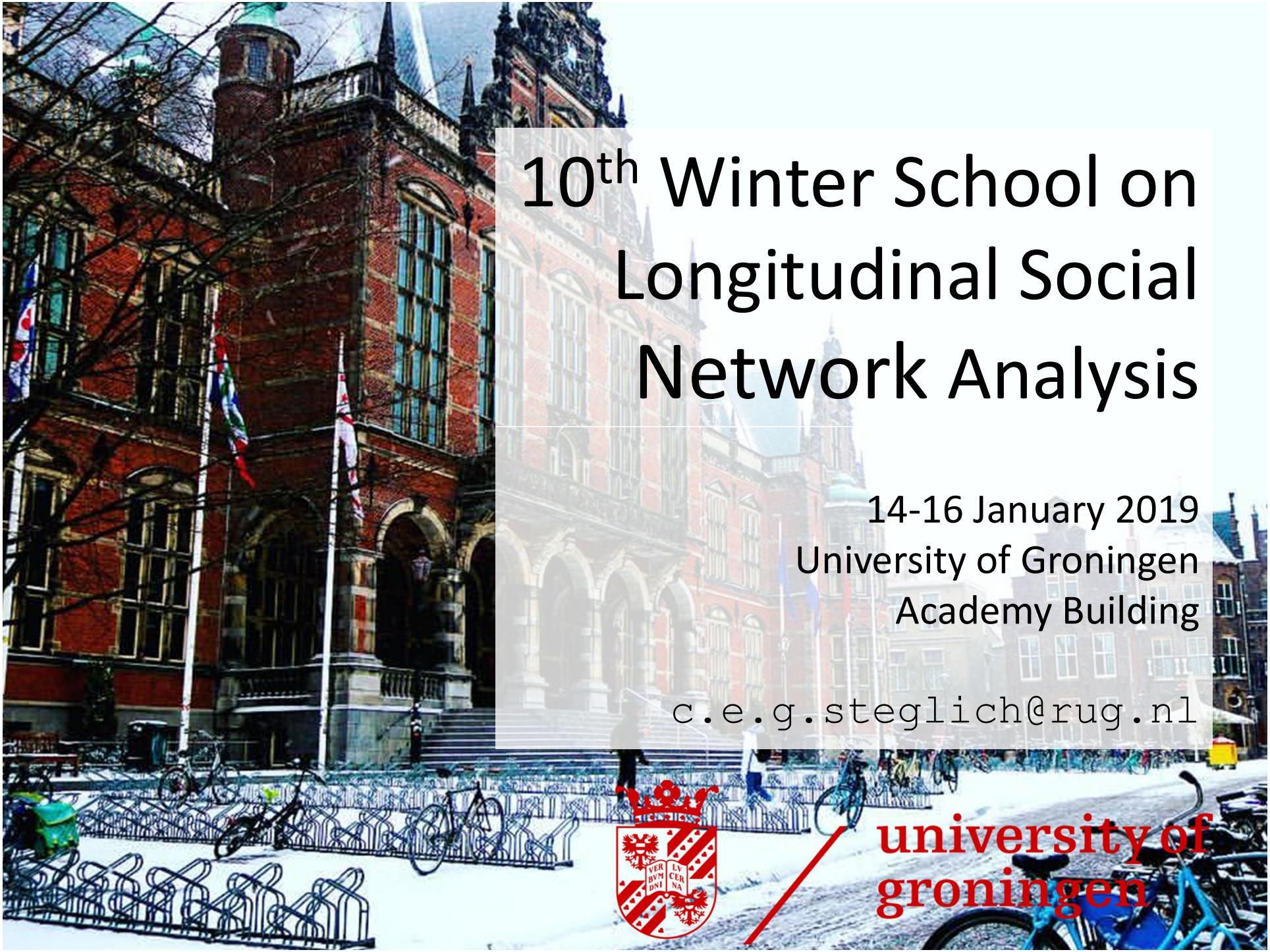

10th Winter School on Longitudinal Social Network Analysis

14-16 January 2019
University of Groningen
Academy Building

c.e.g.steglich@rug.nl

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Bipartite networks (two-mode, affiliation)

Technically, a bipartite (also called *two-mode*) network is a network where the nodes / vertices can be partitioned in *two sets* such that network ties occur *only between* the sets, *not within* them.

