Knowledge and Experience in Two-mode Temporal Networks

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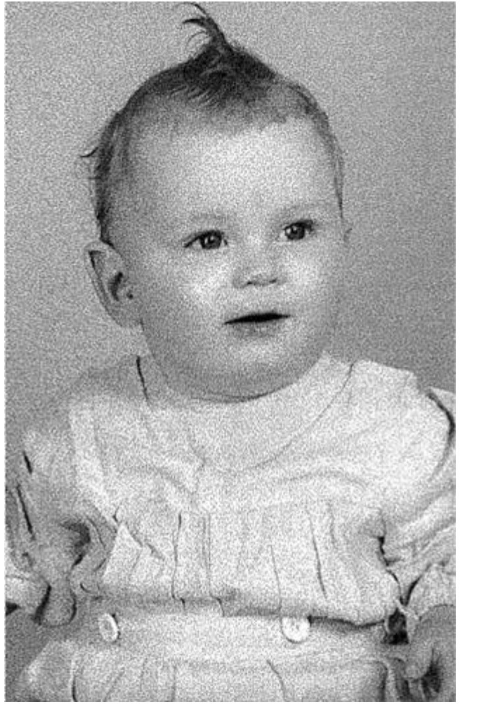
Me



- Loughborough University
  - Mathematics
- Oxford University
  - Mathematics MSc
  - Social Networks DPhil (1980)

Main research SNA

Current: Chair in SNA in Social Sciences at Manchester

Manchester

John Barnes 1918-2010

-social network

-formalized concepts

Elizabeth Bott 1924-2016

- First network theory

J Clyde Mitchell 1918-1995

- -Developed the field
- -Graph theory and data
- -First book 1969

Actor –Event Networks

- Common form of two-mode networks
- Events occur in time
- Events do not overlap or more generally we can attend all events and we know the order
  - Eg Southern Women Data
  - Collaboration networks
  - Criminal and Terrorist networks
  - Members and meetings

Network Knowledge and Experience

- We gain network experience by attending an event
  - We shall assume that there is a unique experience for everyone attending (we can relax this)
  - We can share the experience gained from the event with others at later events.
- We gain network knowledge from others at an event.
  - We may gain “out of network” knowledge but we shall ignore this (again we can change this)

