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Choices of Theatre Events: p* Models for Affiliation Networks with Attributes

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Abstract

In this article we analyse the choice of theatre performances made by theatregoers through the application of network analysis. We use the institution in which the events are staged and the aesthetical expectations of the theatregoers as explanations for the choice patterns. By means of p* models, we are able to simultaneously analyse the patterns of choice, the loyalty to an institution and the co-attendance of events, and the diversity in audience composition. Based on an audience survey in three theatre institutions in the city of Ghent (Belgium), we show that theatregoers with unconventional expectations are more likely to attend plays of the less traditional institutions. Second, audiences are loyal to an institution irrespective of the existence of season tickets. People are more inclined to combine plays that are staged by the institutions with a similar programmation. Furthermore, we find that one institution has very similar audiences for different plays, whereas for others the composition of the audiences differs significantly with regard to aesthetic expectations between different plays.

1 Introduction

A central concern of many cultural institutions is to gain insight in the composition of their audience. Based on data collected via box office systems, internet bookings or audience surveys, the institutions try to map and analyse a diversity of personal, aesthetical and attitudinal characteristics of their audience (Griggs and Alt, 1982; Roose and Waege, 2002). This kind of research seldom includes information on the loyalty – or mobility – of an audience for a certain cultural institution. In other words, in how far do the culturally active combine

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cultural events from different institutions? In this article we want to come to a better understanding of the mobility of members of a theatre audience between different theatres.

This insight is relevant to be able to evaluate the existence or development of a programming policy aimed at a certain target audience. Some theatres aim at a so-called structural audience – a home-loving audience as it were. In this case, season-tickets are of vital importance to be able to 'bind' the audience. Others redefine their target audience *ad hoc* depending on the specific performance. Still others combine both approaches (Dingena and Van der Vlugt, 1999). Do these initiatives make a difference? Is the audience of a certain theatre more loyal or mobile than another? If they are mobile, what performances do they combine? etc. This is especially interesting for cultural marketeers who want to develop certain formulas of subscription. The existence of networks of performances within or between theatre institutions can initiate the development of combi-tickets or reduced entrance fees.

Basically, two research questions will be addressed:

- Are the patterns of choice related to the attributes of the performances (e.g. the institution)?
- Do the attributes of the person making the choice (e.g. educational attainment) explain the pattern of choice?

The choices of theatre performances can be seen as '2-mode' or 'affiliation'-networks (Wasserman and Faust, 1994). A 2-mode network is a form of social network with 2 sets: a set of events (theatre performances) and a set of actors (the audience). The ties in a network between these two sets represent choices made by the audience and are the basis of a bipartite graph.

Hence, we can apply social network analysis methods to address the questions which events are (often) chosen together and how to explain these specific choices. Whether a specific person decides to attend a specific event depends on the characteristics of this event and on the expectations that a person has of a theatre event. Therefore, when investigating the patterns that underlie the choices of events that people make, it is not enough to consider the characteristics of the event itself, or to consider the characteristics of the actor. A complete picture is only possible if one looks at the combinations of characteristics of events and features or expectations of actors at the same time. An obvious choice to combine both perspectives is social network analysis.

We will focus on the local patterns that can be identified in order to capture the overall structure. The choices of events by actors can be seen as one of these local patterns to be unveiled in a two-mode network (Skvoretz and Faust, 1999).

2 Conventional versus unconventional expectations of theatregoers

Our assumption is that, when making the decision to attend a specific theatre performance, theatregoers are influenced by 1) their aesthetical expectations and 2) the characteristics of the institution where the performance is staged (characteristics of the performances). More specifically, we will analyse whether theatregoers with conventional expectations have other choice patterns than persons who are more unconventional in their expectations.

The idea of conventionality has its roots in a larger theoretical framework that tries to account for and capture the aesthetical expectations theatregoers have towards plays (see Van Heusden and Jongeneel, 1993; Roose and Waege, 2002). It is part of a number of criteria by means of which people judge theatre performances. The conventionality/unconventionality axis refers to judgements guided by the wish to see the theatrical conventions challenged, to see an original direction of the play and to see the theatrical treatment of real life situations problematized. In short, it is a tendency to judge plays more or less by their experimental character.

At the same time the characteristics of the performances play a role: in what institution have they been staged ? What are the characteristics of the institution? Do they have a specific audience policy, season tickets, etc.?

Vooruit can be characterized as an institution that offers a contemporary, professional and high-quality mix of dance, theatre and music performances. Most theatre companies that are staged already have a certain national *renommée* among the audience/critics. They have a season-ticket system.

Nieuwpoorttheater is somewhat similar to *Vooruit* with regard to the kind of plays they put on. Yet, *Nieuwpoorttheater* also tends to stage some less known/popular companies or performances by theatre students. They do not work with season tickets, but their marketing strategy is to attract a ‘new’ audience for every new production.

Publiekstheater stages high-quality, traditional drama, plays that already belong to the theatrical *canon*. They have a system with season tickets.

Based on these insights a number of hypotheses can be formulated.

Choices

1) First of all, we expect *Nieuwpoorttheater* and *Vooruit* to attract more people with unconventional expectations, since these theatre institutions – especially *Nieuwpoorttheater* – stage less traditional plays.

Loyalty towards institutions

2) People are more likely to choose events from the same institution. We suspect that for all 3 institutions, theatregoers are quite loyal in their choice of events.

3) We suspect that there is a higher loyalty in institutions who work with season tickets (i.e. *Vooruit* and *Publiekstheater*) than in the other institution (*Nieuwpoorttheater*).

4) Theatregoers with unconventional expectations are more omnivore[2] (Peterson and Kern, 1996) and will be more likely to switch between institutions than those with conventional expectations.

Diversity in the charactersictics of participants

5) Because of its very diverse programming *Vooruit* (and to a lesser extent *Nieuwpoorttheater*) will have more differentiation between events in the composition of their audience with regard to conventional/unconventional expectations.