- Often these are affiliation-type relations.
  - Clubs & members
  - Authors & articles
  - Venues & visitors
  - Boards & directors
  - Amazon clients & books purchased
- Not always very “social” a network, but…

Ron Breiger, 1974:
Duality of groups and people

modern network version of Simmel's (1908) *intersection of social circles*

- Not only are groups defined by the people that belong to them…
- …but also people are defined by the groups they belong to.

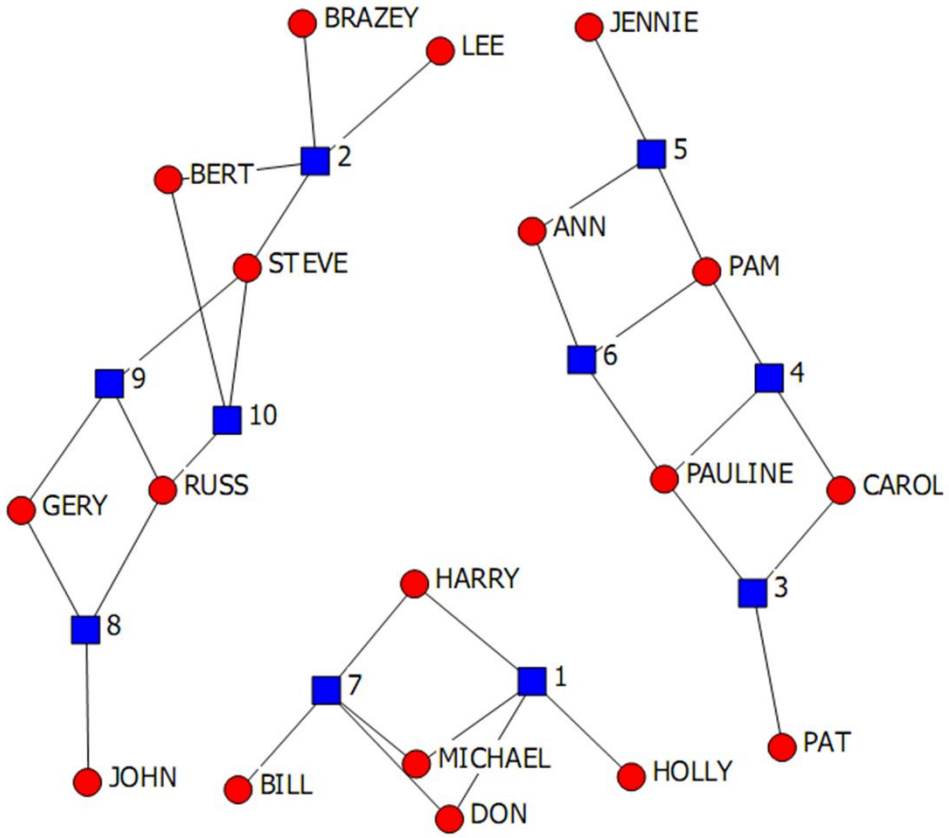
Groups & people constitute a two-mode network

- First mode: people; second mode: groups
- "Affiliation to a group" is the network relation between the two modes.

Possibility to represent social contexts (exogenous, or endogenous).

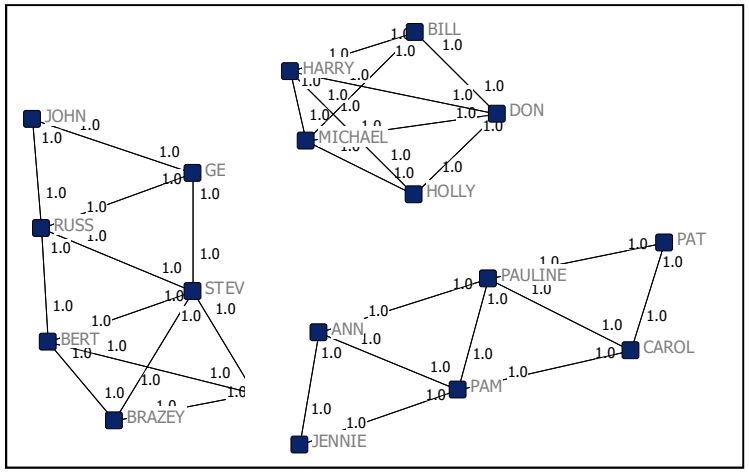
Example 'endogenous'