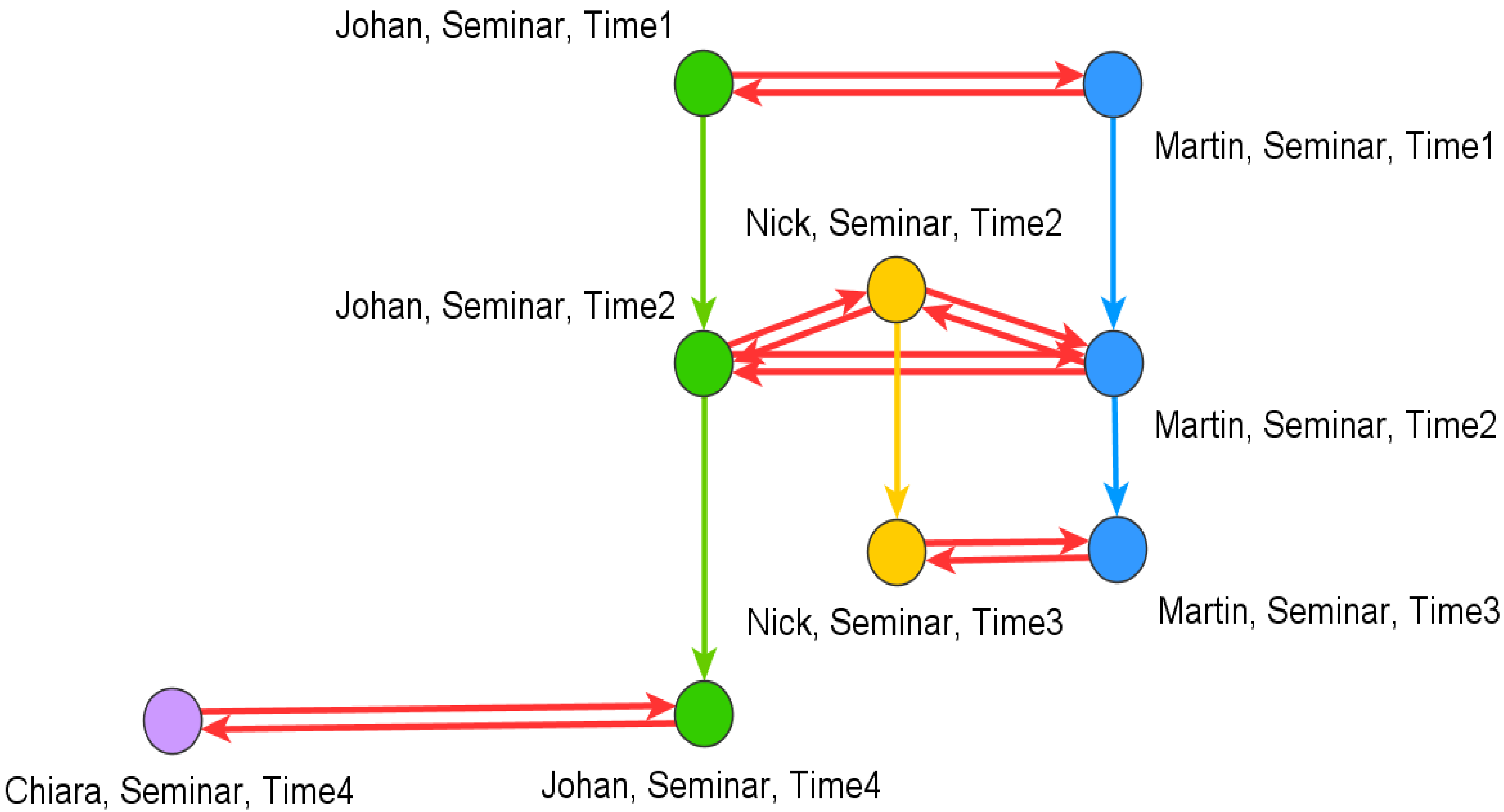
Our Goal

To obtain a measure which captures the potential network knowledge and experience in a given structure.

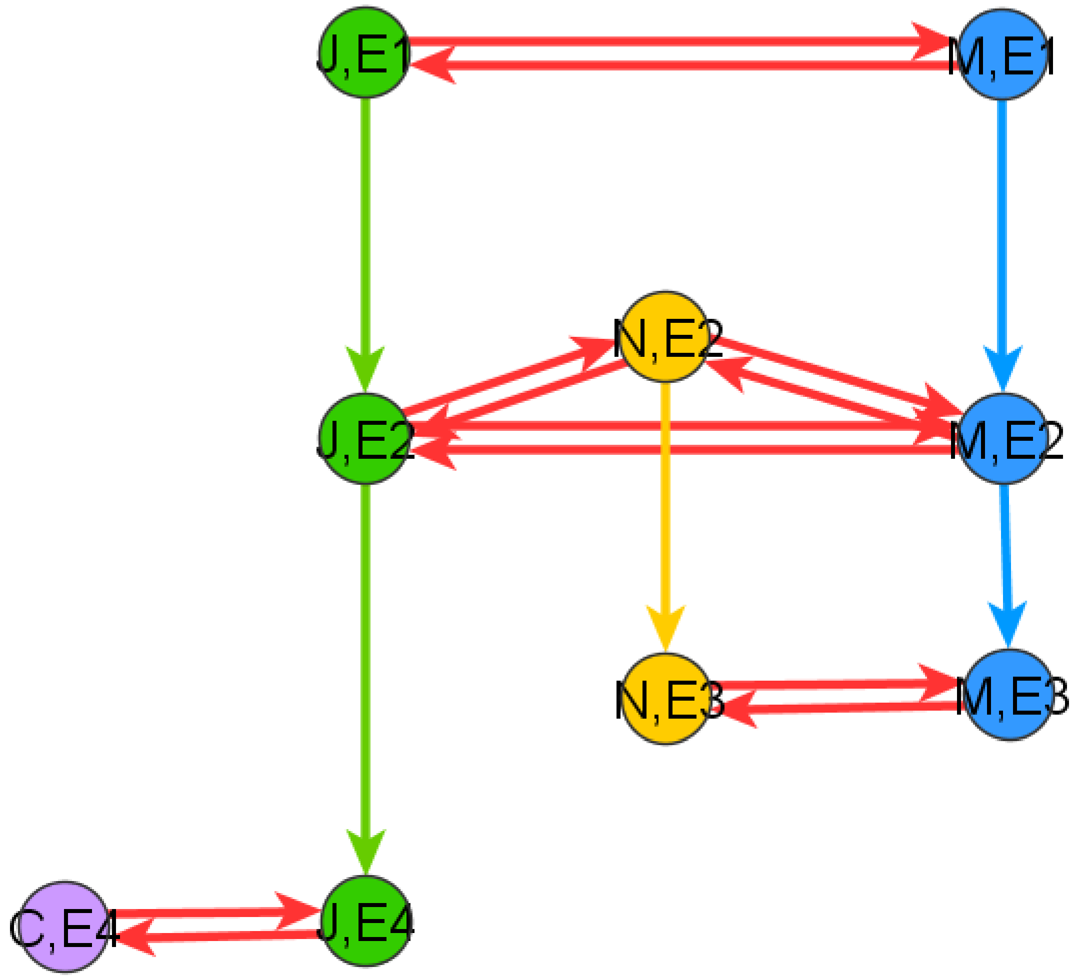
Data Representation

- Bi-dynamic line graph
  - Generalization of Moody's time dynamic line graph
  - Paper available Methodological Innovations
- Nodes are edges from the bipartite graph and are therefore actor-event
- Two types of edges undirected representing different actors at the same event
- Directed same actor at different events

Manchester seminars Bi-Dynamic Line-Graph



Bi-Dynamic Line-Graph



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Recall Our Goal

To obtain a measure which captures the potential network knowledge and experience in a given structure.

