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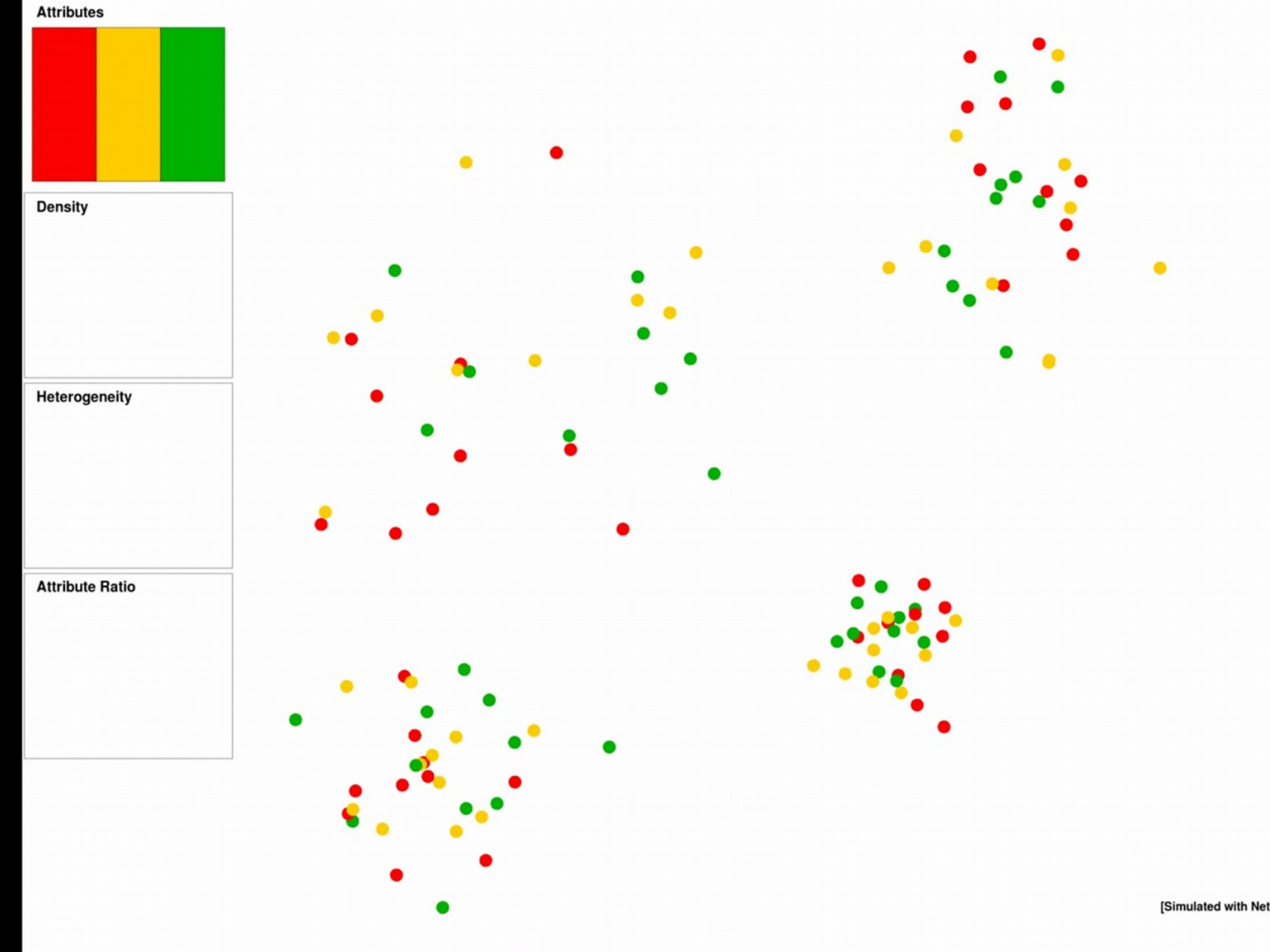
Statistical Power in Longitudinal Network Studies