- Cliques and people in the (symm.) CAMPNET data set
- Ties exist only between nodes of different modes. The original CAMPNET network is not shown here, but could be added (other-type links between the red circles).
- Three components in the two-mode network, corresponding to three network regions in the original CAMPNET

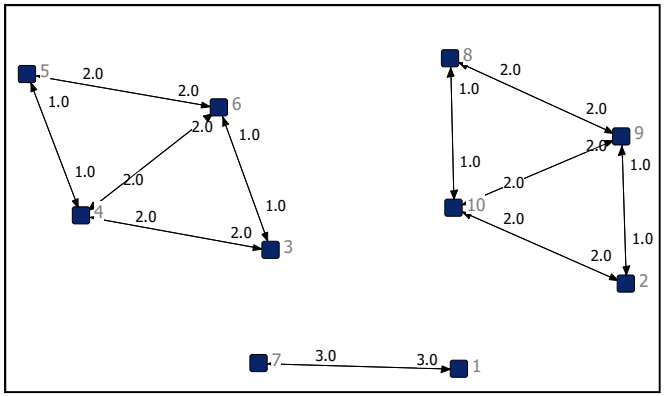


Projections of two-mode data to one-mode data

Actor-by-actor



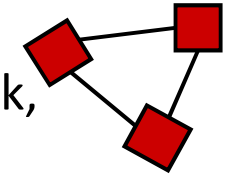
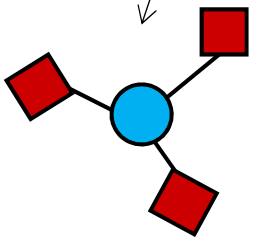
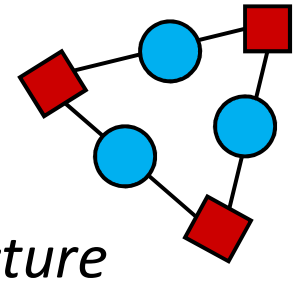
Clique-by-clique



- Projections are valued networks of co-occurrence counts
  - *How many cliques do two actors share (i.e., co-occur in)?*
  - *How many actors do two cliques share?*

Problems with such projections

Non-uniqueness of origin (in particular after binarising)

Example: the projection  could be obtained either from this 2-mode network,  or from this one: 

When observing a one-mode clique structure in a projected network, this can come from a two-mode star structure (left) or from three independent links (right).

A lot of research on co-authorship networks ignores the first possibility and (wrongly) interprets the upper triangle as transitivity…

More on the problems …

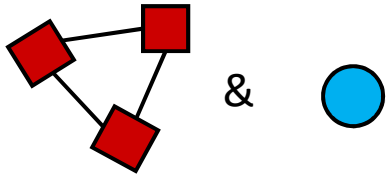
- Common wisdom by now: A lot of information can be lost by projecting two-mode data.
- But how severe is this really?

  Martin Everett showed:
  When keeping both projections plus the count info (i.e., the full valued projection matrices), then you can typically reconstruct the original two-mode matrix!

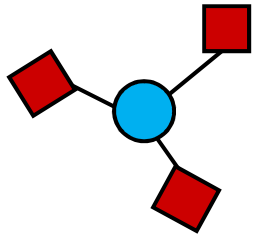
- Conclusion: Do this! (1) don't work with just one projection, but keep the full "dual" data, and (2) don't forget the values, i.e., don't binarise!

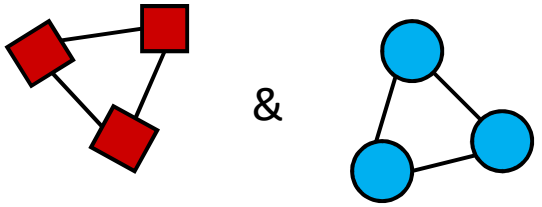
Example revisited:

There is uniqueness of origin if you keep track of <u>both</u> projections:

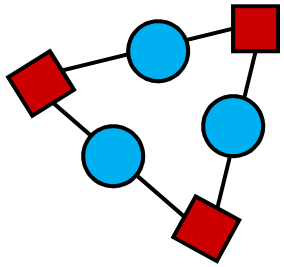


result from projecting





result from projecting



In this example, tie values in the projected networks all are one.