Towards an Algorithm

- I gain experience by attending an event; 1 point for each event I attend
  - My experience is the directed path length plus one
  - Degree in the original bipartite network
- If I meet others who already have some experience from previous events then I gain some of their experience-we call network knowledge
- They may also have network knowledge; they also share this with me.

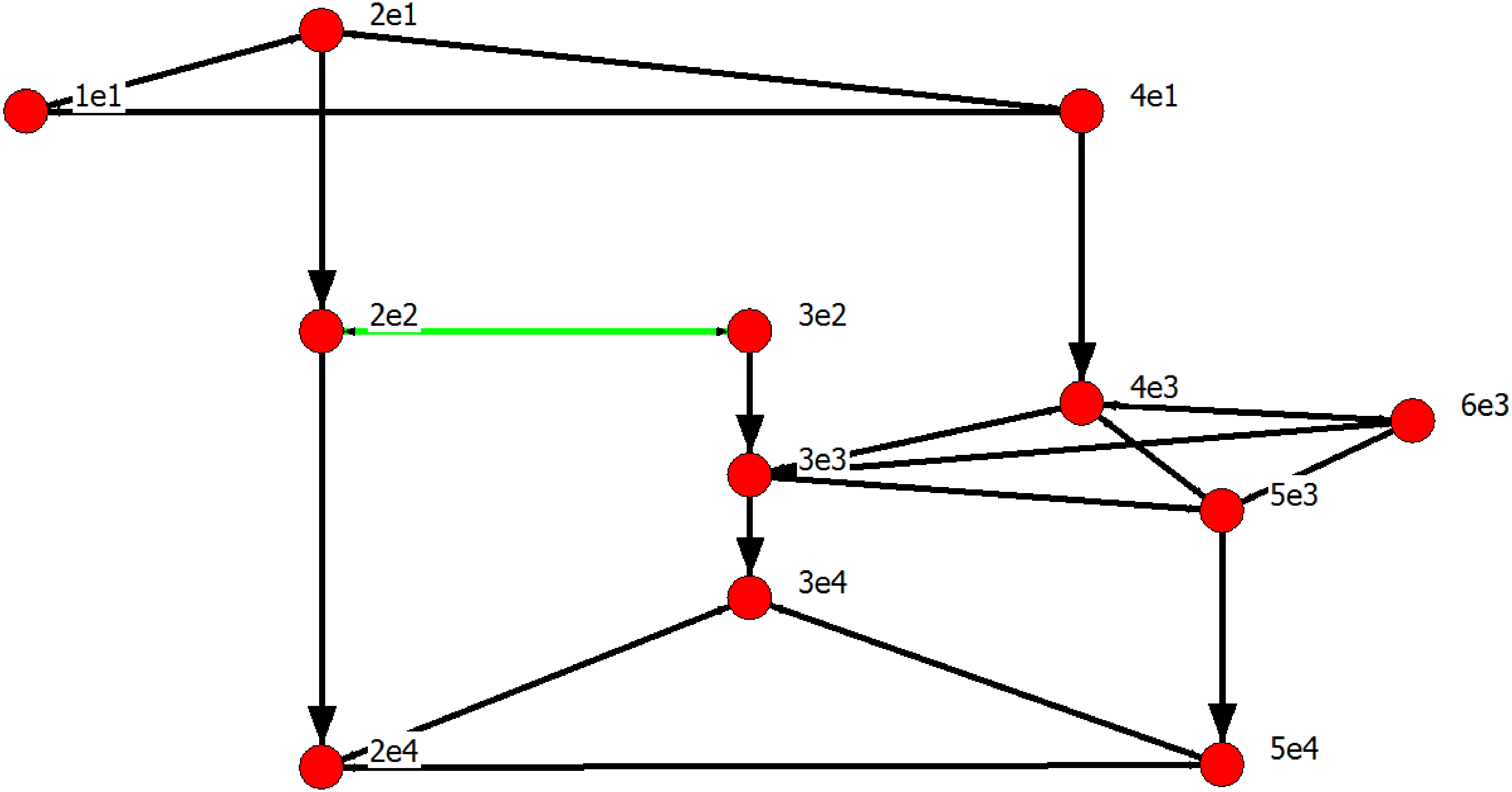
- They can only share some of this knowledge and experience not all of it
- Once they have imparted this to me they cannot do so again
- If we meet again later at another event they can add more of their experience and knowledge at a later event.
- We arbitrarily assume we can pass on half of our knowledge and experience to others at an event

