Dynamic Social Network: An Analysis of Teenage Lifestyle study

SECTION 1: DATA

Data description:

The teenage lifestyle study aimed to identify processes by which the attitude towards smoking and smoking behaviour changed over mid-adolescence. Data was recorded at three points of time over two cohorts. Students were followed over two years starting at age 13 to age 15. 160 students were part of this cohort, 129 of them were present through all three measurement points. Friendship networks were formed where students were allowed to name 6 friends. The students were asked for what they do at leisure time and what substances they use based on which friendship networks were formed.

Data source:

https://www.stats.ox.ac.uk/~snijders/siena/Glasgow_data.htm

Number of nodes/ edges:

4 node sets: Number of pupils (160), Number of Leisure Items (15), Number of music items (16), Number of drug items (14)

Node attributes:

Pupil: Friendship (best friend, just a friend, no friend), sex (M/F), age

Leisure Items: Frequency (Most days, once a week, once a month, less often or never)

Music: Listen (Rock, Classical, Techno)

Substances: Alcohol (None, once or twice a year, once a month, once a week, more than once a week)

Edge attributes:

Age: Between 1995 and 1997

Edge relations:

Friendship->friendship strength, Alcohol->degree of use, music->music style, leisure->degree of participation in leisure activity

SECTION 2: ANALYIS

This study focuses on the social network data collected in the Teenage Friends and Lifestyle study. It covers pupils at a school in West of Scotland for which friendship network data, substance use and several lifestyle variables were recorded in three waves(for analysis) and four waves(for visualization) starting in 1995 with pupils aged 13 and ending in 1997. The number of participating respondents was 150 in the first wave, 146 in the second, and 137 in the third. More than two thirds of the changes in participation are due to pupils leaving or joining the school; the rest are occasional missing values. In total, 160 pupils took part in the study, of which 129 were present at all measurement points. While in principle SIENA allows for special treatment of joiners and leavers, this study include only the complete cases for analyses. The main reason for this was the resulting reduction of expected estimation time by about one third, combined with results of exploratory analyses that did not reveal any qualitative differences between the full sample and the complete cases subsample.

The specification of an actor-driven model is done by defining, for each of the dimensions that co-evolve, a rate function and an objective function. The rate function indicates the speed at which the network actors get an opportunity to change their behaviour on the respective dimension, while the objective function indicates what such changes look like. This amounts to the specification of rate and objective functions for the network evolution part, for the three music dimensions identified, and for the alcohol dimension—a total of 10 functions. In order to keep things simple, it is assumed that the five rate functions are period-wise constant for each of the coevolving dimensions, that is, we estimate one basic rate parameter for each period and each dynamic dimension.

For network evolution, it is assumed that actors express some basic tendencies that are well known to play a role in friendship networks.

• Out degree effect- Negative effect: Actors tend not to establish friendship with unspecific others.

• Reciprocity effect- Actors tend to reciprocate friendship.

• Distance-2 effect- Negative effect: Actors tend to avoid indirect relations via third parties.

• Gender homophily effect- Actors tend to prefer same gender friendships.

• Gender ego effect- Boys and girls may differ in their preferred number of friends.

• Gender alters effect- Boys and girls may differ in popularity.

• Behaviour homophily effect- Actors may prefer friendship to others with the same music taste and/or alcohol-consumption level.

• Behaviour ego effect- Music taste and/or alcohol consumption may determine social activity.

• Behaviour alters effect- Music taste and/or alcohol consumption may determine popularity.

For behavioural evolution, it is assumed that the actors are affected by the following determinants:

• Tendency effect- Captures the overall preference for the three music dimensions and alcohol consumption.

• Assimilation effect- Actors tend to adapt to the music taste and/or alcohol consumption of their friends.

• Gender effect- Boys and girls may differ in music taste and/or alcohol consumption.

• Other behaviours' effects- Alcohol consumption and the preference for the three music dimensions may affect each other.