Peer influence in two-mode networks

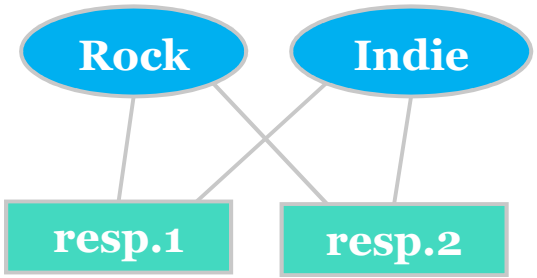
Suppose you ask a battery of items to any set of respondents…

43. Which of the following types of music do you like listening to? Tick one or more boxes.

Rock	☐	*Indie*	☐
Chart music	☐	*Jazz*	☐
Reggae	☐	*Classical*	☐
Dance	☐	*60's/70's*	☐
Heavy Metal	☐	*House*	☐
Techno	☐	*Grunge*	☐
Folk/Traditional	☐	*Rap*	☐
Rave	☐	*Hip Hop*	☐

Other (what?).....

… then you can create a two-mode network from the responses:



a four-cycle structure, frequent in two-mode data

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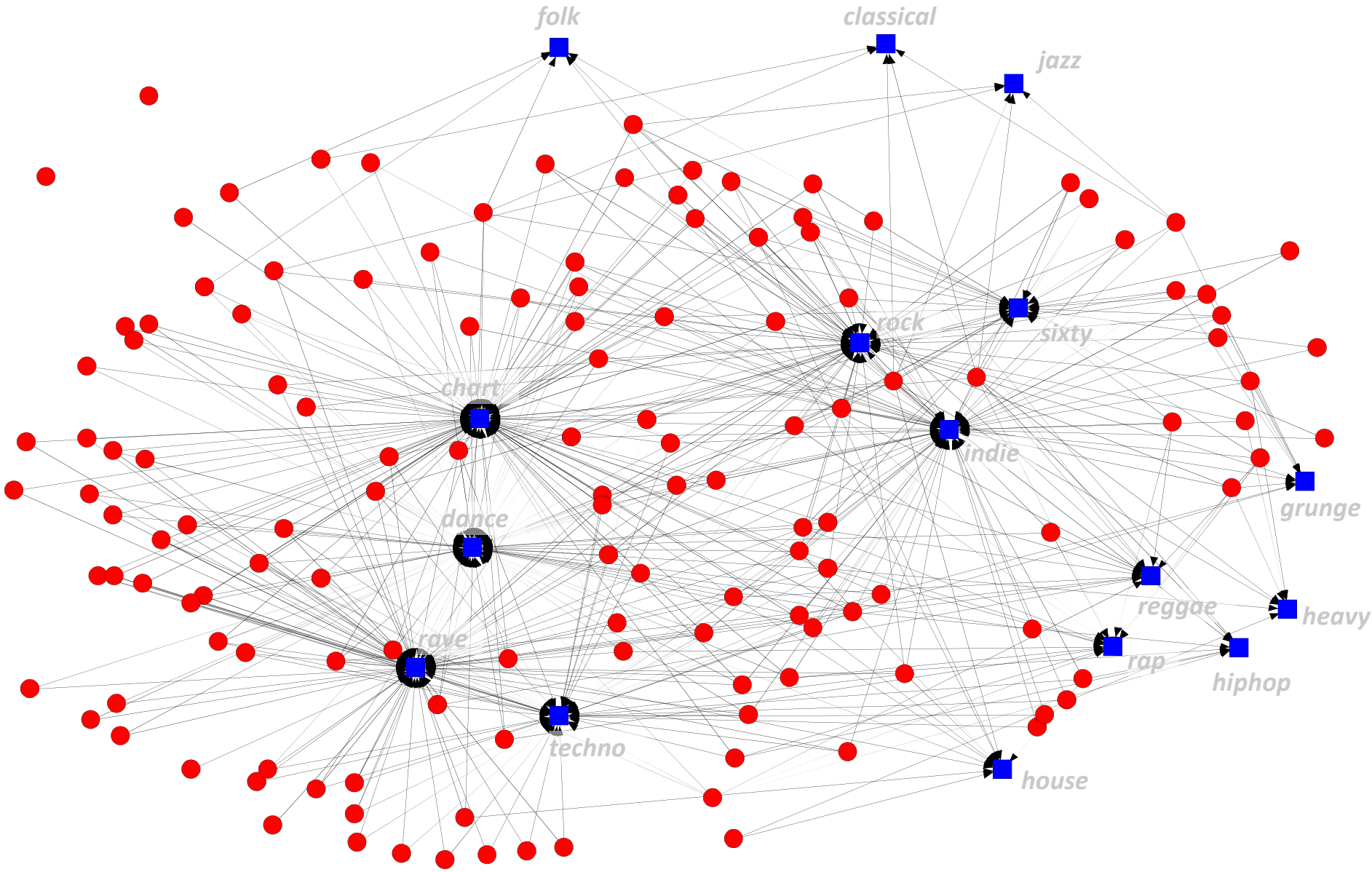
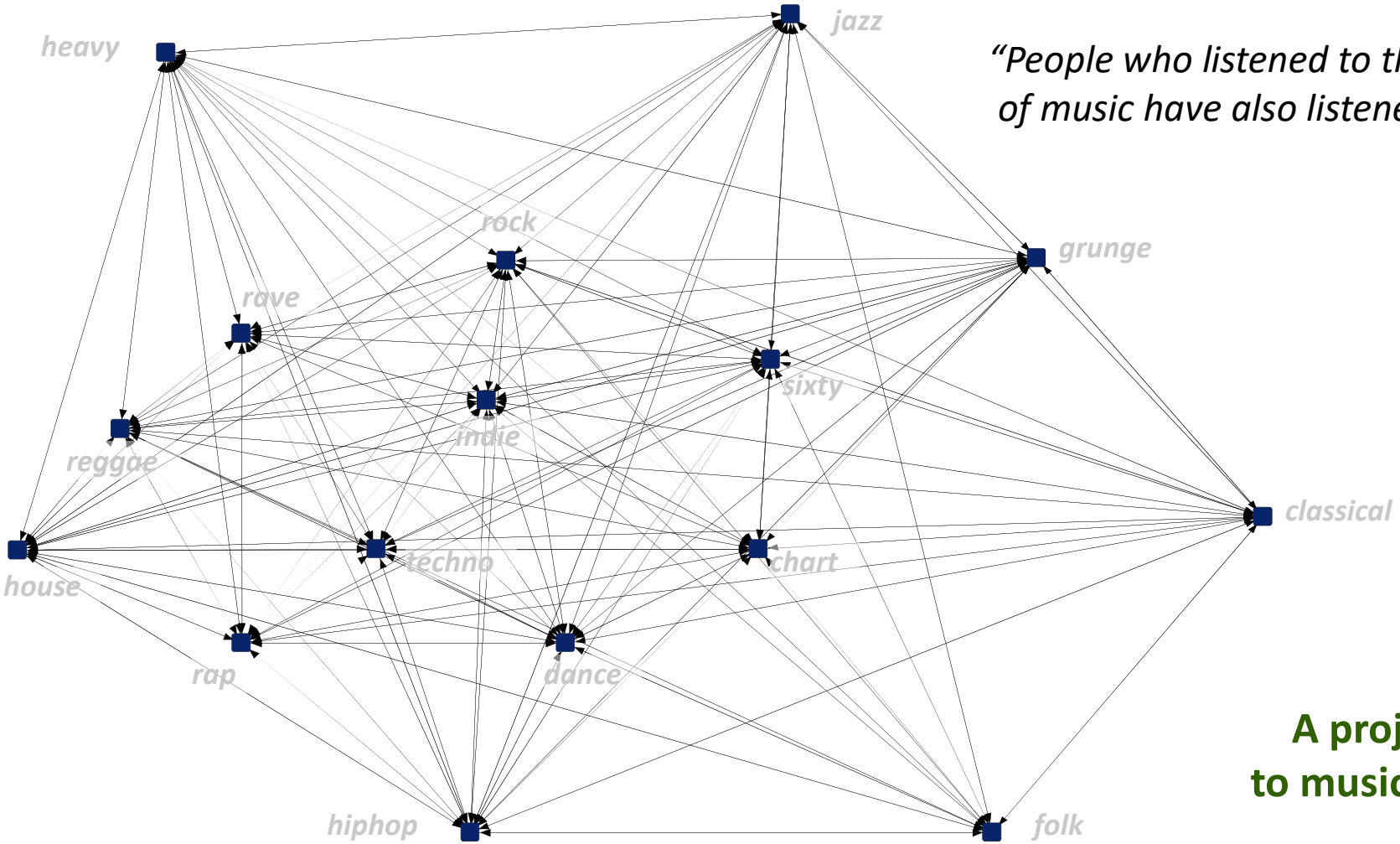
Two-mode network of music styles by listeners