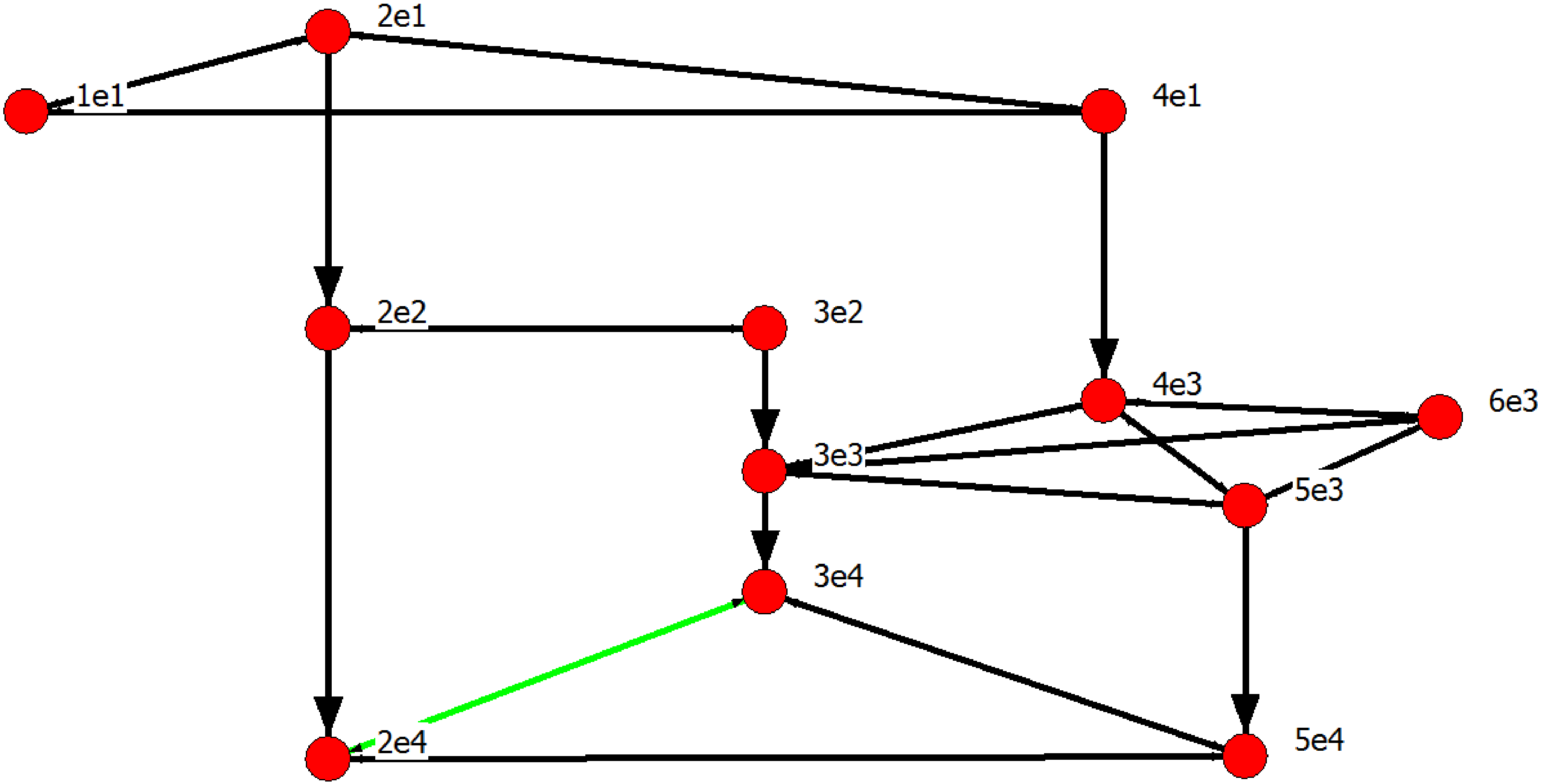
The Algorithm

- Consider each pair of actors step through the events
- At each step calculate how much each attendee at the event can pass on to every other actor
- Any un-passed on knowledge or experience goes forward with the actor to the next event

