Egocentric Relational Event Models

Christopher Steven Marcum
and
Lorien Jasny

August 25th, 2009

Carter T. Butts's Network Research Lab

Egocentric Relational Event Models

- Outline:
- Recap REF and introduce egocentric goals
- Review simple case and likelihood
- Discuss advantages and challenges
- Walkthrough empirical example (Lorien Jasny)
  - Improv Data
  - Markov transition model comparison

Egocentric Relational Event Models

- Recap:
  - Relational Event Framework (Butts 2006)
  - Excellent for Network/Dyadic Data

Egocentric Relational Event Models

- Recap:
  - Relational Event Framework (Butts 2006)
  - Excellent for Network/Dyadic Data
- Goal:
  - Extend Relational Event Framework
    - In this case, to egocentric models of action.

Egocentric Relational Event Models

- Examples of REF Appropriate Egocentric Data
  - Reconnaissance reports from individual field agents
  - Emergency personnel accounts of disaster response efforts – i.e. Improv dataset (more later)
  - Time use diaries – i.e. American Time Use Survey
  - Or any informant/actor observations on a sequence of potentially related events.

Egocentric Relational Event Models

- In principle, not too hard to do
- Assume piecewise constant hazard for the event series
- Approximate incoming events as exogenous, which alter the likelihood only through sufficient statistics
- Treat multiple informant event histories as conditionally independent
- Lose ability to infer complex (non-local) structural effects, but still very useful to learn about sequential behavior patterns and responses to environmental stimuli.

Egocentric Relational Event Models

- In principle, not too hard to do
- Assume piecewise constant hazard for the event series
- Approximate incoming events as exogenous, which alter the likelihood only through sufficient statistics
- Treat multiple informant event histories as conditionally independent
- Lose ability to infer complex (non-local) structural effects, but still very useful to learn about sequential behavior patterns and responses to environmental stimuli.
- Can answer many interesting questions:

What will happen next? What event sequences are important/unimportant? What predicts agent behavior?

Egocentric Relational Event Models

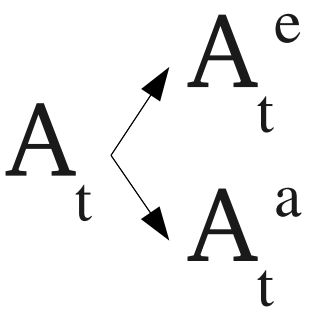
- Simple Example: First Order Markov Model
- Let $A^{(1)}_t,\ldots,A^{(n)}_t$, be a set of egocentric event histories on event type set C
- Let sufficient statistics μ be CxC set of indicators for types of previous, current events
- May need to further sub-classify by ego's role, omitting indicators for current events which are treated as exogenous (e.g., incoming communication)
- Under homogeneity, model reduces to first order Markov model with $\theta_{ij} = log\ p_{ij}$ (for transition from event of type i to event of type j)

Egocentric Relational Event Models

$$\left\{ e_1 \blacktriangleright e_2 \blacktriangleright a_1 \blacktriangleright e_3 \blacktriangleright a_2 \blacktriangleright a_3 \ \ldots \ e_t \blacktriangleright a_t \ \ldots \right\}$$

Egocentric Relational Event Models

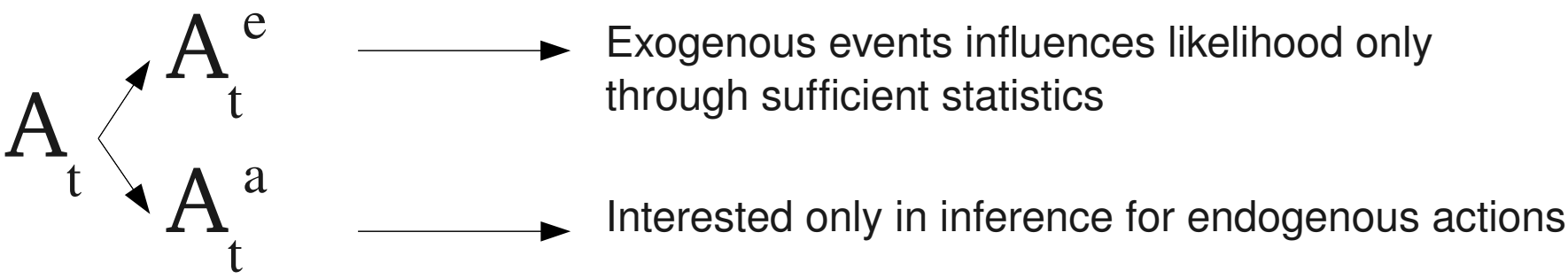
$$\left\{ e_1 \blacktriangleright e_2 \blacktriangleright a_1 \blacktriangleright e_3 \blacktriangleright a_2 \blacktriangleright a_3 \ \ldots \ e_t \blacktriangleright a_t \ \ldots \right\}$$



Exogenous events influences likelihood only through sufficient statistics

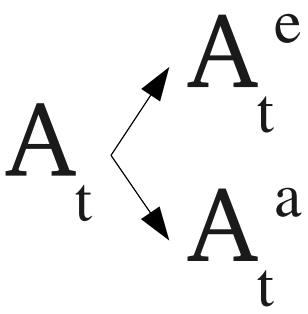
Egocentric Relational Event Models

$$\left\{ e_1 \blacktriangleright e_2 \blacktriangleright a_1 \blacktriangleright e_3 \blacktriangleright a_2 \blacktriangleright a_3 \ \ldots \ e_t \blacktriangleright a_t \ \ldots \right\}$$