"People who listened to this type of music have also listened to…"

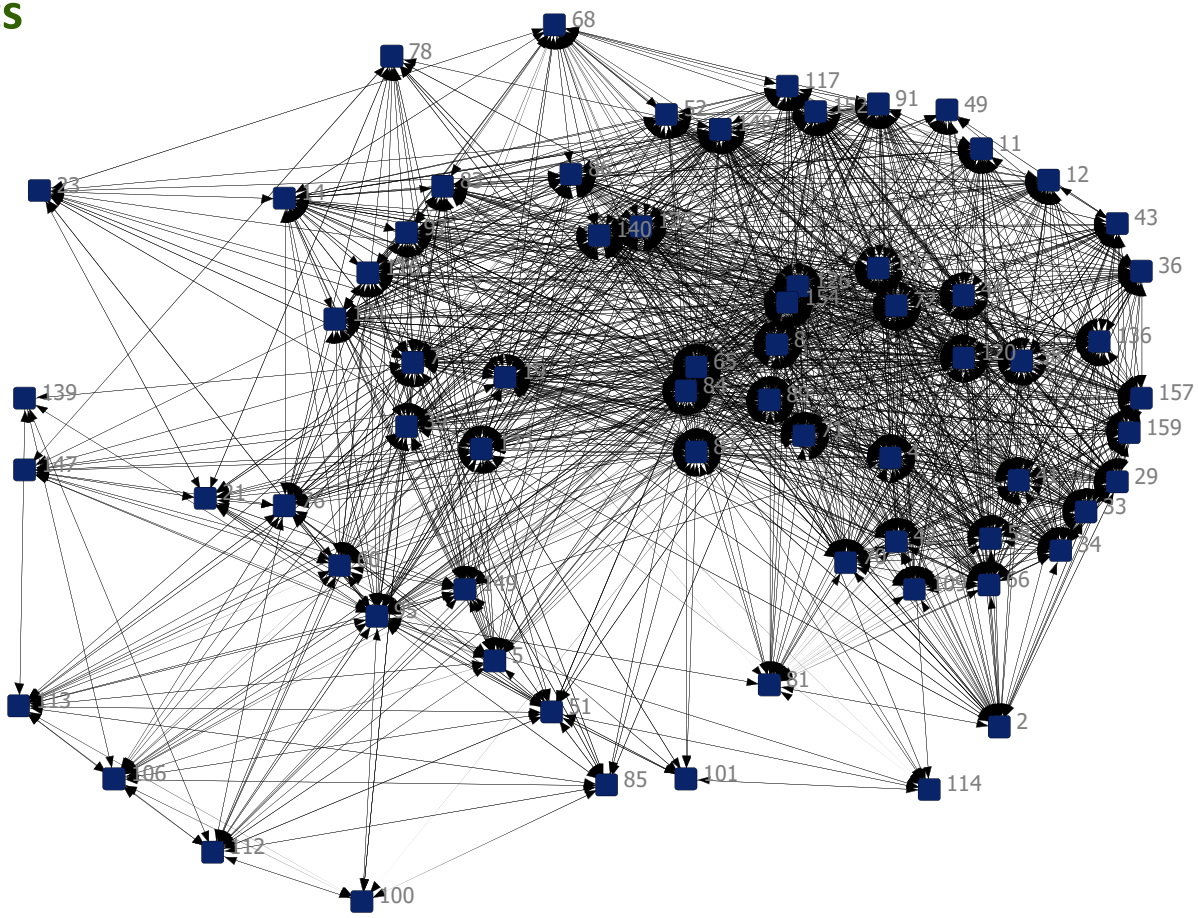
A projection to music items

A projection to respondents

Link width corresponds to number of music styles co-listened-to.

Two-mode data from survey questionnaires generally don't lead to 'social' networks in the sense of this course!