3 Choices of theatre events: p* models for affiliation networks with attributes

In order to capture these local forces at work we make use of what has become known as p* models or exponential random graph models. These p* models were first developed for one-mode networks by Wasserman and Pattison (1996). Skvoretz and Faust (1999) have extended these to two-mode networks. Robins, Pattison and Elliott (2001) have proposed p* models for social influence processes. p* models for social selection processes have also been proposed (Robins, Elliott and Pattison, 2001). Faust (et al., 2002) expanded this type of models to affiliation models with attributes for actors and events in event 2-stars.
In order to test our hypotheses we include both actor and event 2-stars configurations with actor and event attributes. We will first expound on the p* model, and will then present the model for affiliation networks in which the attributes for both the actors and the events are taken into account.

3.1 Basic principles of p* models

Traditional statistical models for measuring local characteristics of social networks had to assume that the occurrence of a tie between i and k was independent of the occurrence of a tie between i and l or j and k. Only recently a group of models has been proposed, called p* models, in which this assumption no longer has to hold (Wasserman and Pattison, 1996). Based on the developments made by Frank and Strauss (1986) and Strauss and Ikeda (1990), the local characteristics can be estimated, be it approximately, using logistic regression (Wasserman and Pattison, 1996).

[2] Omnivore refers to the fact that higher educated cultural participants have a broad spectrum of taste, ranging from traditional high-brow taste to liking less legitimate genres and styles.

The probability of a graph G is formulated as a function of a vector of parameters θ and a vector of graph statistics y(G). For a specific graph the parameters have to be estimated so that the probability of the specific graph is maximized. In order to ensure that the sum of the probabilities over all possible graphs is equal to 1, a normalizing constant $Z(\theta)$ is introduced:

$$P(G) = \exp(\theta' * y(G)) / Z(\theta) \tag{3.1}$$

However in practice calculating the denominator Z(θ) in equation (3.1) is an almost impossible task. Therefore the equation (3.1) is reformulated in terms of a specific arc y_{ik} conditional on the rest of the graph G^{-ik}:

$$P(y_{ik} = 1 \mid G^{-ik}) = \frac{\exp(\theta' \cdot y(G^{+}))/Z(\theta)}{\exp(\theta' \cdot y(G^{+}))/Z(\theta) + \exp(\theta' \cdot y(G^{-}))/Z(\theta)} \tag{3.2}$$

When taking the odds of an arc being present versus absent given the rest of the graph, the resulting logit of an arc can be formulated as:

$$\left[\frac{P(y_{ik} = 1 \mid G^{\text{-ik}})}{P(y_{ik} = 0 \mid G^{\text{-ik}})}\right] = \frac{\exp(\theta' \cdot y(G^{+}))/Z(\theta)}{\exp(\theta' \cdot y(G^{-}))/Z(\theta)} \tag{3.3}$$

Since the denominator Z(θ) cancels out, the logit for $P(y_{ik}=1 \mid G^{-ik})$ becomes:

$$\text{Log}\left[\frac{P(y_{ik} = 1 \mid G^{\text{-ik}})}{P(y_{ik} = 0 \mid G^{\text{-ik}})}\right] = \frac{\exp(\theta' \cdot y(G^{+}))}{\exp(\theta' \cdot y(G^{-}))} = \theta' \cdot [y(G^{+}) - y(G^{-})] = \theta' \cdot [\delta(y)] \tag{3.4}$$

Thus the logit of an arc being present given the rest of the graph depends on a vector of properties of a graph if the tie between i and k is present, versus absent. The difference in a property of a graph is called the change score for that property δ(y) when considering the tie between i and k. The parameters for the corresponding change scores can then be estimated by logistic regression with standard statistical software. However, we need to be very careful when interpreting the results, since this is a pseudo-likelihood method and uncertainty exists about the properties of the estimation (Snijders, 2002).

3.2 Graph statistics for a 2-mode network with attributes

In order to build a model a selection has to be made among all possible properties of a graph. Commonly, the p* model makes the following three assumptions about the underlying model. First of all, a homogenous assumption is made, implying that the estimated parameter values apply for all nodes. This means that the patterns are independent of the specific actors or events. Because we include attributes we can identify a node up to a group. For example, an actor can either belong to a the group with highly educated people, or the group of lowly educated people. At the same time the events can be catalogued according to, for example, the theatre-group or the theatre institution where it is scheduled. In what follows we will use the homogenous assumption to build a p* model with both (be it different) attributes for actors and events.

Second, the Markov graph assumption is made, meaning that two ties are only dependent if they share a common node. This implies that the choice of an event by an actor is only dependent on the other events chosen by the same actor, and on the choice of the same event made by another actor.

A third restriction is that only different triangles and 2-stars are considered. Any configuration with more than 3 nodes are supposed not to have any influence.

The combination of these assumptions results in a homogenous Markov model of order 3.

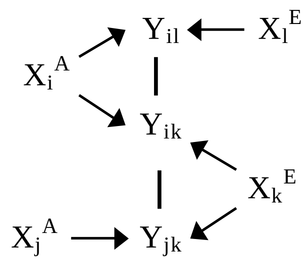

Figure 1: Directed dependence graph for affiliation network with attributes for actors and events.

For a set of N actors and M events a relational tie between actor i and event k exists if actor i chooses event k. The dependence in a network can be represented using a dependence graph. A dependence graph is a graph for a network, where the ties between two nodes is represented as a node in the dependence graph and the dependence between two ties is represented by a tie between the nodes in the dependence graph (Frank and Strauss, 1986). Following the notation of Robins, Elliott and Pattison (2001) we represent a relational tie between an actor i and an event k as a binary random variable Y_{ik}, where $Y_{ik} = 1$ if person i attended event j. We can assume that the attributes of the actors and the events determine the choices made and not vice versa. Following the argument developed by Robins, Elliott and Pattison (2001) the ties between the events and the actors are supposed to be the result of the attributes of both the actors and the events. In such a case, a directed dependence graph can be made where the attributes of the events and actors precede the ties between actors and events. The attribute for actor i is represented by X_i^A, and the attribute for event k is represented by X_k^E. These attributes can be seen as the parents, while the ties are the children in the graph. Therefore, we are dealing with a social selection process rather than a social influence model (where ties determine attributes).