The result of the analysis is shown in the table below. In the friendship part of the model, a negative out-degree parameter indicates that friendship tends to be avoided, unless there is a desirable parameter (like reciprocation, or same-gender friendship). Additionally, girls tend to be more active in friendship networks than boys, i.e., they tend to have more friends than boys as indicated by the parameter gender ego. With regards to the impact of music on friendship dynamics, there is a positive

effect of listening to rock on popularity (parameter rock alter), homophily according to classical listening habits, and a positive effect of classical listening on activity (parameter classical ego). For the popularity-ranking hypothesis, this means that if there is a status hierarchy based on music listening, it is the rock listeners that are highest in this hierarchy (parameter rock alter) while classical listeners are lowest (because they are equally shunned by techno as well as rock listeners). As expected, alcohol consumption has a strong impact on friendship in terms of homophily. As a result of the analysis, a majority of the pupils listening to music is summarized in the techno and rock scales, for which the hypotheses are confirmed and there is a preference for rock music with higher social status. And there is a small group of mainly girls, listening to music styles in the classical scale because of reasons other than their school environment, barely drinking alcohol, and being avoided by most of their schoolmates. Their taste in music, though, seems to have appeal to the rock listeners, which makes it difficult to position these pupils on the social hierarchy.

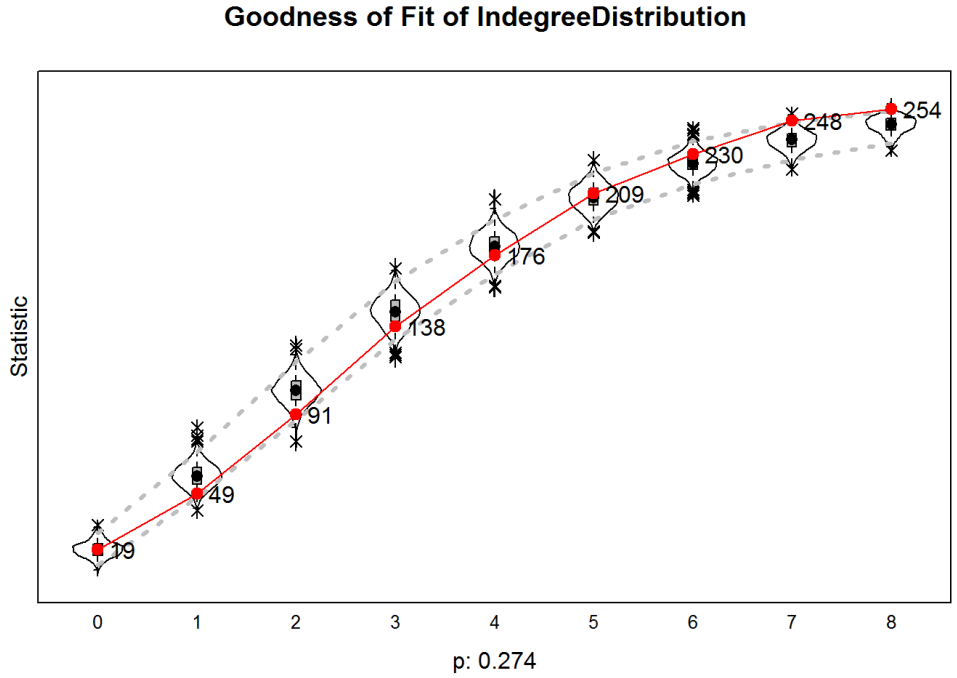
Model	Parameter	Estimate	pvalue

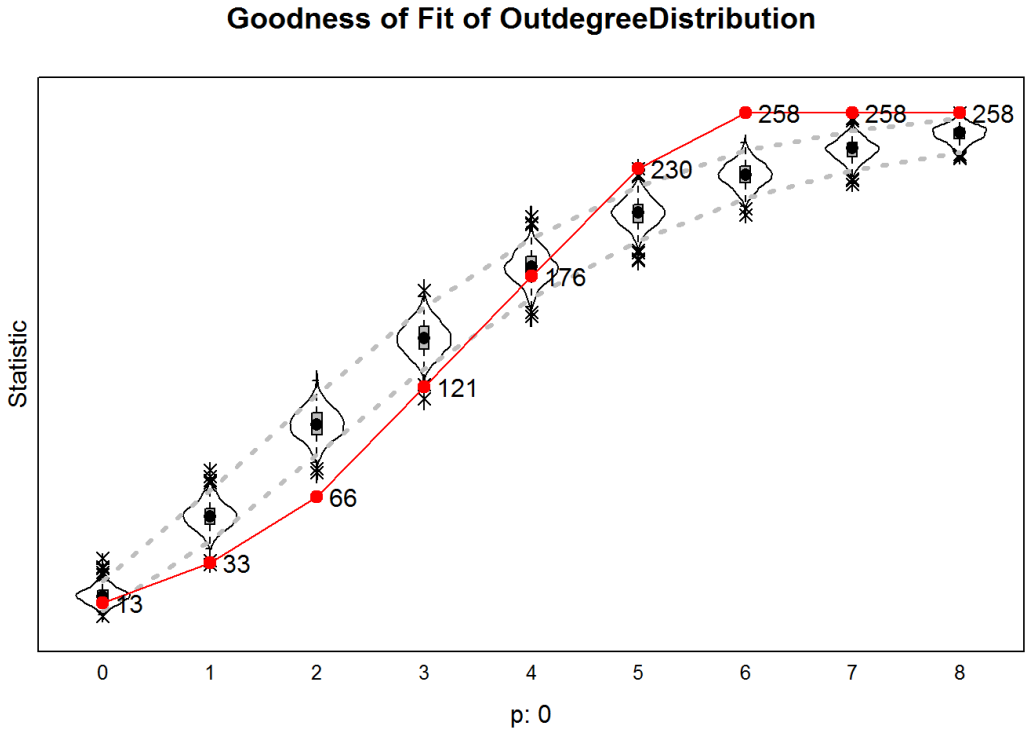
Network	Out degree	-1.89	<0.001
	reciprocity	2.34	<0.001
	Distance-2	-1.09	<0.001
	Gender homophily	0.80	<0.001
	Gender ego	0.24	<0.001
	Gender alter	-0.21	0.030
	Techno homophily	0.80	<0.001
	Techno ego	0.24	<0.001
	Techno alter	-0.21	0.030
	Rock homophily	0.11	0.791
	Rock ego	-0.07	0.357
	Rock alter	0.19	0.006
	Classical homophily	1.44	0.039
	Classical ego	0.40	0.015
	Classical alter	0.15	0.362
	Alcohol homophily	0.83	0.002
	Alcohol ego	-0.03	0.397
	Alcohol alter	-0.03	0.456
	Rate period 1	12.45	<0.001
	Rate period 2	9.56	<0.001
Alcohol	Tendency	-0.30	0.420
	Assimilation	0.94	<0.001
	gender	-0.06	0.745
	Rate period 1	1.54	<0.001
	Rate period 2	2.50	<0.001

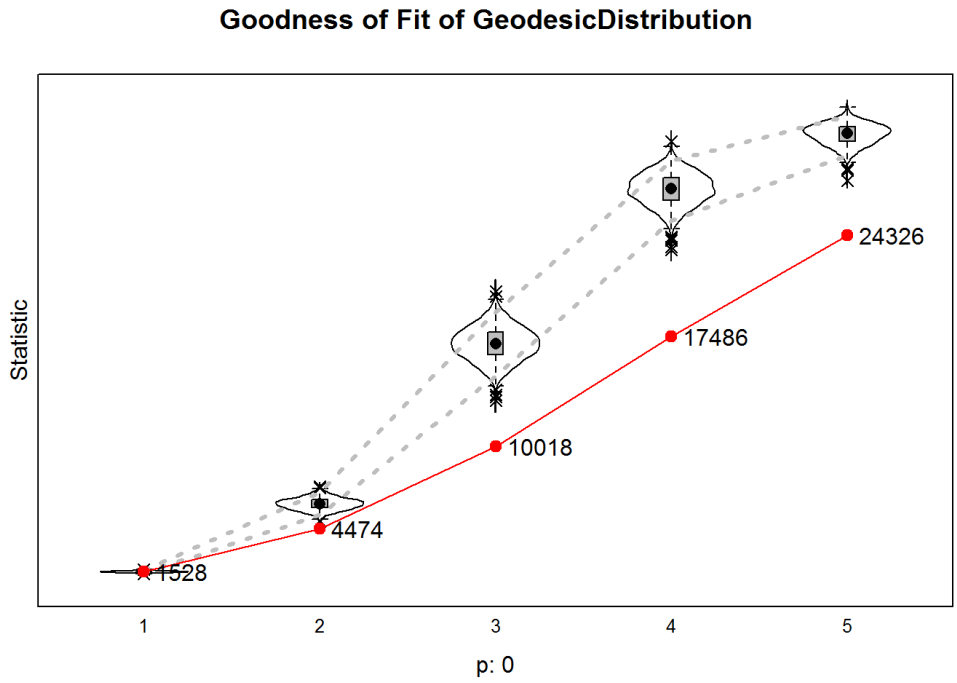
Table: SIENA estimation results for the full model (α=0.05) (two-sided t-tests)