But they illustrate "homophily potential" – here based on shared music tastes.



What options does RSiena offer for analysing two-mode networks?

First of all, additional model assumptions are made:

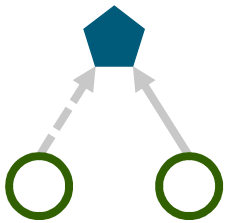
Both node sets must be stable over time.

→ *This rules out co-authorship and other event-type second modes! A journal article cannot be repeated.*

Besides this, the differences to the "usual" modelling are mainly in the special type of effects that one can select in a model specification.

Some examples on the following slides…

Some effects for modelling the dynamics of bipartite networks

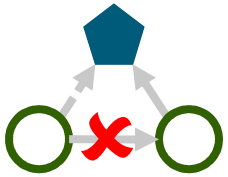


Indegree popularity
"Matthew effect"

Not really new, it is an effect that also can be included in normal 'one mode' networks.

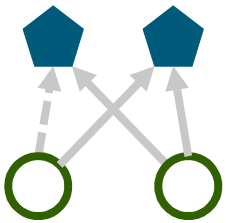
Several other "normal one mode effects" do not exist for two-mode networks:

reciprocity



transitivity

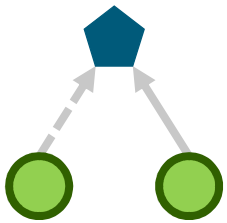
etc.



4-cycle effect
"Amazon recommender"

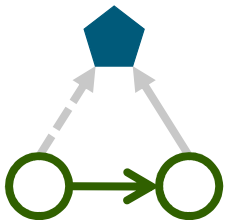
Expresses *peer influence* and/or *group formation* in two-mode networks

More effects for modelling the dynamics of two-mode networks: exogenous variables



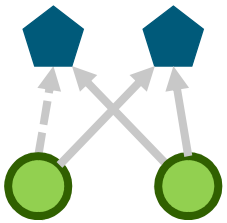
Similarity-to-agreement

Similarity on an individual variable (here ***green colour***) may lead to the choice of the same clubs.



Network-to-agreement

Also a normal one-mode network (here ***friend-ship***) can lead to the choice of the same clubs.



4-cycle × similarity

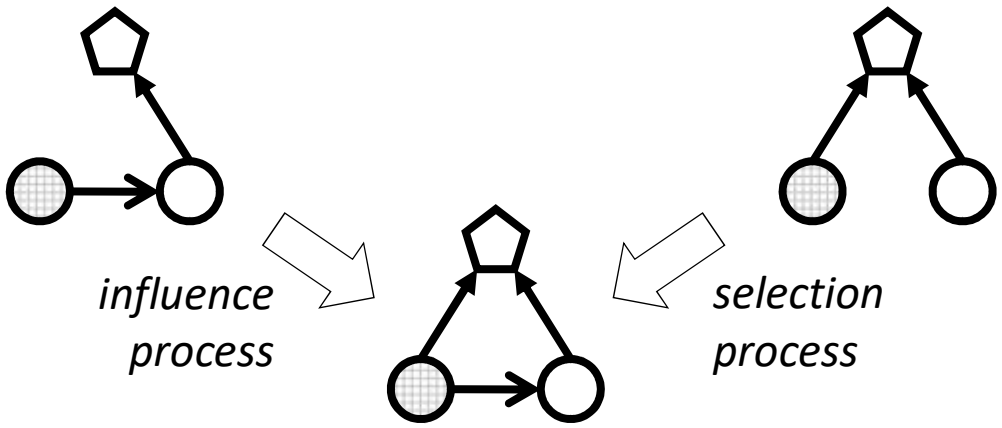
Copying the behaviour of those who are similar to you on an individual variable.

etc.

Conjugate mechanism for binary influence

possible preceding state #1

possible preceding state #2



my network contact has the same affiliation as I have

Which process occurs?

Voted-on topics

1. Moderation (18 votes)
2. Forward & backward model selection (14)
3. Valued networks (9)
4. Other models of network dynamics (9)

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1. Moderation

= working with interaction effects.

Crucial Rsiena command:

```
includeInteraction()
```

It is used as follows (snippet from lab script):

```
ModerationModel <- includeInteraction(ModerationModel,
 recip,simX,interaction1=c("","drinking"),
  name="friendship")
```

up to 3 interacted effects ..