For networks with two modes, the graph properties that fulfill these criteria can be grouped into 3 categories: choice (a tie between an actor and an event), actor 2-stars (the ties between an actor and 2 events), and event 2-star (the ties between an event and 2 actors).

4 Parameter estimation

4.1 Choice statistic

The simplest patterns in a network consists of a tie between an actor and an event (Figure 2). If a categorical actor-attribute with U categories and a categorical event-attribute with W categories is considered, U•W actor-event specific choice parameters can be calculated. These parameters are denoted as $C_{u,w}$, where the first subscript (u) refers to the attribute category of the actor and the second subscript (w) to the attribute of the event. In order to control for overall effects, W actor-specific, U event-specific parameters, and one general choice parameters are added to the model. We refer to the overall effect with the label "*A*".

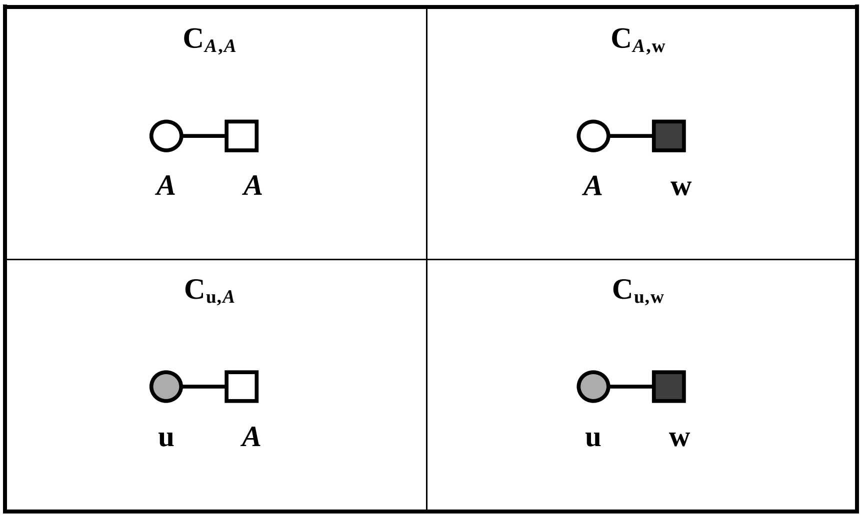

Figure 2: Graphical presentation of choice parameters with actor and event attributes (white = over all category).

As a result, these patterns can be subdivided into 4 different types: 1) a *general choice parameter* referring to the log odds of a tie (choice) irrespective of the attribute category of the actor or of the event ($C_{A,A}$), 2) *choice parameters* for each category (u) of the actor attribute but irrespective of the category for the attribute of the event ($C_{u,A}$), 3) *choice parameters* for each category (w) of the event-attribute but irrespective of the category for the attribute of the actor ($C_{A,w}$), 4) *choice parameters* for each combination of event attributes (u) times actor attributes (w) ($C_{u,w}$).

A graphical representation of the different types of choice parameters for a tie between an actor with attribute category u and an event with attribute category w is given in Figure 2.

The tie between actor i and event k is dependent on the attribute category of the actor and the attribute category of the event. The logit for these graph statistics can be found in equation (4.1):

$$\text{Logit } P(y_{ik} = 1 \text{ with } X_i^A = u \text{ and } X_k^E = w \mid G^{-ik})$$
$$= \theta_{C(A,A)}\, C_{A,A} + \theta_{C(u,A)}\, C_{u,A} + \theta_{C(A,w)}\, C_{A,w} + \theta_{C(u,w)}\, C_{u,w} \qquad (4.1)$$

The general choice parameter ($C_{A,A}$) in equation (4.1) refers to the density of the 2-mode network and is calculated as the mean effect of choice over all categories of actors (W) and events (u). All other choice parameters are compared to this general choice parameter. The actor-attribute specific ($C_{u,A}$) and event-attribute specific parameters ($C_{A,w}$) are also the mean of all event-specific, respectively actor-specific effects. As a result (U+W-1) of the actor-event-specific parameters ($C_{u,w}$) and one parameter of the actor-specific and event-specific parameters are linear dependent on the other parameters of the same type.

$$\sum_{u=1}^{U} \sum_{w=1}^{W} \theta_{C(u,w)} = 0 \qquad (4.2)$$

$$\sum_{w=1}^{W} \theta_{C(A,w)} = 0 \qquad (4.3)$$

$$\sum_{u=1}^{U} \theta_{C(u,A)} = 0 \qquad (4.4)$$

4.2 Event 2-stars

The second set of parameters consists of stars where two actors have a tie with one and the same event as shown in Figure 3. These parameters pertain to an event being attended by two actors. The configuration $S_{uv,w}$ consists of an event of category (w) being named by an actor who belong to category u and another belonging to category v.

For a categorical actor-attribute with U categories and a categorical event-attribute with W categories the event 2-star model can consist of ½•(U+1)•U•W event 2-star parameters. These parameters are: 1) a *general event 2-star parameter* irrespective of the attribute category of both actors and the institution of the event

($S_{AA,A}$), 2) event 2-star configurations where one actor attribute u or v is taken into account ($S_{uA,A}$ and $S_{Av,A}$), 3) event 2-star configurations where both actor attributes u and v are taken into account ($S_{uv,A}$), 4) event 2-star configurations where the attribute of the event w is taken into account but over all actor categories ($S_{AA,w}$), 5) event 2-star configurations where one actor attribute u or v is taken into account and the event attribute w ($S_{uA,w}$ and $S_{Av,w}$), and 6) event 2-star configurations where both actor attributes u and v and the event attribute w are taken into account ($S_{uv,w}$). Figure 4 gives a graphical representation of the 8 different resulting event 2-star parameters. The directed dependence graph that underlies these configurations can be found in Appendix.