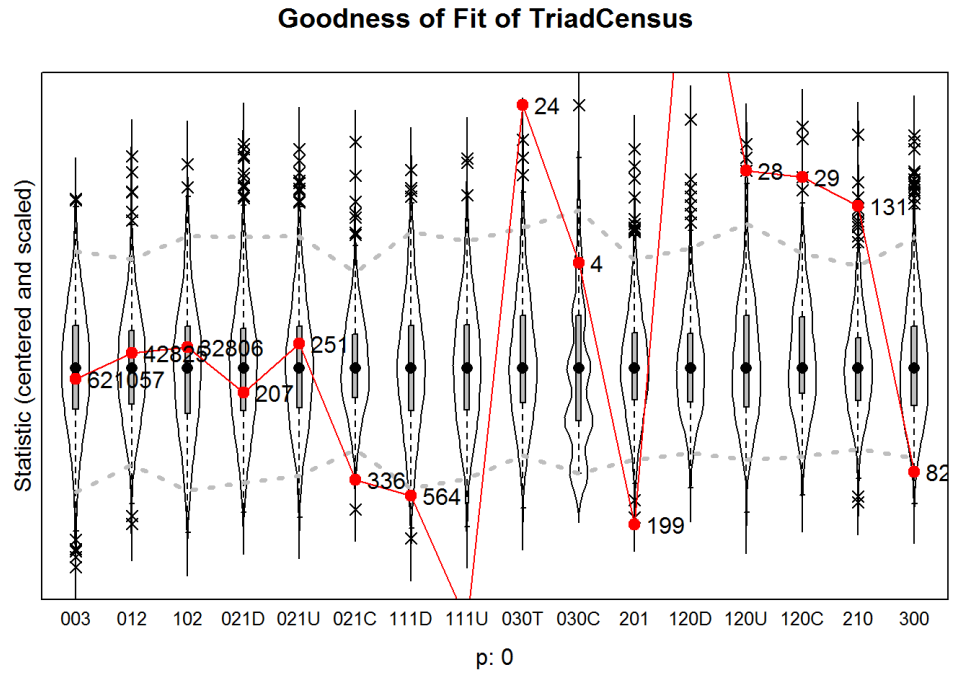
SECTION 3: MODELS AND VISUALIZATION

The best model is the one where the significant effects are reciprocity, geometrically weighted edgewise shared partners, and 3 cycles(all positive) and transitive reciprocated triplets, out degree popularity, and out degree activity(all negative) jointly give a good representation of the distributions of indegrees, outdegrees, and geodesic distances and of the triad census.