.. and a vector of the same length indicating the required variable names per effect

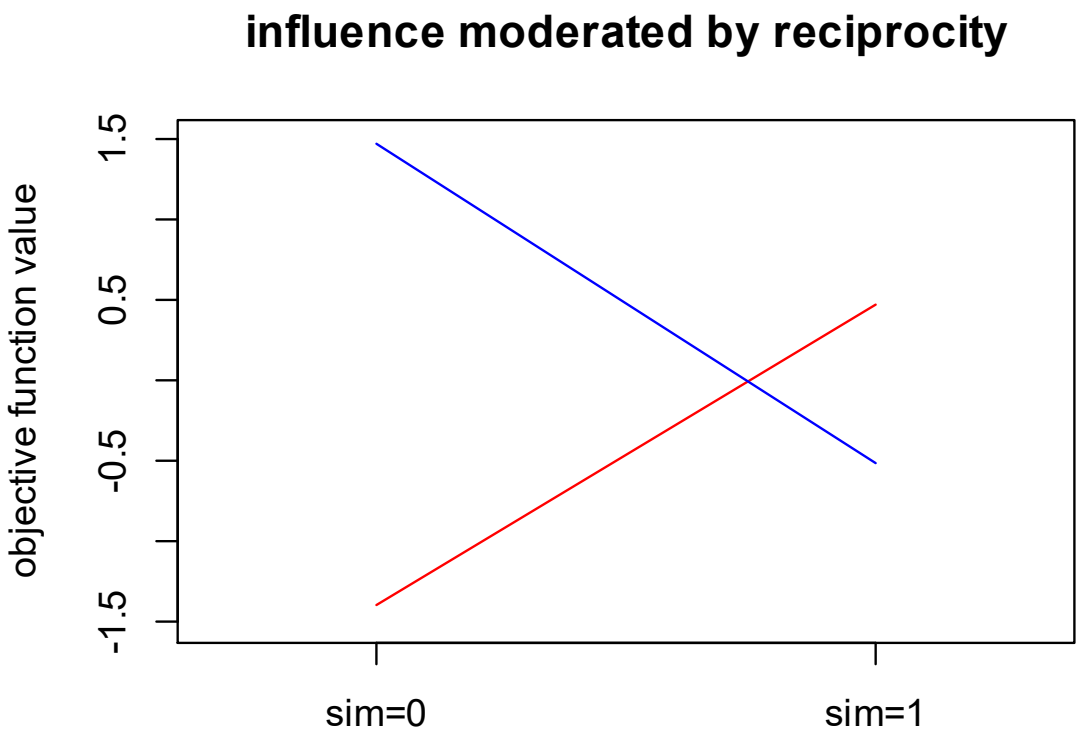
Some interactions are pre-programmed

E.g., ”influence in reciprocal friendship dyads”

`avSimRec`, `avAltRec` etc.

Consult Manual!

With some extra effort, plots can be made



Girls prefer to be similar to their reciprocated friends.

They prefer to be dissimilar to their unreciprocated friends.

2. Forward & backward model selection

See Chapter 8 of the Manual! Comparison of nested models:

- Both models estimated: Likelihood ratio (type) tests

  Not facilitated.

- Only larger model estimated: Wald tests

  Facilitated with functions `Wald.RSiena()` and `Multipar.RSiena()`.

  Used in backward model selection procedure.

- Only smaller model estimated: Score (type) tests

  Facilitated with function `score.Test()`.

  Used in forward model selection procedure.

Backward model selection

- Start with big model.
- Drop parameters based on non-significant Wald test results.

Problematic: Data driven. Big model may not be possible to estimate due to collinearity issues, and/or take very long calculation times.

Forward model selection

- Start with small model, but score-test candidate effects to add.
- Add parameters based on significant score test results.

Problematic: Also data driven. Suppressor effects hard to detect this way.

Advantage: ”It works”, non-convergence is avoided, can help with decision making when theory is silent about operationalisations.

3. Valued networks

See R-Script *RscriptSienaOrdered.R* on Siena webpage.

4. Other models of network dynamics

See paper by Block, Koskinen, Hollway, Steglich & Stadtfeld.

c.e.g.steglich@rug.nl

https://steglich.gmw.rug.nl

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