Advanced SIENA meeting; EUSN Conference 2016, Paris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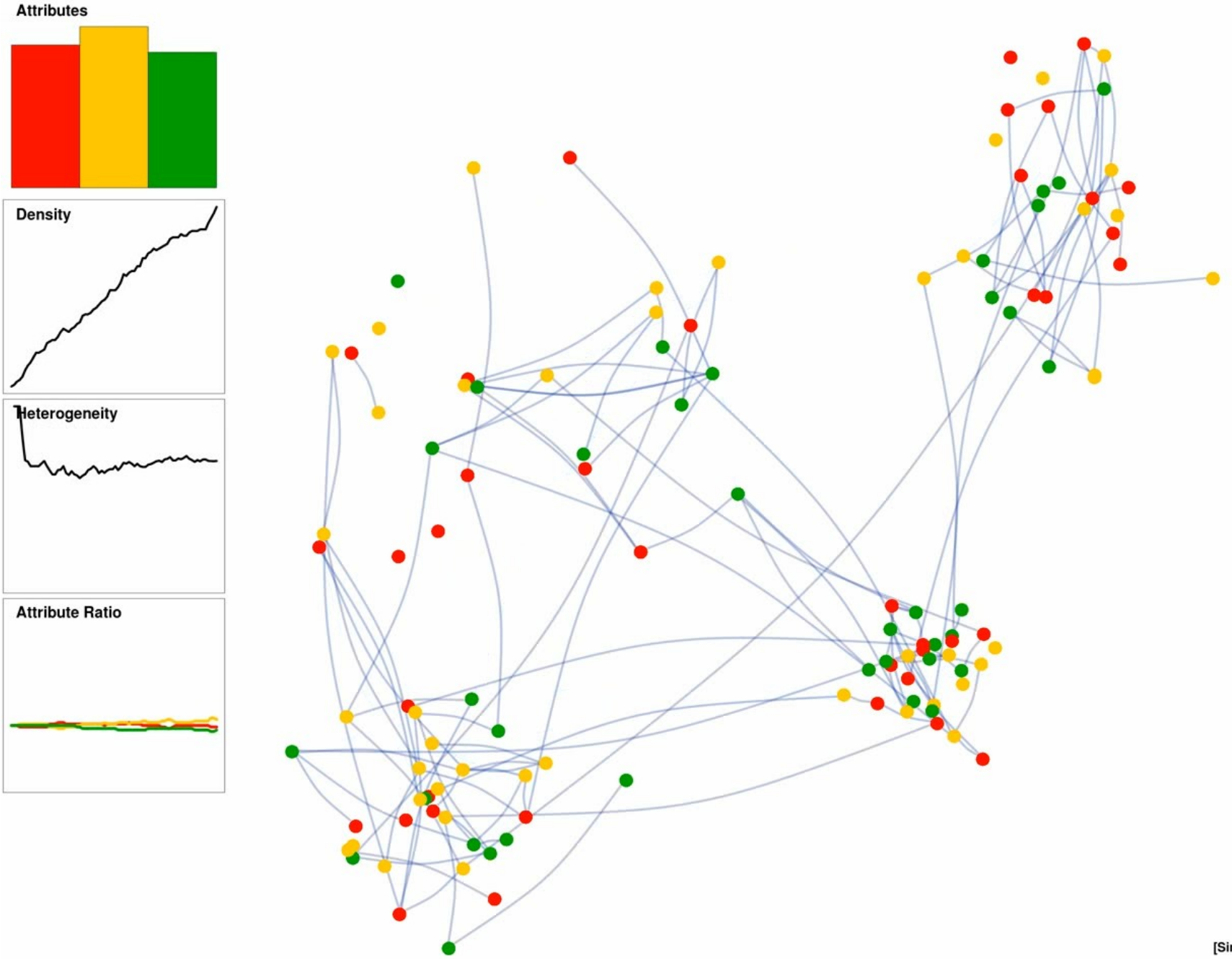
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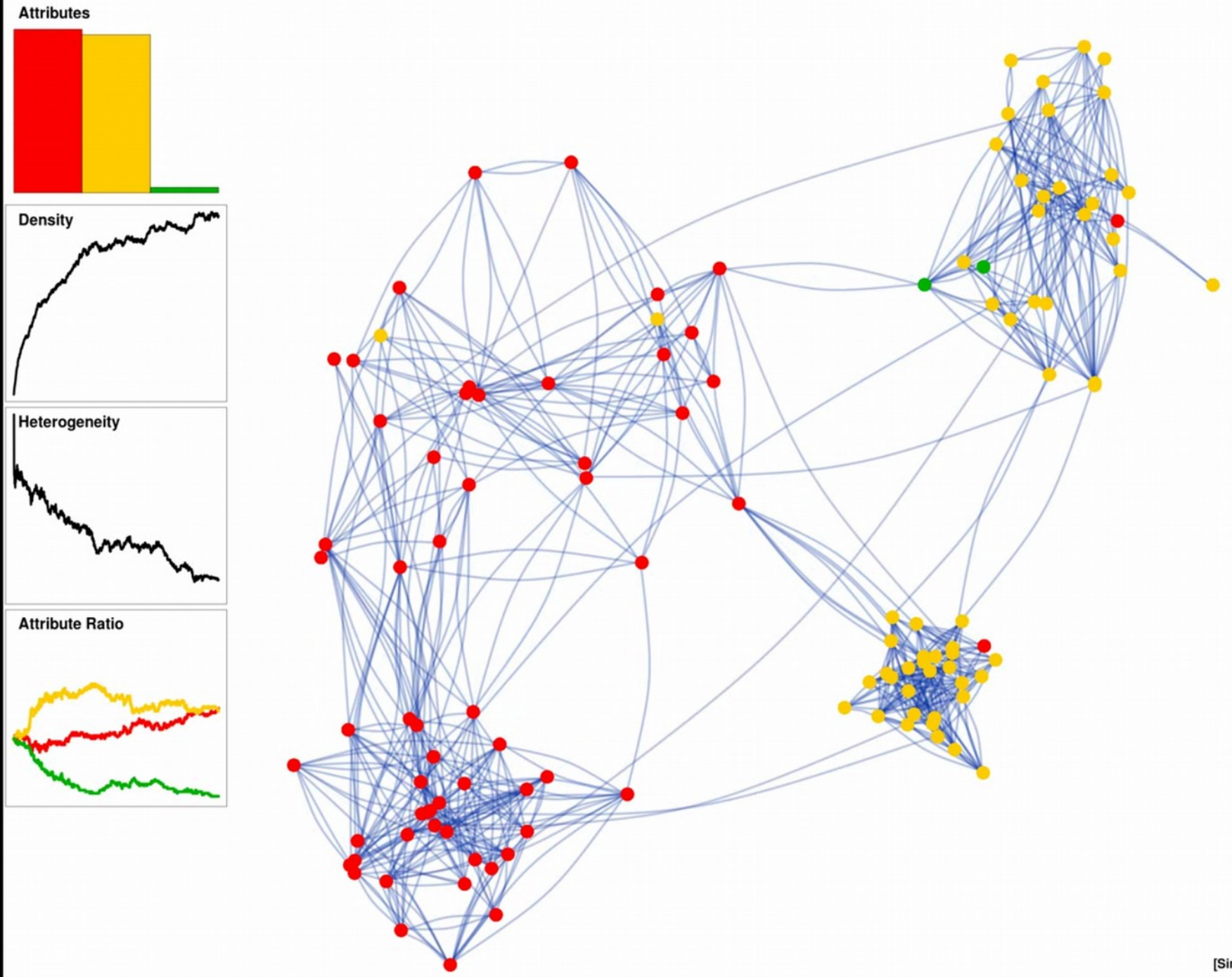
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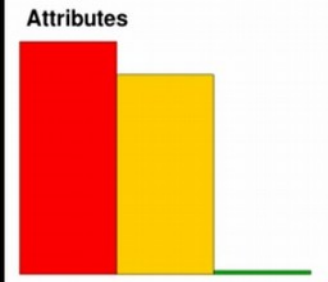