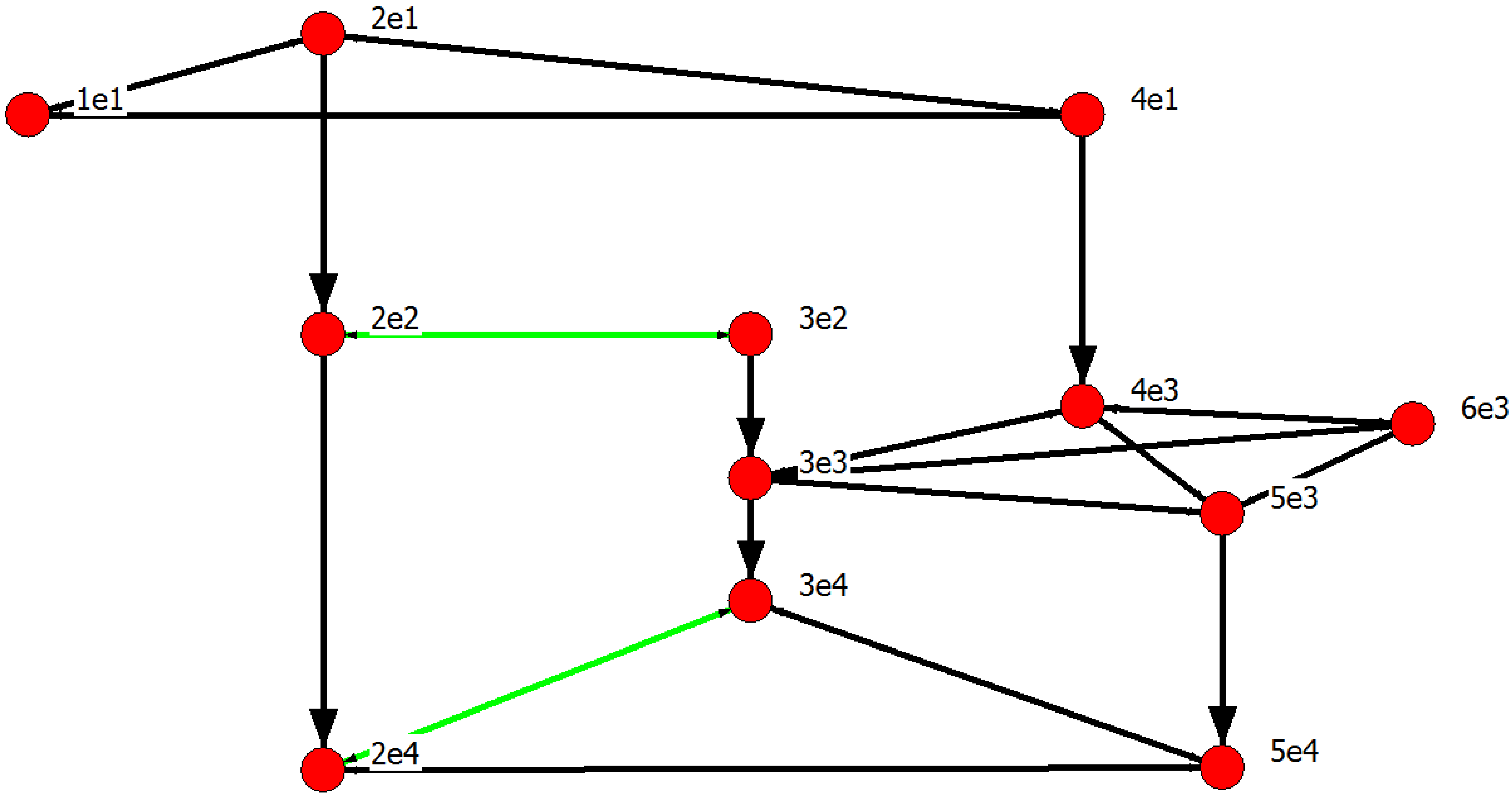
Note

- Learnt experience ie information passed on to another actor we have called knowledge
- In the algorithm since we look at all possible paths we need only look at passing on experience. This could be passed as knowledge (ie indirectly) or passed directly.