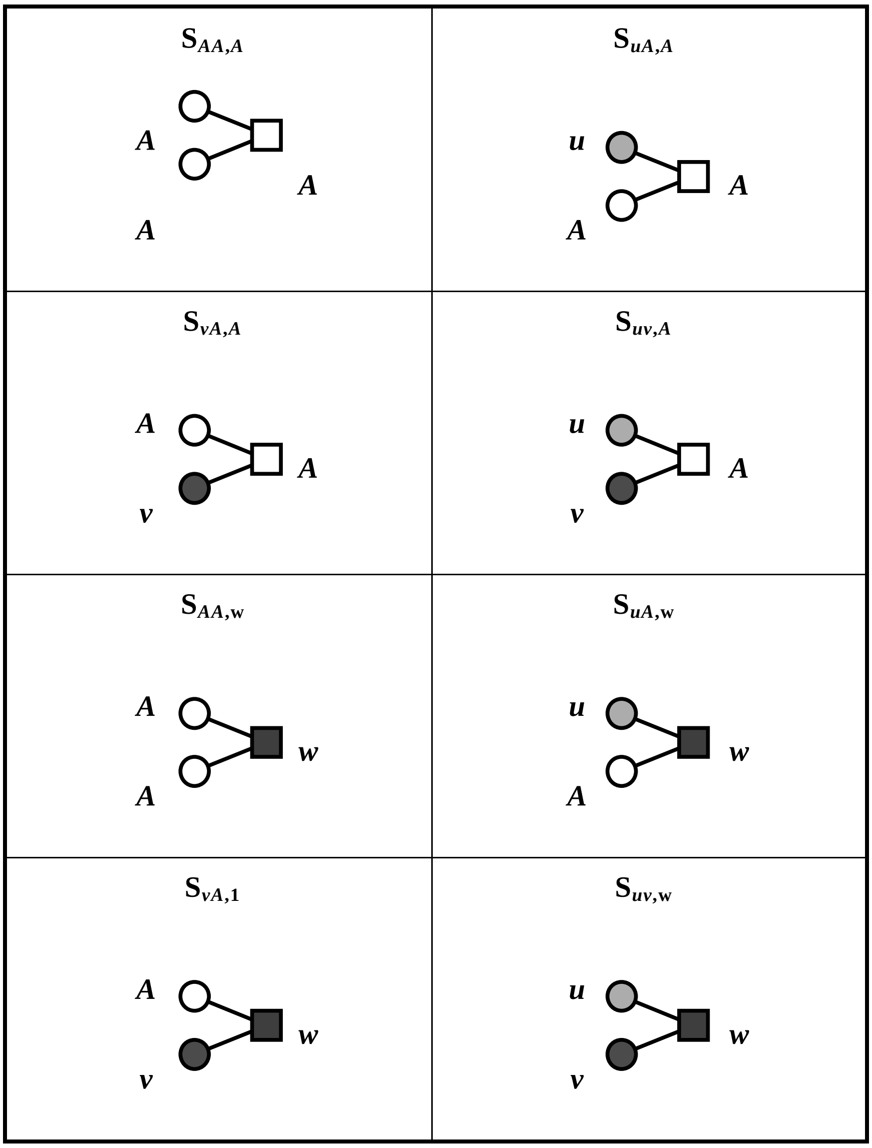

Figure 3: Graphical presentation of event 2-star parameters with actor and event attributes (white = over all of category).

When event 2-stars are included in the model equation (4.5) applies.

$$\begin{aligned}
&\text{Logit } P(y_{ik} = 1 \text{ with } X_i^A = u \text{ and } X_k^E = w \mid G^{-ik}) = \\
&\theta_{C(A,A)}\, C_{A,A} + \theta_{C(u,A)}\, C_{u,A} + \theta_{C(A,w)}\, C_{A,w} + \theta_{C(u,w)}\, C_{u,w} + \\
&\theta_{S(AA,A)}\, S_{AA,A} + \theta_{S(Av,A)}\, S_{Av,A} + \theta_{S(uA,A)}\, S_{uA,A} + \theta_{S(uv,A)}\, S_{uv,A} + \\
&\theta_{S(AA,w)}\, S_{AA,w} + \theta_{S(Av,w)}\, S_{Av,w} + \theta_{S(uA,w)}\, S_{uA,w} + \theta_{S(uv,w)}\, S_{uv,w}
\end{aligned} \tag{4.5}$$