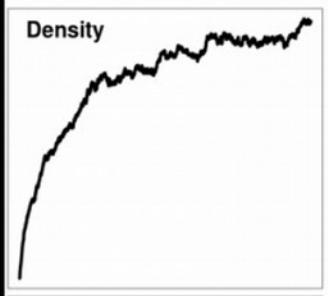

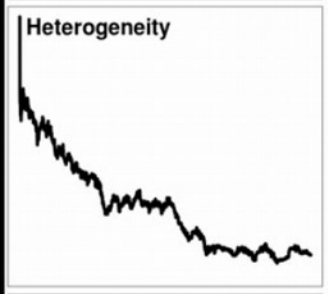

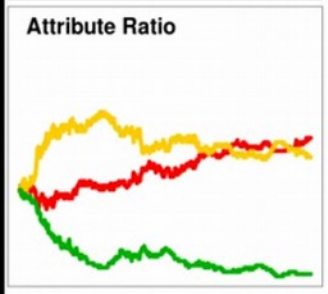

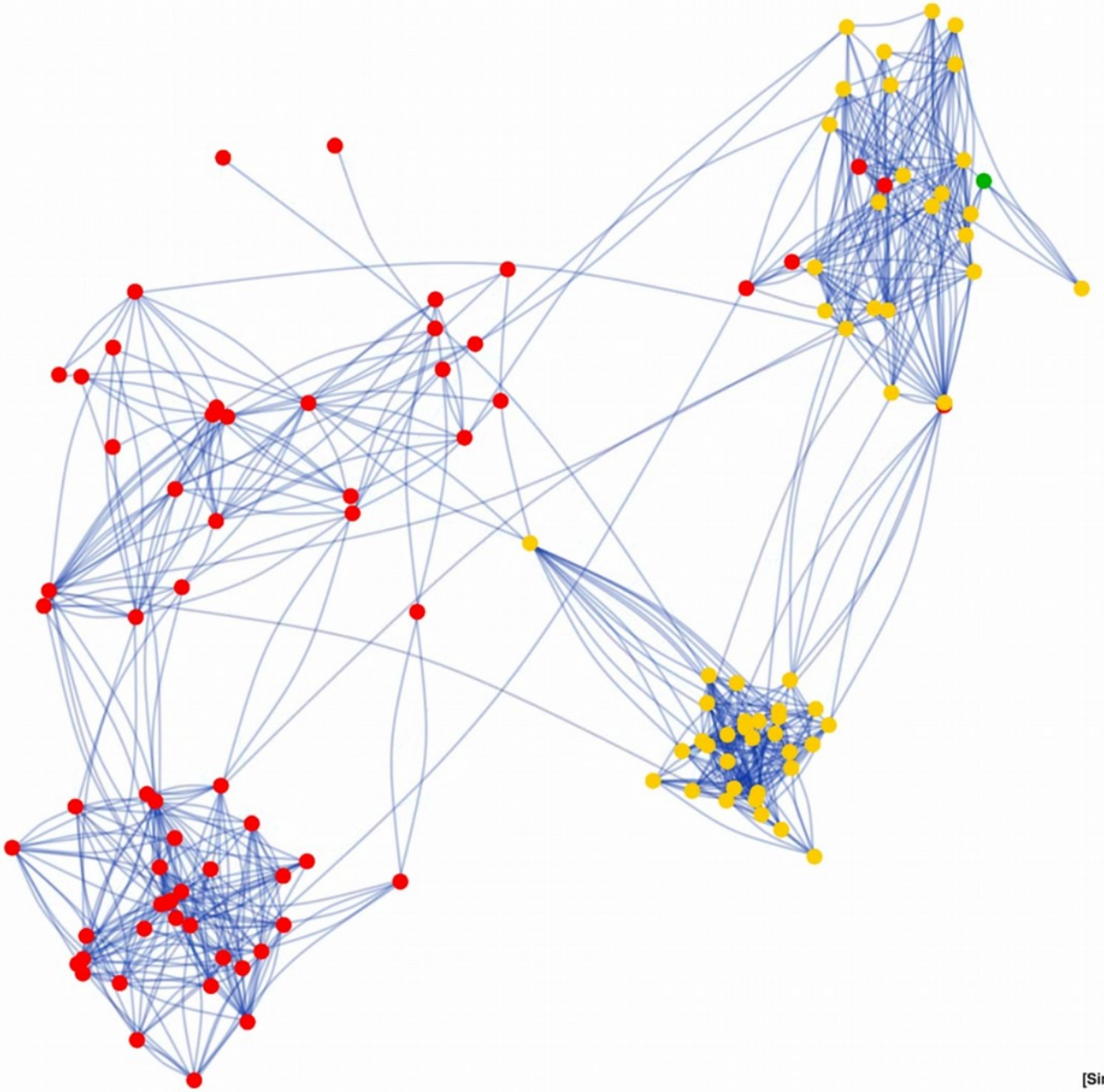

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