Egocentric Relational Event Models

$$\left\{ e_1 \blacktriangleright e_2 \blacktriangleright a_1 \blacktriangleright e_3 \blacktriangleright a_2 \blacktriangleright a_3 \ \ldots \ e_t \blacktriangleright a_t \ \ldots \right\}$$



So, we condition on the exogenous events in the likelihood:

$$\Pr\left(A_t^a \middle| A_t^e\right) = \prod \frac{\exp(\theta^T u(a_i, A_{\tau i}))}{\sum_{a' \in A_\tau^a} \exp(\theta^T u(a'_i, A_{\tau i}))}$$

Egocentric Relational Event Models

- Why egocentric relational event models?
- Cost effective data collection and bountiful archives
- Scalability

Egocentric Relational Event Models

- Why egocentric relational event models?
- Cost effective data collection and bountiful archives
- Scalability
- Challenges to egocentric relational event models:
  - Massive heterogeneity
  - Loss of global network properties (how to infer?)
  - Despite scalability, need computational efficiency (better optimizers, quadrature innovations, etc)

Ego-Centric Relational Events Data and Example

- introduce the data
- demonstrate the coding schema
  - micro events
  - improvisation
- possible parameters
- fit models

Micro Event Data

- Events taken from police reports, firefighter oral history interviews
- 168 police in WTC (8722), 30 firefighters for WTC (3817), 30 police for OKC (1678)
- Movement, Communication, Aid, Other, Cognitive Reasoning, Cognitive Memory
- Events coded for Realized or Hypothetical, and Informant Behavior (Sender, Receiver, Acting, Reporting)

Event Coding

•"I called LaGuardia police desk again to make another notification of the incident @ 8:54 am.

Communication, Informant is Sender

•"Desk officer Baicich told me to respond to WTC for mobilization. "

Communication, Informant is Receiver

•'We arrived at WTC and parked our vehicle on the north-west corner of west Broadway and Barclay street opposite the truck dock/parking garage entrance. "

Movement, Acting

Movement, Acting

Movement, Acting

Baseline Model

	Estimate	Std. Error	Pr(>|z|)
Send Aid	-1.96	0.04	<2.2e-16***
Send Communication	-0.66	0.02	<2.2e-16***
Move	0.56	0.02	<2.2e-16***
Memory	-4.34	0.13	<2.2e-16***
Reasoning	-1.33	0.03	<2.2e-16***
Other	0	0	

Null deviance: 31327.12 on 8742 degrees of freedom
Residual deviance: 23026.72 on 8737 degrees of freedom
Chi-square: 8300.4 on 5 degrees of freedom, asymptotic p-valu
AIC: 23036.72 AICC: 23036.73 BIC: 23072.1

Improvisation

- In each “role performance” event, an action can be improvised if the
  - procedure
  - status
  - equipment
  - location

    are not standard

Improvisation: Examples

- Procedure: called and said he was going to work on day off
- Status: established base of operations at Borough of Manhattan Comm College
- Equipment: commandeered golf cart
- Location: carried bodies to temp morgue in WTC 3 lobby

Baseline Model with Improvisation

	Estimate	Std. Error	Pr(>|z|)	
Send Aid – Improvised	-2.66	0.07	<2.2e-16	***
Send Aid – no Improv	-2.12	0.05	<2.2e-16	***
Send Communication – Improvised	-2.26	0.05	<2.2e-16	***
Send Communication – no Improv	-0.53	0.03	<2.2e-16	***
Move – Improvised	-0.53	0.03	<2.2e-16	***
Move – no Improv	0.57	0.02	<2.2e-16	***
Cognitive Memory – Improvised	-6.38	0.41	<2.2e-16	***
Cognitive Memory – no Improv	-4.14	0.13	<2.2e-16	***
Cognitive Reasoning – Improvised	-3.58	0.1	<2.2e-16	***
Cognitive Reasoning – no Improv	-1.11	0.03	<2.2e-16	***
Other – Improvised	-1.06	0.03	<2.2e-16	***
Other – no Improv	0	0		

Null deviance: 43446.11 on 8742 degrees of freedom
Residual deviance: 32232.46 on 8731 degrees of freedom
Chi-square: 11213.64 on 11 degrees of freedom, asymptotic p-value 0
AIC: 32254.46 AICC: 32254.49 BIC: 32332.3

Model Markov Transitions

- stimulus – response
  - received communication followed by an action type
- arrival – action
  - movement followed by an action type
- action -- improvisation
  - do any actions predict improvisation by the informant

Longer Sequences

- Where this model shines
  - combine stimulus response with improvisation
    - received communication leads to a cognitive event which spawns improvisation

Sequence Results

	baseline	model 1	model 2	model 3	model 4	model 5
base rates						
ComRectoComSend	NA	+	NA	+	+	+
ComRectoAidSend	NA	-	NA	-	-	-
ComRectoMov	NA		NA	+	+	+
ComRectoOth	NA	-	NA			
MoveToComSend	NA	NA	-	-	-	-
MoveToAidSend	NA	NA				
MoveToMove	NA	NA	+	+	+	+
MoveToOther	NA	NA	+	+	+	+
CogRtoImp	NA	NA	NA	NA		
CogMtoImp	NA	NA	NA	NA		
ComSendtoImp	NA	NA	NA	NA		
ComRecto Imp	NA	NA	NA	NA		
MovetoImp	NA	NA	NA	NA		
OthertoImp	NA	NA	NA	NA		
ImpToImp	NA	NA	NA	NA		
ComRectoCogtoImp	NA	NA	NA	NA	NA	
BIC	32332	32275	32196	32161	27685	27694

To-Do

- more complex sequence hypotheses
- hierarchical modeling with informant level variables, event level variables
- faster tools