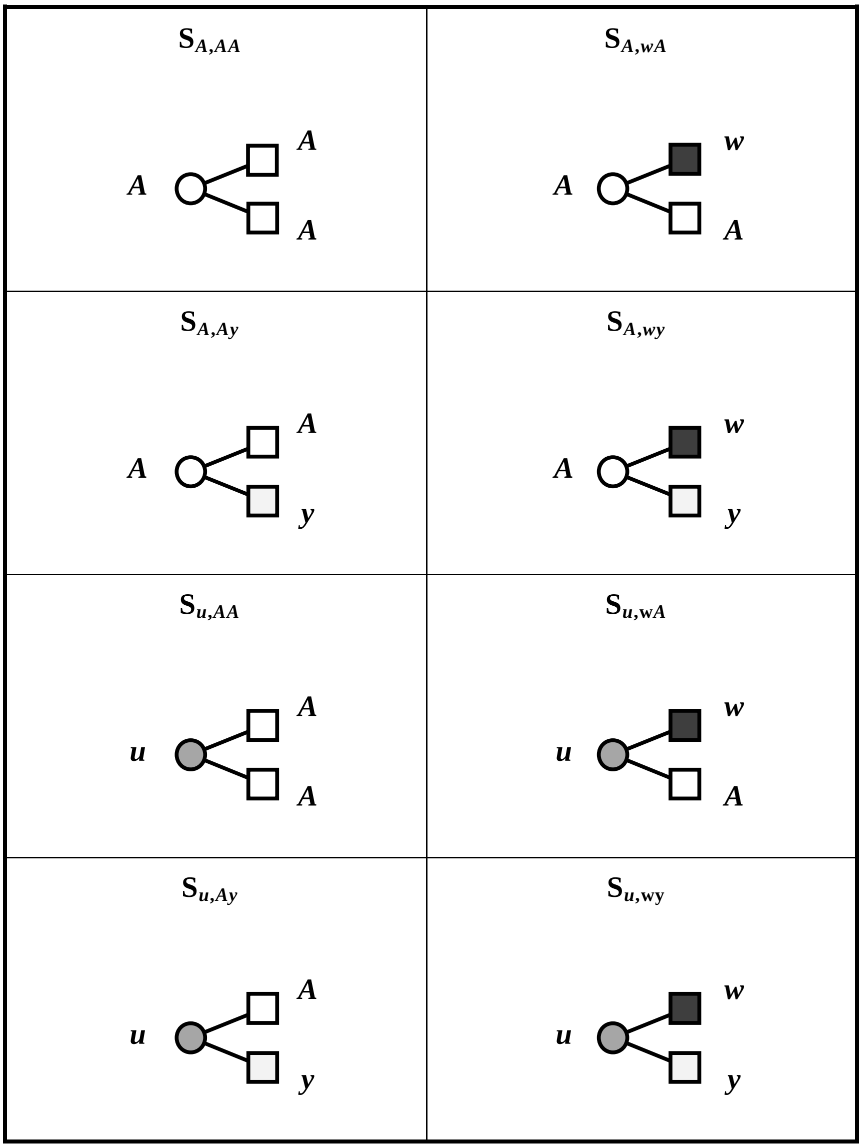

Figure 4: Graphical presentation of actor 2-star-parameters with actor and event attributes (white = irrespective of category).

4.3 Actor 2-stars

Finally a set of parameters can be built in which one actor has ties with two events. These statistics refer to co-attendance of events by specific actors. The parameter $S_{u,wy}$ refers to the configuration for an actor of category u naming two events of category w and y.

Analogous to event 2-stars, for a categorical actor-attribute with U categories and a categorical event-attribute with W categories the actor 2-star model can have ½•U•(W+1)•W actor 2-star parameters. These parameters are: 1) a general actor 2-star parameter irrespective of the attribute category of both actors and the institution of the event ($S_{A,AA}$), 2) actor 2-star configurations where one event attribute w or y is taken into account ($S_{A,wA}$ and $S_{A,Ay}$), 3) actor 2-star configurations where both event attributes w and y are taken into account ($S_{A,wy}$), 4) actor 2-star configurations where the attribute of the actor u is taken into account but over all event categories ($S_{u,AA}$), 5) actor 2-star configurations where the actor attribute u and one event attribute w or y is taken into account ($S_{u,wA}$ and $S_{u,Ay}$), and 6) actor 2-star configurations where the actor attribute u and both event attributes w and y are taken into account ($S_{u,wy}$). A graphical representation of the 6 different actor 2-star parameters when both attributes are binary can be found in Figure 4.

By including actor 2-stars into the model equation (4.6) applies.

$$\begin{aligned}
&\text{Logit } P(y_{ik} = 1 \text{ with } X_i^A = u \text{ and } X_k^E = w \mid G^{-ik}) = \\
&\theta_{C(A,A)}\, C_{A,A} + \theta_{C(v,A)}\, C_{u,A} + \theta_{C(A,w)}\, C_{A,w} + \theta_{C(v,w)}\, C_{u,w} + \\
&\theta_{S(AA,A)}\, S_{AA,A} + \theta_{S(Av,A)}\, S_{Av,A} + \theta_{S(uA,A)}\, S_{uA,A} + \theta_{S(uv,A)}\, S_{uv,A} + \\
&\theta_{S(AA,w)}\, S_{AA,w} + \theta_{S(Av,w)}\, S_{Av,w} + \theta_{S(uA,w)}\, S_{uA,w} + \theta_{S(uv,w)}\, S_{uv,w} + \\
&\theta_{S(A,AA)}\, S_{A,AA} + \theta_{S(A,wA)}\, S_{A,wA} + \theta_{S(A,Ay)}\, S_{A,Ay} + \theta_{S(A,wy)}\, S_{A,wy} + \\
&\theta_{S(u,AA)}\, S_{u,AA} + \theta_{S(u,wA)}\, S_{u,wA} + \theta_{S(u,Ay)}\, S_{u,Ay} + \theta_{S(u,wy)}\, S_{u,wy}
\end{aligned} \tag{4.6}$$

This model will be demonstrated using data on theatre attendance in 3 different institutions in the city of Ghent (Belgium).

5 Data

Capturing the total population of different theatres is practically impossible. Instead we sample from among the theatregoers and ask them to indicate the past theatre performances they attended. Using these data we try to capture the patterns of choices underlying our model.

When investigating affiliation networks social network analysts often restrict themselves to the analysis of complete networks. In this paper we use a sample of participants of a theatre to investigate the local network patterns choices of events made by actors.

We randomly selected 24 theatre performances from all the performances scheduled in February and March 2001 at 3 theatre institutions in the city of Ghent (Belgium). In each performance a selection was made of the audience. The selection was asked to tick the productions they attended from a list of 35 performances from theatre institutions in Ghent between October 2000 and January 2001. From the 290 respondents who answered our questionnaire we selected the respondents that attended at least 2 performances and extracted an ‘affiliation’-network. From this sample 119 individuals indicated to have gone to more than one event.

6 Results for aesthetical expectations of actors and institution

Using the data we would like to analyse whether conventional/unconventional expectations have a significant impact on the choices of theatre productions. Taking this as the attribute for the actors, we use participants expecting theatre performances to follow the conventions as category (1) and actors with unconventional expectations were labeled as category (2). The institution where an event was staged, was used as an attribute for the event. Events staged in the *Vooruit* were coded as category (1), events from *Nieuwpoorttheater* were coded as (2) and events from the *Publiekstheater* as (3).

Table 1: Model fit of different p* models.