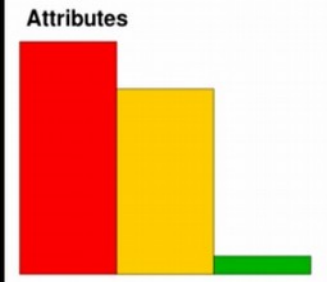
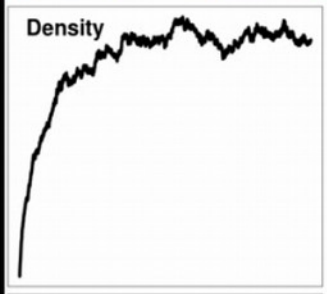
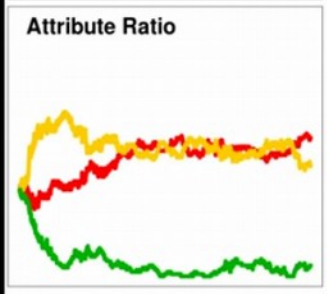
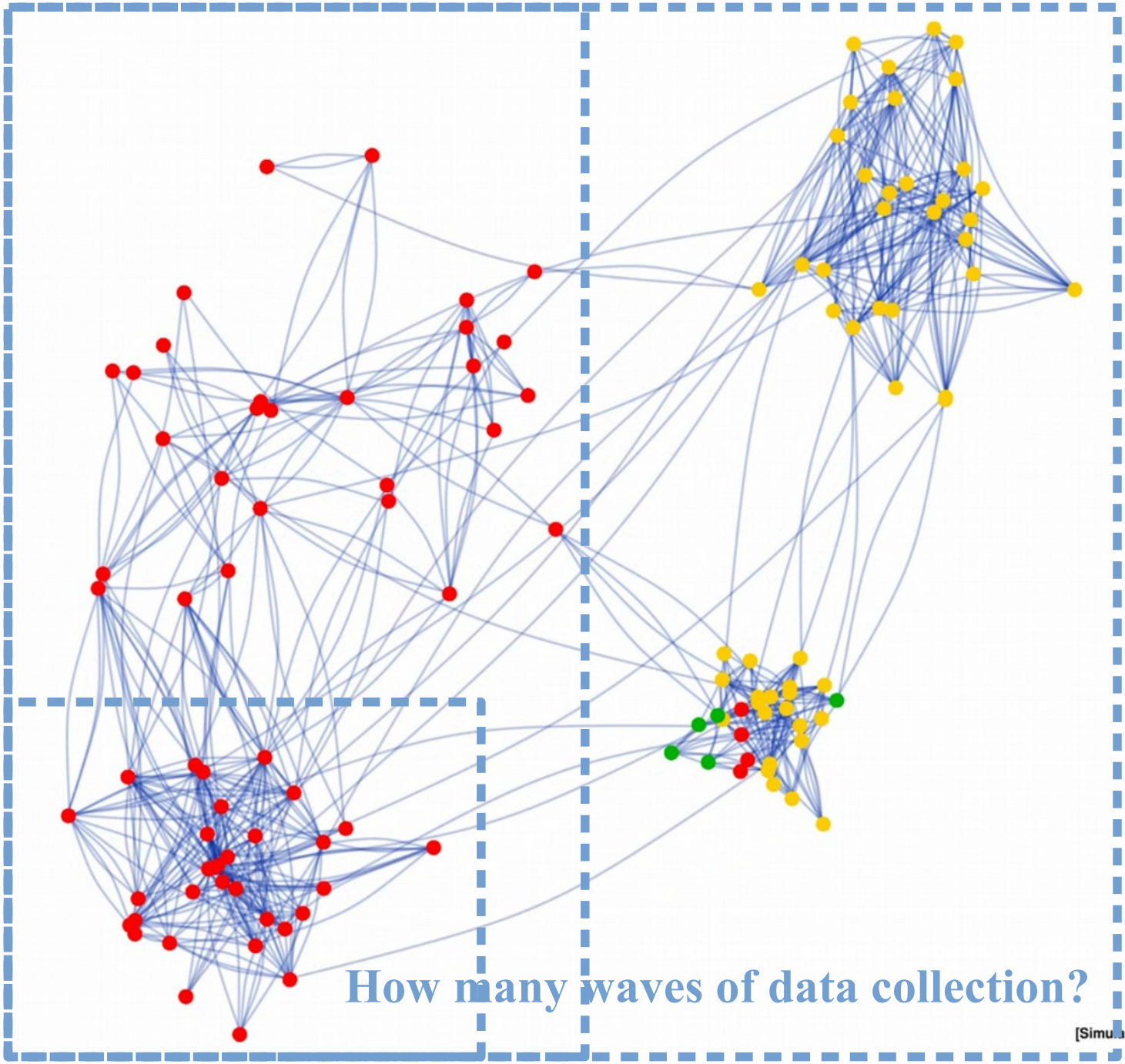








How many waves of data collection?

