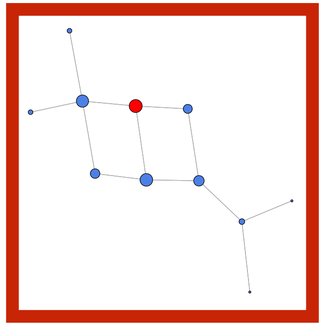


Collection

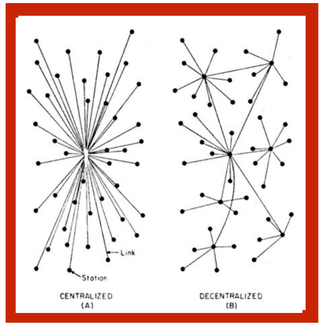


Design

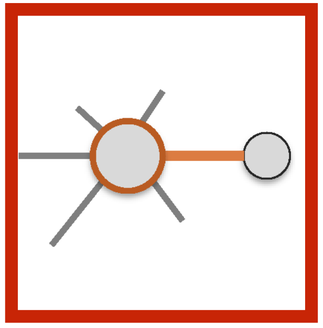
Content



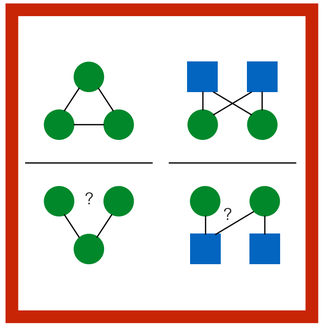
Centrality



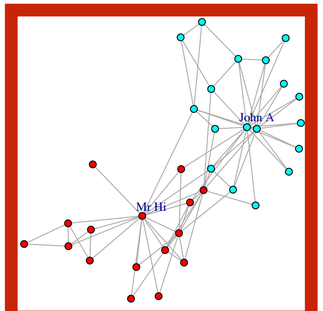
Centralization



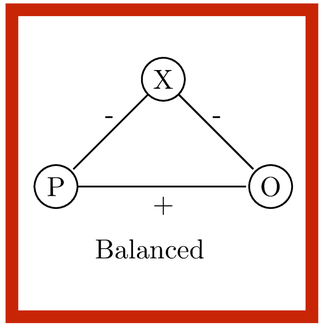
Visualization



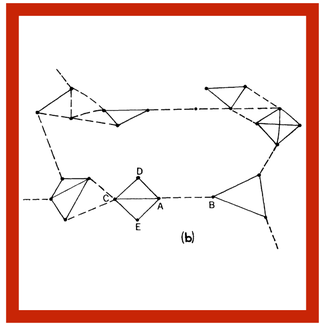
Cohesion



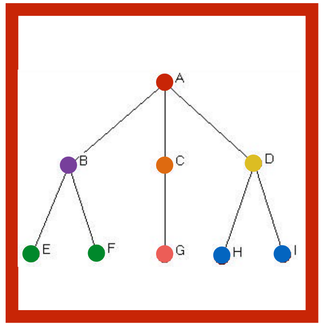
Communities



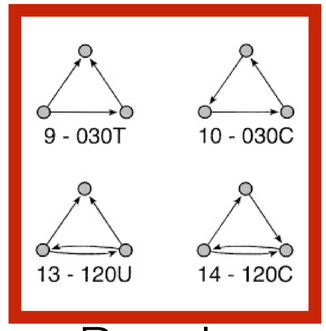
Balance



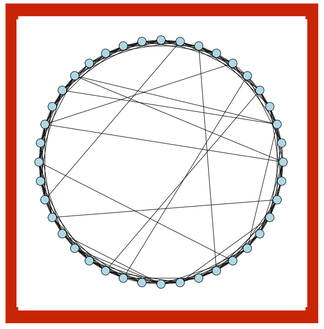
Structural Holes



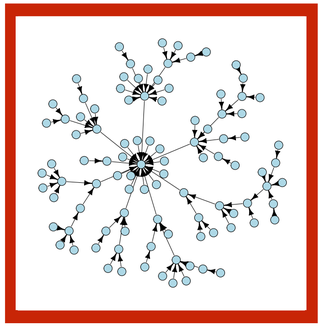
Structural Equivalence



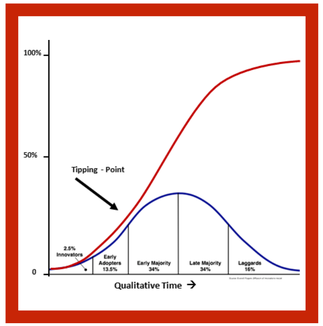
Regular Equivalence



Small-World



Scale-Free



Diffusion

GENEVA GRADUATE INSTITUTE

INSTITUT DE HAUTES ÉTUDES INTERNATIONALES ET DU DÉVELOPPEMENT

GRADUATE INSTITUTE OF INTERNATIONAL AND DEVELOPMENT STUDIES

Course review

James Hollway
and Jael Tan

Now?

- Break into two groups – diffusion and SAOMs – for James and Jael to lend support
- Free to go once you are ready to get to work network modelling
- Next week there will be optional consultancy sessions to discuss your progress/ideas
- Any questions or suggestions: Slack, office hours, and manynet/migraph
- Further interest in networks?