	Model	Number of parameters	-2LPL	X^2	Mean of absolute residuals
1	Mean	1	3466,056	2307,860	0,2500
2	Choice	6	3376,430	2397,486	0,2442
3	Choice + actor 2-stars	18	3031,763	2742,153	0,2197
4	Choice + event 2-stars	15	3056,096	2717,820	0,2203
5	Choice + actor 2-stars + event 2-stars	27	2659,960	3113,956	0,1910

Table 1 gives the fit statistics for 5 different models. Model 1 only includes a general choice parameter. Model 2 includes all attribute specific choice parameters. In model 3 actor 2-stars are included besides the attribute specific choice parameters. Attribute specific choice parameters and event 2-stars are included in model 4. Model 5 combines the parameters in model 3 and model 4: attribute specific choice parameters, actor 2-stars and event 2-stars. We should emphasize that the significance level is only an approximation. The model actually uses a pseudo likelihood estimation (Wasserman and Pattison, 1996).

In each step a substantive improvement over earlier models is found. Therefore, model 5 will be used. The results for model 5 are presented in Table 2.

Table 2: Parameter estimates for model 5.

	B	S.E.	Wald	df	Sig.	Exp(B)
$C_{A,A}$	**-4,231**	**0,243**	**304,019**	**1**	**0,000**	**0,015**
$C_{A,1}$	0,249	0,254	0,962	1	0,327	1,283
$C_{A,2}$	-0,662	0,395	2,812	1	0,094	0,516
$C_{A,3}$	0,413	0,327	1,592	1	0,207	1,511
$C_{1,A}$	-0,082	0,229	0,130	1	0,719	0,921
$C_{2,A}$	0,082	0,229	0,130	1	0,719	1,086
$C_{1,1}$	-0,117	0,244	0,228	1	0,633	0,890
$C_{2,1}$	0,117	0,244	0,228	1	0,633	1,124
$C_{1,2}$	**-0,934**	**0,359**	**6,757**	**1**	**0,009**	**0,393**
$C_{2,2}$	**0,934**	**0,359**	**6,757**	**1**	**0,009**	**2,545**
$C_{1,3}$	**1,051**	**0,315**	**11,115**	**1**	**0,001**	**2,860**
$C_{2,3}$	**-1,051**	**0,315**	**11,115**	**1**	**0,001**	**0,350**
$S_{A,AA}$	**0,128**	**0,038**	**11,395**	**1**	**0,001**	**1,137**
$S_{A,A1}$	-0,048	0,038	1,560	1	0,212	0,953
$S_{A,A2}$	0,029	0,049	0,346	1	0,556	1,029
$S_{A,A3}$	0,019	0,039	0,242	1	0,623	1,019
$S_{A,11}$	**0,215**	**0,049**	**18,954**	**1**	**0,000**	**1,240**
$S_{A,22}$	**0,427**	**0,104**	**16,797**	**1**	**0,000**	**1,533**
$S_{A,33}$	**0,648**	**0,071**	**83,844**	**1**	**0,000**	**1,911**
$S_{A,12}$	0,003	0,058	0,002	1	0,963	1,003
$S_{A,13}$	**-0,218**	**0,043**	**25,706**	**1**	**0,000**	**0,804**
$S_{A,23}$	**-0,430**	**0,075**	**32,896**	**1**	**0,000**	**0,651**
$S_{2,AA}$	0,005	0,038	0,016	1	0,899	1,005
$S_{2,A1}$	0,006	0,038	0,028	1	0,866	1,006
$S_{2,A2}$	**-0,128**	**0,048**	**6,936**	**1**	**0,008**	**0,880**
$S_{2,A3}$	**0,121**	**0,039**	**9,796**	**1**	**0,002**	**1,129**
$S_{2,11}$	-0,055	0,049	1,251	1	0,263	0,946
$S_{2,22}$	-0,044	0,104	0,180	1	0,672	0,957
$S_{2,33}$	0,134	0,071	3,636	1	0,057	1,144
$S_{2,12}$	**0,117**	**0,058**	**4,089**	**1**	**0,043**	**1,124**
$S_{2,13}$	-0,062	0,043	2,069	1	0,150	0,940
$S_{2,23}$	-0,073	0,075	0,956	1	0,328	0,930

$S_{AA,A}$	**-0,099**	**0,023**	**18,942**	**1**	**0,000**	**0,905**
$S_{A1,A}$	**-0,359**	**0,047**	**57,444**	**1**	**0,000**	**0,698**
$S_{A2,A}$	**0,359**	**0,047**	**57,444**	**1**	**0,000**	**1,432**
$S_{21,A}$,$S_{12,A}$	**0,804**	**0,103**	**61,386**	**1**	**0,000**	**2,234**
$S_{22,A}$,$S_{11,A}$	**-0,804**	**0,103**	**61,386**	**1**	**0,000**	**0,448**
$S_{AA,1}$	**0,168**	**0,023**	**52,880**	**1**	**0,000**	**1,183**
$S_{A1,1}$	**0,366**	**0,048**	**59,367**	**1**	**0,000**	**1,443**
$S_{A2,1}$	**-0,366**	**0,048**	**59,367**	**1**	**0,000**	**0,693**
$S_{21,1}$, $S_{12,1}$	**-0,813**	**0,103**	**62,088**	**1**	**0,000**	**0,443**
$S_{22,1}$, $S_{11,1}$	**0,813**	**0,103**	**62,088**	**1**	**0,000**	**2,255**
$S_{AA,2}$	**-0,332**	**0,045**	**53,717**	**1**	**0,000**	**0,717**
$S_{A1,2}$	**-0,706**	**0,095**	**55,716**	**1**	**0,000**	**0,494**
$S_{A2,2}$	**0,706**	**0,095**	**55,716**	**1**	**0,000**	**2,026**
$S_{21,2}$, $S_{12,2}$	**1,476**	**0,203**	**53,127**	**1**	**0,000**	**4,375**
$S_{22,2}$, $S_{11,2}$	**-1,476**	**0,203**	**53,127**	**1**	**0,000**	**0,229**
$S_{AA,3}$	**0,164**	**0,023**	**49,532**	**1**	**0,000**	**1,178**
$S_{A1,3}$	**0,340**	**0,048**	**50,843**	**1**	**0,000**	**1,404**
$S_{A2,3}$	**-0,340**	**0,048**	**50,843**	**1**	**0,000**	**0,712**
$S_{21,3}$, $S_{12,3}$	**-0,663**	**0,107**	**38,286**	**1**	**0,000**	**0,515**
$S_{22,3}$, $S_{11,3}$	**0,663**	**0,107**	**38,286**	**1**	**0,000**	**1,940**

Table 3: Choice parameters.