[Simulated with N

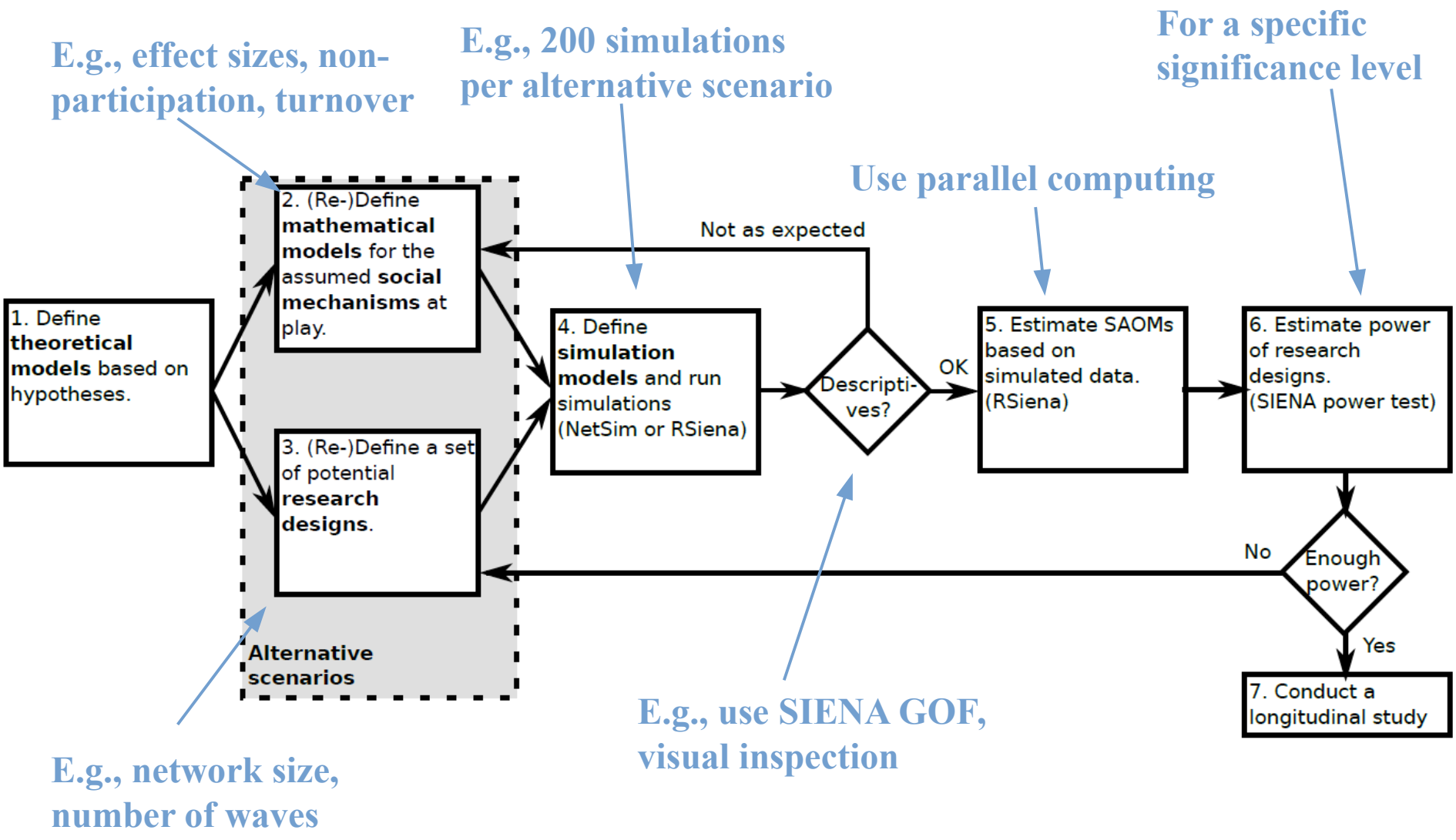
Researchers need to make decisions about the research design...

- The size and delineation of a social network
- The number of social networks that are simultaneously studied
- The number of data collection waves
- The time intervals between subsequent waves
- The granularity of behavioral variables
- Restrictions of the number of peer nominations in network questions

...under uncertainty about the social mechanisms at play

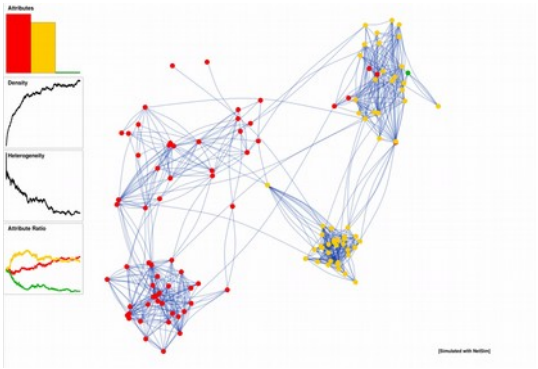
- Effect sizes (e.g., how strong are influence processes?)
- Prevalence of potential confounding processes (e.g., homophily on a correlated variable)
- Potentially amplifying social mechanisms (e.g., reciprocation, transitivity, and homophily)
- Processes generating non-response (e.g., due to non-consent / absence of single participants)
- Turnover/dropout of participants between data collection waves