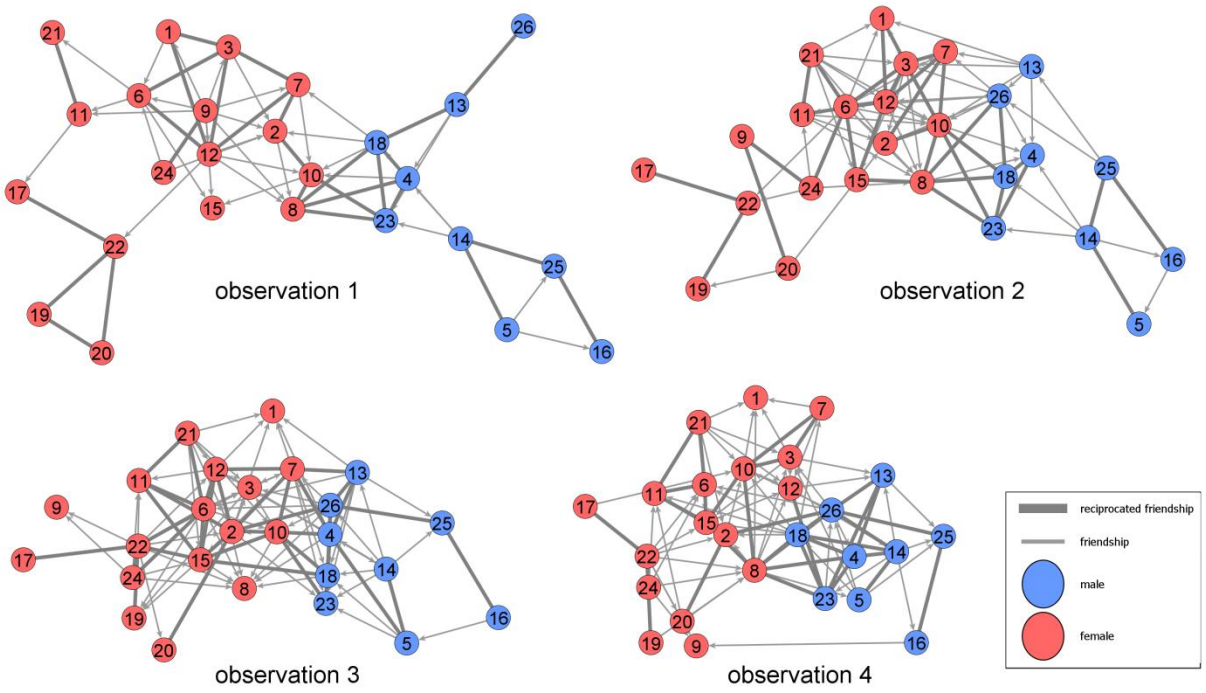






The above graphs show the goodness of fit of indegree distribution, outdegree distribution, geodesic distribution and triad census of the best model.

The visualization for this network was done using the Visone software for dynamic social network analysis and the following network was formed:



Keeping sex of the pupil as the constant covariate and the changing covariates being the use of alcohol and the type of music (leisure time activities), the above network displays the dynamic network changes from the initial friendship wave to the final wave over time period 3. Visone generates an animated graph that displays how the edges change and strengthen over time (over the three waves from the initial wave). The friendship networks (edges represent the friendship strength) are created with respect to the leisure time activity (alcohol, music, etc.) and the network is factorized by the sex of the student.

SECTION 4 : CONCLUSION

This study shows how analysis can be done on the dynamics of social network and behavioural analysis using actor-driven models. The data was estimated using SIENA which suggested a social hierarchy of music-listening habits, in which the rock dimension dominated the techno dimension. Listening habits on the classical dimension were shown to be related to a special group of pupils, and could not be positioned in this hierarchy. The result is rather exploratory than conclusive. Further, the study was limited to straightforward tests of model parameters, which express micro behaviour, that is, the actions of individuals. An area still underexplored is the empirical relationship of such micro

behaviour of network actors to macro phenomena like segregation or segmentation of a social network.

My huge take away from this project is a deeper understanding of dynamic social networks and the function of RSIENA in dynamic modelling. This study is only a small aspect of what RSIENA modelling can do and with more time a lot more can be exploited and explored with dynamic network modelling. Additionally, due to the time consuming learning process on how to apply RSIENA towards the model, adequate time couldn't be spent on the visualization aspect of the model as it could be improved a lot more and more aspects may be included towards creating a better model and a better visualization. This study definitely motivated me to think further on the applications of dynamic modelling and its various applications in social network analysis.