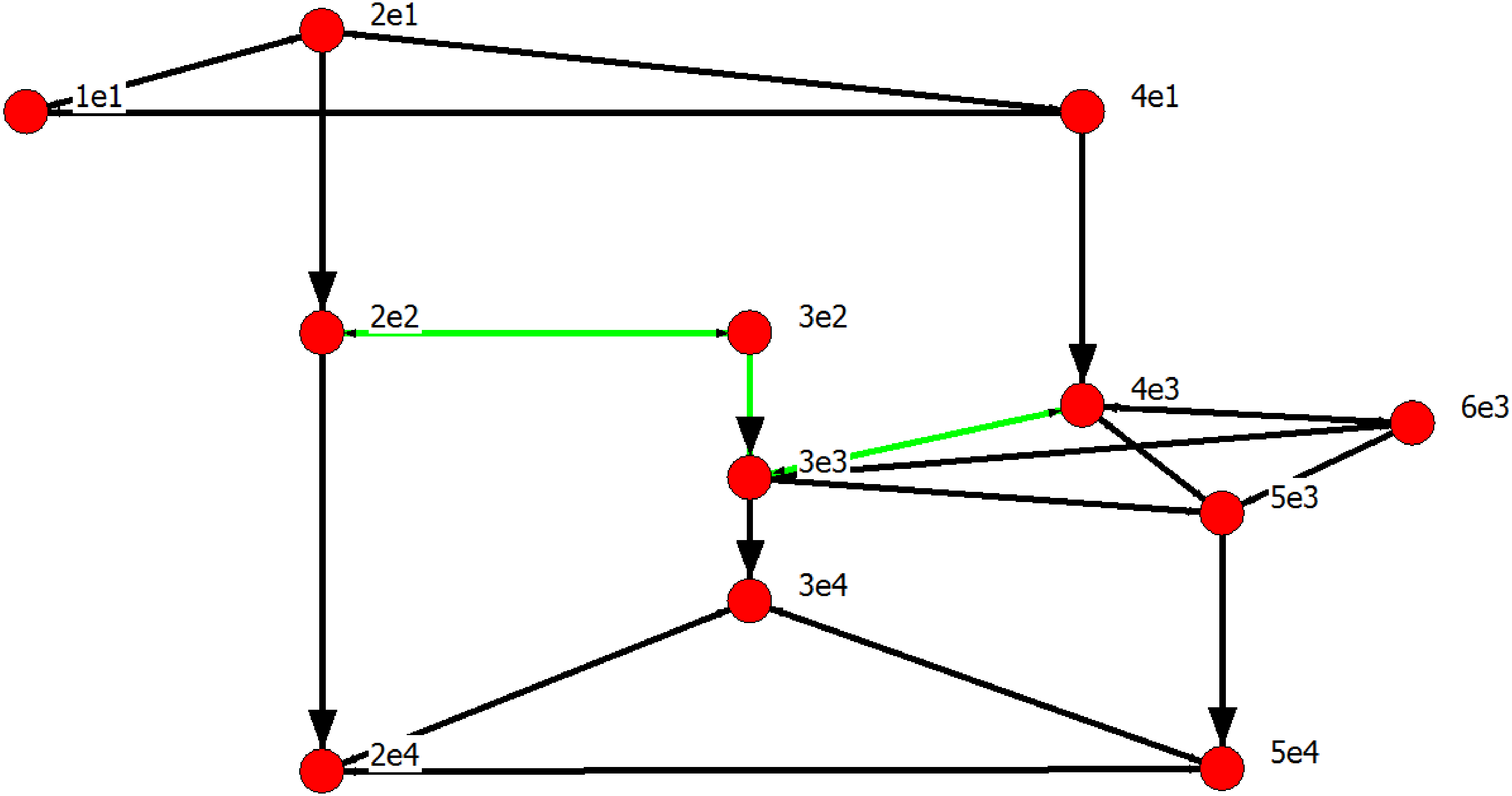

2e1
1e1
4e1
2e2
3e2
4e3
6e3
3e3
5e3
3e4
2e4
5e4


2e1
1e1
4e1
2e2
3e2
4e3
6e3
3e3
5e3
3e4
2e4
5e4

2e2-3e2 score 0.5
2e4-3e4 score (1.0+0.5)/2=0.75



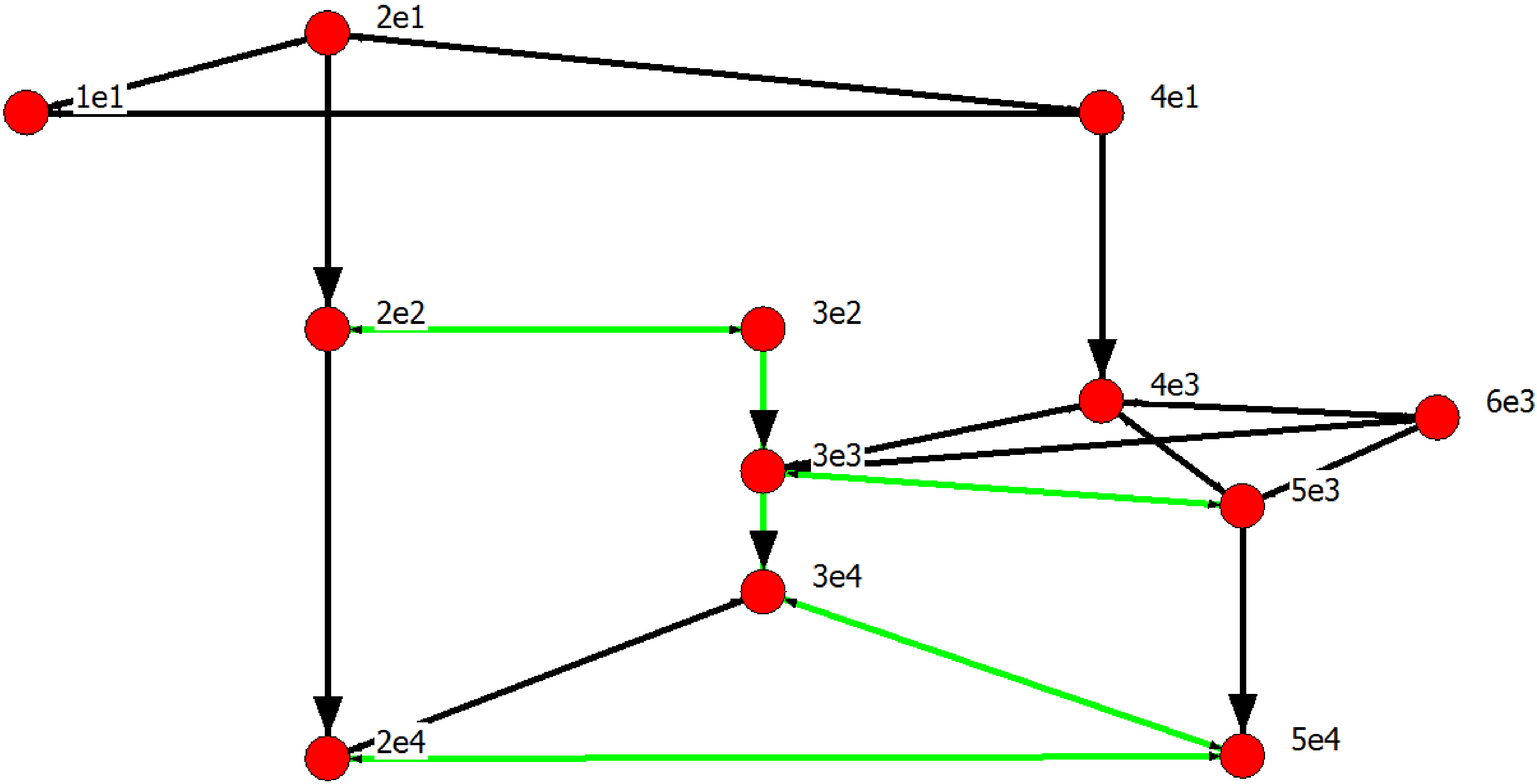
2e2-3e2->3e3-4e3 score 0.25



2E2-3E2->3E3-5E3 (1/4 = 0.25)

2E2-3E2 ->3E3-3E4-5E4 (1-0.25)/4=0.1875

2E4-5E4 [2-(0.25+0.1875)]/2 = 0.78125



	1	2	3	4	5	6	Knowledge Given
1	1	0	0	0	0	0	0
2	0	3	0.5 + 0.75=1.25	0.25	0.25 + 0.1875 + 0.7813=1.22	0.25	2.9687
3	0	0.25 + 0.875=1.13	3	0.5	0.5 + 0.75=1.25	0.5	3.375
4	0	0.25 + 0.1875=0.44	0.5 + 0.125=0.63	2	0.5 + 0.125=0.63	0.5	2.1875
5	0	0.5	0.5	0	2	0	1
6	0	0	0	0	0	1	0
Knowledge Received	0	2.0625	2.375	0.75	3.09375	1.25	

Computational Issues

- The algorithm can be made more efficient by using the original bi-partite formulation
- An alternative formulation can be done using in essence an agent based simulation model.
- The simulation gives very similar (but not exactly the same) results.

Exact v Sim

	1	2	3	4	5	6
1	1	0	0	0	0	0
2	0	3	1.25	2.5	1.19 1.22	2.5
3	0	1.14 1.13	3	0.5	1.25	0.5
4	0	0.43 0.44	0.62 0.63	2	0.62 0.63	0.5
5	0	0.5	0.5	0	2	0
6	0	0	0	0	0	1

Real Example

Noordin Mohammed Top

A well-known terrorist responsible of several terrorist attacks such as the bombing in Bali in 2002 and 2005. He was also the p
instigator of the suicide bombing
outside the
Marriott Hotel on
the 5th August 2003 in
South Jakarta, Indonesia.