A six-step procedure to estimate power of research designs



A power study based on the initial network simulation

- 30, 60 or 120 individuals?
- Two, three or five waves of data collection?
- Pronounced effect sizes
- A somewhat typical, but not state-of-the-art SAOM



Mechanism	SIENA effect name	Parameter
Network change	`rate`	3.0
Density	`density`	-2.0
Reciprocity	`recip`	2.0
Transitivity	`transTrip`	0.2
Hierarchization	`cycle3`	-0.1
Propinquity (Distance)	`X`	-2.5
Homophily	`simX`	1.5
Attribute change	`rate`	0.6
Strive for polarization	`linear`	-0.8
	`quad`	0.2
Influence	`totSim`	0.8

Only in the largest research design, power for both key effects is excellent

		Community size					
		N = 120		N = 60		N = 30	
		Hom.	Inf.	Hom.	Inf.	Hom.	Inf.
Number of waves	5 waves	100	97.5			97.5	28.5
	3 waves			99.5	34.5		
	2 waves	99.5	34.5			34.5	10.0

- Conclusions: Researchers who are mainly interested in homophily could choose the most do-able of the intermediate research designs
- Only the largest research design has a good power expectation regarding the social influence effect

A power study inspired by the delinquency study of Baerveldt et al. (2008)

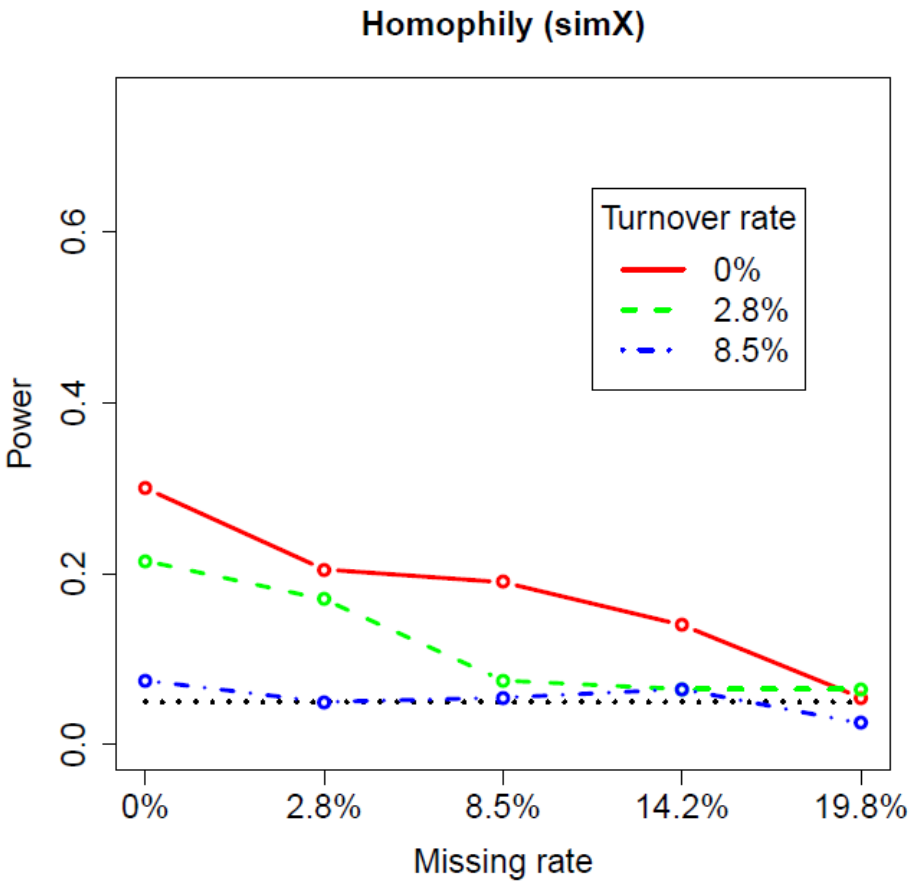
- 742 students in 21 schools
- 2 waves of data collection
- Average friendship degree in wave 1 is 1.4
- Average delinquency score is 1.8 (scale from 0 to 4) with low dispersion