	Overall (M)	**Vooruit (1)**	**Nieuwpoort (2)**	**Publiekstheater (3)**
Overall (M)	**0.015***	**1.283**	**0.516**	**1.511**
Conventional (1)	**0.921**	0.890	0.393*	2.860*
Unconventional (2)	**1.086**	1.124	2.545*	0.350*

6.1 Choices

The exponent of the values for the parameters in Table 1 referring to choice are reproduced in Table 3 using pseudo-likelihood estimation.

The $C_{A,A}$ captures the tendency for a person to go to an event – this is the density of the network. The parameters are odds ratios. Since we are using deviance coding, the general choice parameter gives the tendency over all categories. If we interpret these parameters in terms of a normal logistic regression, a value lower than 1 means that there is a smaller chance (odds) for a person (irrespective of her/his aesthetical expectations) to choose an event from any of the three institutions, and therefore that this type of configuration decreases the likelihood of finding the given network.

Since none of the marginal choice parameters ($C_{1,A}$, $C_{2,A}$, and $C_{A,1}$, $C_{A,2}$, $C_{A,3}$) is significant, this means that this pattern applies regardless of the attributes of the actors or events. From the choice parameters $C_{1,2}$ and $C_{2,2}$ we conclude that *Nieuwpoorttheater* has more unconventional attendants (2.545) than conventional attendants (0.393), whereas *Publiekstheater* is an institution in which the unconventional attendants have a lower probability ($C_{2,3}$ 0.350) than conventional attendants ($C_{1,3}$ 2.860) of attending a production (compared to the expected probability when taking into account the lower order effects). Hence, persons with unconventional expectations are underrepresented in *Publiekstheater*, but overrepresented in *Nieuwpoorttheater* compared to the overall distribution of conventional and unconventional attendants and given the popularity of each of these institutions.

Thus, our results partially support hypothesis 1. Theatre events staged at *Nieuwpoorttheater* attract (proportionally) more unconventional theatergoers than the other two institutions and *Publiekstheater* less. *Vooruit* is somewhere in the middle. This can be due to the the fact that *Nieuwpoorttheater*, although very similar to *Vooruit*, stages more unknown plays, which will attract more unconventional attendants.

6.2 Actor 2-stars

The parameter $S_{R,RR}$ in Table 4 refers to actor 2-stars. The odds ratio for an actor to choose an event is higher (1.137) if this actor has already attended other events irrespective of the institution (above the overall inclination expected from the choice parameter). Hence, this parameter denotes a variance in the number of events being attended by actors (Skvoretz and Faust, 1999).

The odds of a person choosing an event from an institution increases with the number of events attended in that institution ($S_{A,11}$, $S_{A,22}$, and $S_{A,33}$). This confirms hypothesis 2 which stipulated that people are more likely to attend events from the same institution. This loyalty is especially pronounced at *Publiekstheater* (1.911 times more likely than overall). The absence of a season ticket system in *Nieuwpoorttheater* does not have an impact on the loyalty of their audience. The value for *Nieuwpoorttheater* (parameter $S_{A,22}$) is higher than that for *Vooruit* (1.533 versus 1.240) and lower than *Publiekstheater*. These results do not support hypothesis 3. However, the fact that *Vooruit* and *Nieuwpoorttheater* have a lower loyalty might be due to the fact that they stage quite similar kind of plays. In that case we would expect *Vooruit* and *Nieuwpoorttheater* – with the most similar kind of plays – to have the most co-attendance. Likewise, we expect the least co-attendance between *Publiekstheater* on the one hand and *Vooruit* and *Nieuwpoorttheater* on the other.

Table 4: Actor 2-stars (overall).

	Overall (M)	**Vooruit (1)**	**Nieuwpoort (2)**	**Publiekstheater (3)**
Overall (M)	**1.137***			
Vooruit (1)	**0.953**	1.240*		
Nieuwpoort (2)	**1.029**	1.003	1.533*	
Publiekstheater (3)	**1.019**	0.804*	0.651*	1.911*

This is corroborated by our data: the odds ratio for a person choosing both events from *Vooruit* and *Publiekstheater* ($S_{A,13}$) or events from *Nieuwpoorttheater* and *Publiekstheater* ($S_{A,23}$): both are significantly lower than 1 (0.804 and 0.651), meaning that this is less likely to occur than expected. The odds ratio for a person to attend events at *Vooruit* and *Nieuwpoorttheater* is not lower than 1 ($S_{A,12}$). Thus, we have found a lower mobility between events from *Publiekstheater* and events from the other two institutions.

We can further differentiate between people having conventional versus unconventional expectations. Since the effects are complementary, we only present the effect for theatregoers with unconventional expectations (hereafter referred to as ‘unconventionals’) in Table 5.

If an unconventional chooses an event from *Nieuwpoorttheater* s/he will be less likely than a conventional to choose events from other institutions ($S_{2,A2}$ 0.880). If such a person chooses an event from *Publiekstheater* s/he is more likely than unconventionals to attend plays in other institutions ($S_{2,A3}$ 1.129). Moreover, the positive effect of $S_{2,12}$ shows that unconventional people are more likely (1.124) to combine events from *Vooruit* and *Nieuwpoorttheater* than conventional people. These findings do not support our idea that unconventional theatregoers would be less loyal (hypothesis 4). They only seem somewhat more likely to co-attend events from *Vooruit* and *Nieuwpoorttheater*. This might be due to the similarity of the plays in both institutions being more relevant for unconventional than for conventional theatregoers.

Table 5: Actor 2-stars (for unconventionals).