Sean Everton:
https://sites.google.com/site/sfeverton18/research/appendix-1

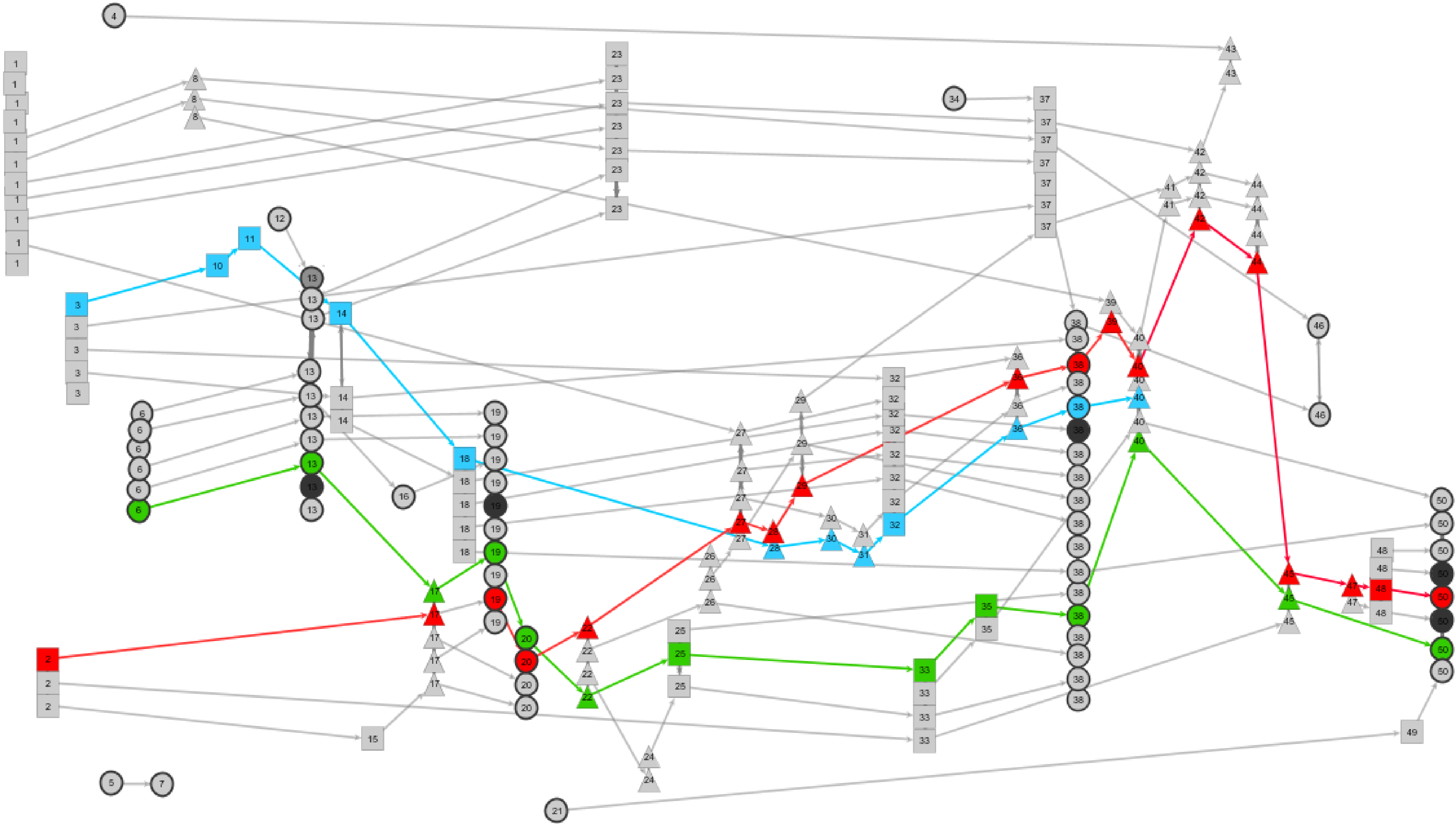
Type of relationships:

- Meetings 79x20
- Trainings 79x16
- Operations (terrorist attacks) 79x14

Two-mode matrix: 79x50

4. Noordin Top BDLG

□ training camps, △ meetings, ○ terrorist attacks



Noordin Top (red), Azhari Husin (green), Iwan Dharmawan/Rois (skyblue)

What we see

- See the progression of some key players
- Can identify key events that bring actors together
- But
  - Overall tricky to interpret
  - Possibly misleading
- Require some robust measures.

Top Individuals for knowledge giving

Role	ID	Knowledge GIVING
Noordin Top, network's main leader	**59**	339.624
Master bomb-maker technician	**23**	294.187
Main military training instructor	**45**	293.108
Courier for Noordin	**77**	129.65
Operative in the Marriot bombing, he gave to Noordin the leftover explosive from the Chrismas Eve bombing.	**72**	103.599
Instructor, with planning and logistic expertise	**61**	101.373

Top ranking of individuals for knowledge receiving

Role	ID	Knowledge RECEIVING
Suicide bomber candidate in Bali bombing II	**64**	103.515
Trainee and trainer of suicide bombers for Bali bombing II	**18**	103.457
Suicide bomber candidate in Bali bombing II	**50**	103.142
Provided religious instructions and support to martyrs, operative in the Australian embassy bombing	**24**	102.561
23's bomb-maker student and recruiter	**46**	101.654
Courier for Noordin	**69**	100.999

Next Steps

- Try on data from other sources and types
- Add facilities to track importance of events
- Consider extensions

Extensions

- Include knowledge and experience from outside the network
- Control for event size
- Actors at the same event cannot exchange knowledge of that event at a later stage .
- We can also bound learnt knowledge from an event at 1 or some other figure. ie everyone does not have unique knowledge but there is an absolute amount.
- Take more account of time.