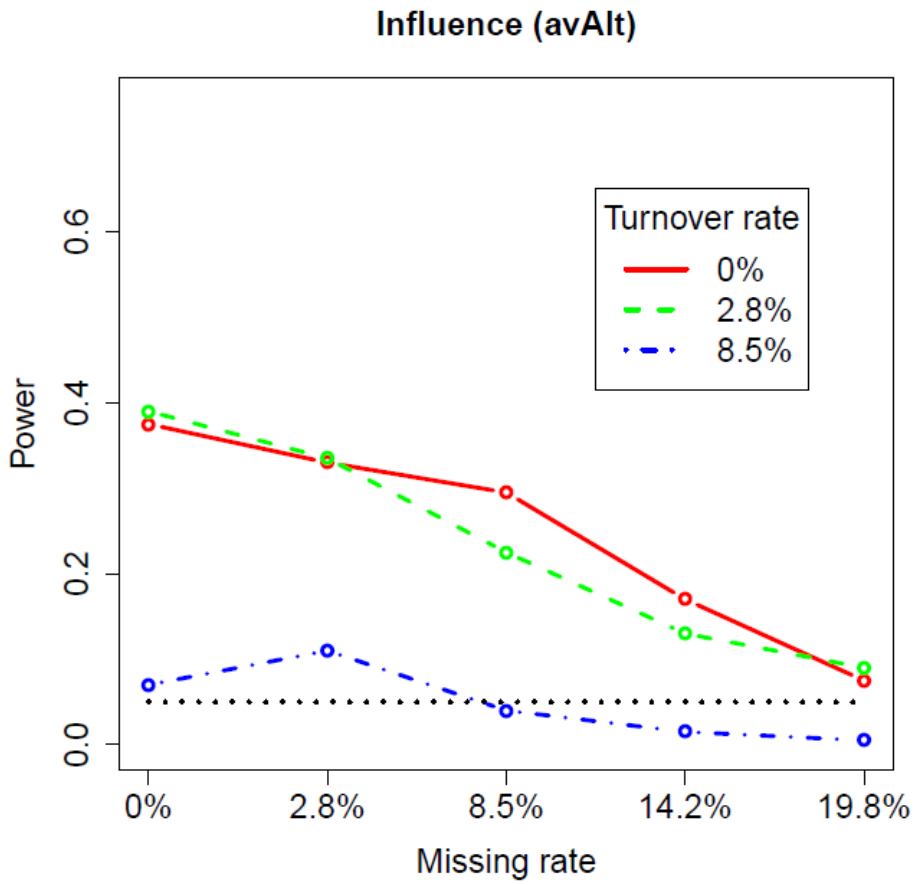
Mechanism	SIENA effect name	Parameter
Network change	`rate`	4.3
Density	`density`	-3.1
Reciprocity	`recip`	2.4
Transitivity	`transTrip`	1.2
Reciprocity in triads	`transRecTrip`	-0.8
Homophily Sex	`sameX`	0.6
Homophily Delinquency	`simX`	low: 0.4 / high: 0.6
Delinquency change rate	`rate`	1.3
Strive for delinquency	`linear`	-0.2
	`quad`	-0.2
Influence Delinquency	`avAlt`	low: 0.3 / high: 0.4

The research design is fixed, but the social mechanisms vary

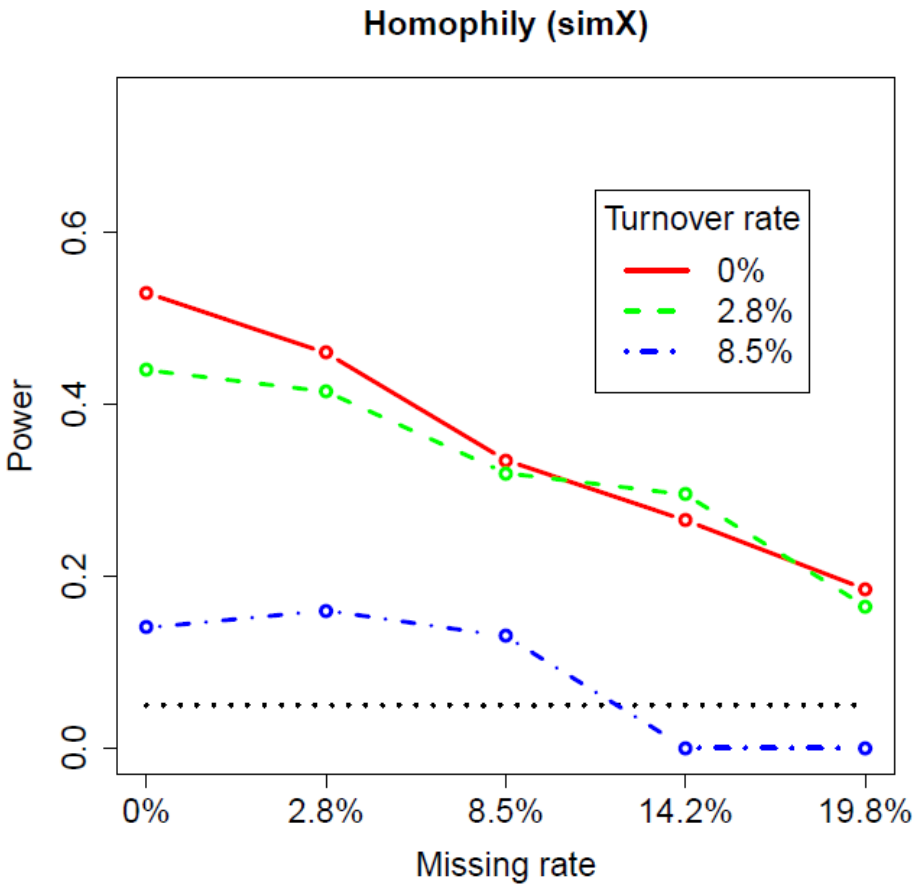
- Two additional social mechanisms are expected
  - Some individuals drop out after half of the period and are replaced by the same number of individuals with randomly drawn delinquency scores
  - Some individuals do not participate in a single questionnaire wave (complete random missing data)