	Overall (M)	**Vooruit (1)**	**Nieuwpoort (2)**	**Publiekstheater (3)**
Overall (M)	**1.005**			
Vooruit (1)	**1.006**	0.946		
Nieuwpoort (2)	**0.880***	1.124*	0.957	
Publiekstheater (3)	**1.129***	0.940	0.930	1.144

6.3 Event 2-stars

The parameters in Table 1 can be used as a baseline for the event 2-star parameters. The results in Table 6 clearly show all event 2-star parameters should be included in the model.

Table 6: Event 2-stars (over all institutions).

	Overall (M)	**Conventional (1)**	**Unconventional (2)**
Overall (M)	**0.905***		
Conventional (1)	**0.698***	0.448*	
Unconventional (2)	**1.432***	2.234*	0.448*

The parameter for the event 2-star ($S_{RR,R}$) refers to the odds ratio of a production being chosen by 2 actors. The parameters ($S_{11,A}$, $S_{12,A}$, $S_{21,A}$, and $S_{22,A}$) in Table 5 indicate that generally the audience attending events is heterogenous with respect to its aesthetical expectations (conventionality vs. unconventionality). Considering Table 7, Table 8 and Table 9, we find that plays staged in *Vooruit* ($S_{22,1}$) and *Publiekstheater* ($S_{22,3}$) are more homogenous in their audience composition than *Nieuwpoorttheater* ($S_{22,2}$). This means that events from the first two institutions are attended more by persons with the same aesthetic expectations with respect to conventionality/unconventionality (given the overall pattern for all events of the three theatre institutions). This may indicate that both *Vooruit* and *Publiekstheater* stage very different plays, some events attracting people with unconventional expectations, and other events mostly attracting people with conventional expectations. Overall, different events from *Nieuwpoorttheater* have a very similar audience composition with respect to aesthetic expectations. This contradicts hypothesis 5. *Nieuwpoorttheater* – although it has to some extent a diverse programmation – does not have different audiences attending different events (the idea of an *ad hoc* audience per production does not apply). Events in *Publiekstheater* do vary substantially in the sort of audience they attract.

Table 7: Event 2-stars for *Vooruit*.

	Overall (M)	Conventional (1)	Unconventional (2)
Overall (M)	**1.183***		
Conventional (1)	**1.443***	2.255*	
Unconventional (2)	**0.693***	0.443*	2.255*

Table 8: Event 2-stars for *Nieuwpoorttheater*.

	Overall (M)	Conventional (1)	Unconventional (2)
Overall (M)	**0.717***		
Conventional (1)	**0.494***	0.229*	
Unconventional (2)	**2.026***	4.375*	0.229*

Table 9: Event 2-stars for *Publiekstheater*.

	Overall (M)	Conventional (1)	Unconventional (2)
Overall (M)	**1.178***		
Conventional (1)	**1.404***	1.940*	
Unconventional (2)	**0.712***	0.515*	1.940*

Thus, on the basis of this p* model we find both differences between institutions in attendance of specific groups of participants and differences between these groups of actors in their attendance of specific types of events.

7 Conclusion

Until recently statistical network models had to assume dyadic independence. The development of the p* models has made it possible to make more complex models focusing on local structures to explain the overall patterns in networks.

In this paper we have used a specific form of this model to include both attributes of actors (theatregoers) and attributes of events (the institution where the performance was put on) in order to explain the choices of productions made by theatregoers. Both the attributes of the actors: aesthetical expectations (conventionality versus unconventionality), and the attributes of the events make major contributions to the explanation of the choices of events.

These findings are of major importance to try to map loyalty to an institution and the co-attendance of specific events according to the sort of actor. The data showed that *Nieuwpoorttheater* had more unconventionals attending their plays, whereas *Publiekstheater* had more conventionals with *Vooruit* somewhere in between. We found support for the idea that loyalty towards an institution exists. This is especially the case for *Publiekstheater*. The absence of a season ticket (*Nieuwpoorttheater*) does not have any substantial influence on loyalty. Co-attendance between *Publiekstheater* and other institutions was less likely to occur than between *Vooruit* and *Nieuwpoorttheater*. We explained this by the (dis)similarity in the plays they stage. The pattern of co-attendance of events from *Vooruit* and *Nieuwpoorttheater* was even more pronounced for persons with unconventional expectations. Contrary to what we expected, unconventionals did not show a lower loyalty towards theatre institutions than unconventionals: omnivorisation for the unconventionals seen as mobility between institutions does not exist. Diversity in audience composition (with regard to conventionals and unconventionals) was more likely for events staged in *Nieuwpoorttheater* than for the two other institutions.

By means of this p* model we were able to address three aspects of theatre attendance for different kinds of theatregoers at the same time: patterns of choices, loyalty to an institution and co-attendance of events, and diversity in audience composition.

A further step in the use of social network analysis would be to include more attributes of events or actors, and to investigate whether the models can be further improved by extending them to k-stars. On the statistical level, there is still a debate on the usefulness of pseudolikelihood estimation for estimating parameters in a p* model (Snijders, 2002).

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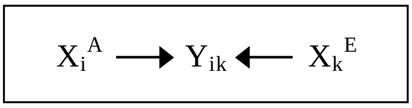
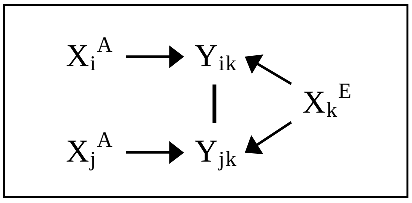
Appendix

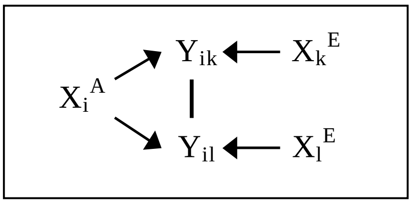
Dependence graph for choice, actor 2-star and event 2-star parameters



Directed dependence graph for a single tie (choice) with actor and event attribute



Directed dependence graph for an event 2-star with actor and event attribute



Directed dependence graph for actor 2-stars with actor and event attribute