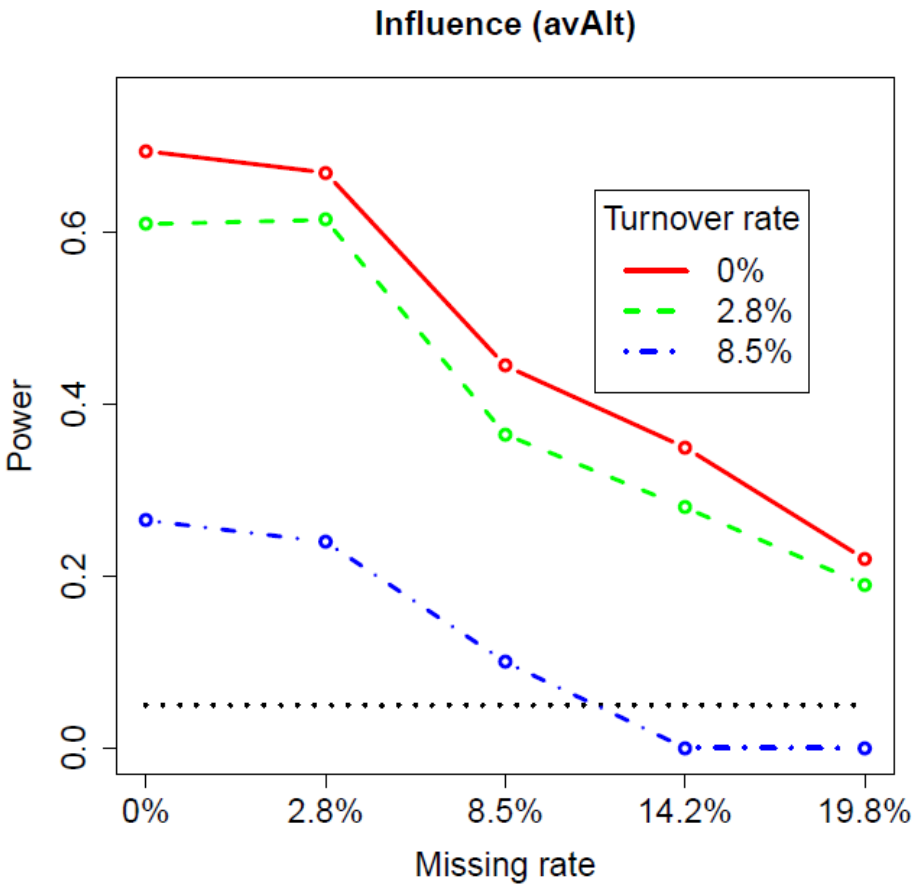
Power estimates for the model with low effect sizes





Power estimates for the model with larger effect sizes





Conclusions of the second power study

- Homophily power was lower than influence power. This is surprising at first, because homophily parameter are typically estimated on more observations (N times k, rather than N); in this study, however, k is small (1.4 in wave 1)
- The distributions of the individual variables matter; in this case the dispersion was very low (only 9.6% were in the two extreme categories 0 and 4); this affects the information carried by the cross-lagged statistics
  - ➔ try a Maximum Likelihood estimation
  - ➔ try defining a delinquency scale that carries more information for the population under study
- High turnover affects the convergence of the SIENA method – which is an issue when estimating the power

What can post-hoc power studies be used for?

1. Post-hoc power studies are irrelevant in the interpretation of results. The level of confidence about an estimate is already captured by its standard error (Cox, 1958; Goodman and Berlin, 1994; Senn, 2002; Lenth, 2007)
2. However, post-hoc *design analyses* may be useful when the assumptions about social mechanisms at play stem from prior expectations, rather than from empirical results
   (Gelman and Carlin, 2013)
3. The latter may motivate suggestions for future research

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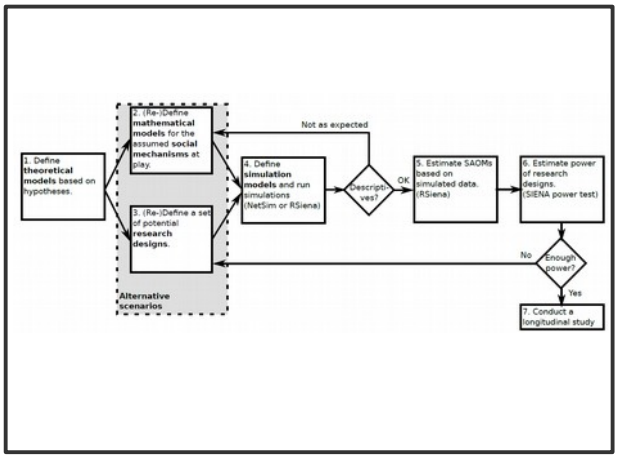
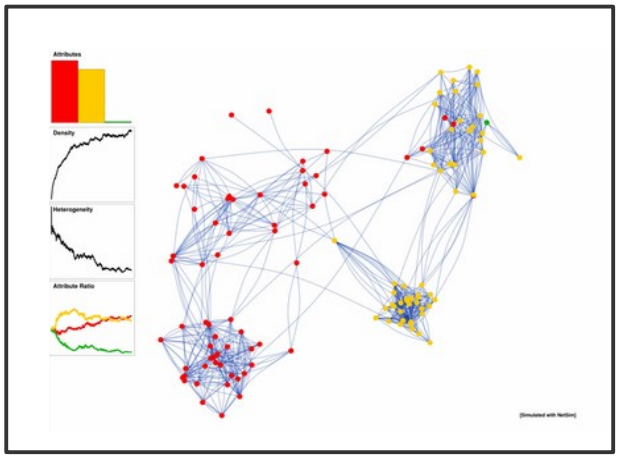
Statistical Power in Longitudinal Network Studies

A six-step procedure for the estimation of statistical power



Network size and number of waves matter



Missing data and participant turnover are critical issues