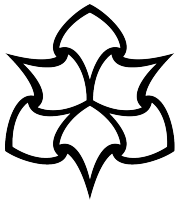


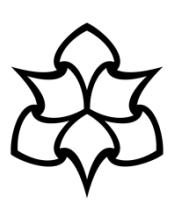
Post hoc *identification of essential properties of the social networks from a complex simulation base*

Bruce Edmonds

Centre for Policy Modelling

Manchester Metropolitan University

Credits



Research reported here was done as part of the EPSRC-funded "**Social Complexity of Immigration and Diversity**" project by

- *Laurence Lessard-Phillips*, *Ed Fieldhouse*, *Thomas Loughran*, *with advice from others,* Institute for Social Change (now part of the Cathie Marsh Centre), University of Manchester
- *Bruce Edmonds*, Centre for Policy Modelling, Manchester Metropolitan University
- *Luis Fernandez Lafuerza*, *Louise Dyson*, *Alan McKane*, Department of Theoretical Physics, University of Manchester

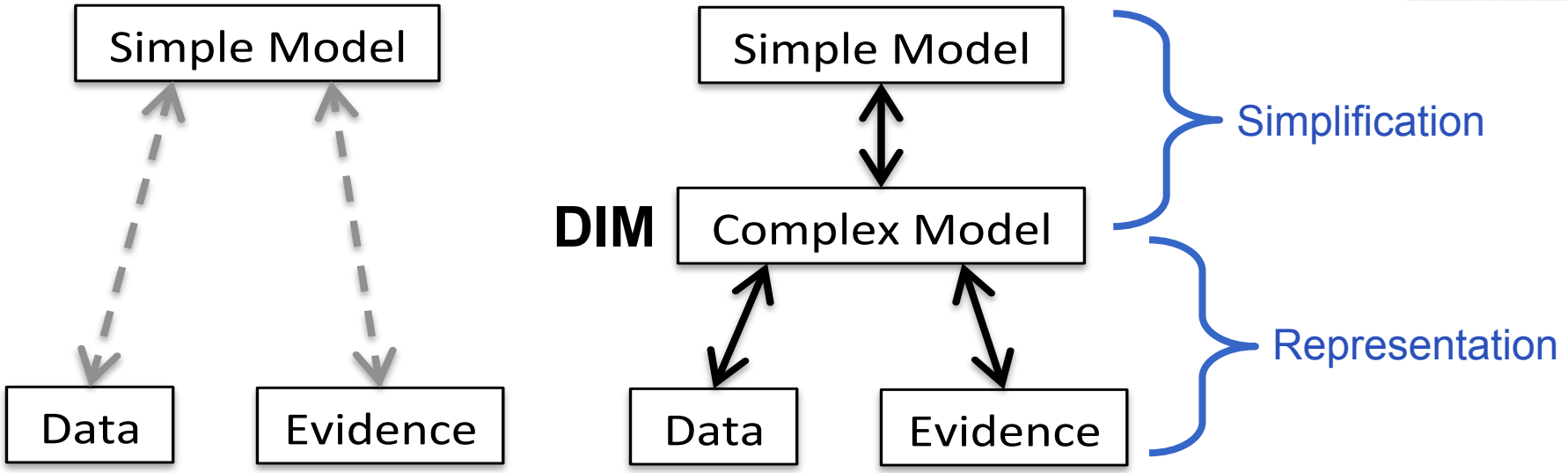
Agent-based modelling and social networks

- In ABM one has to represent interaction/ communication events explicitly
- This may involve a prior constraint of such interaction to certain routes between agents
- But simulation then allows us to see what interaction networks emerge from these and the strength and persistence of this
- However there is another question – what aspects of these social networks make any difference to the outcomes – ABM allows us also to explore this kind of question

Aim of this stream of modelling

- To understand voter turnout (why people bother to vote), in particular how different factors/processes might affect each other
- To apply complexity science to this social issue to see what insights could be gained
- To try a methodology of starting with a complex, descriptive model and then analysing from there (staged abstraction)
- Seeing if this facilitated interdisciplinary collaboration

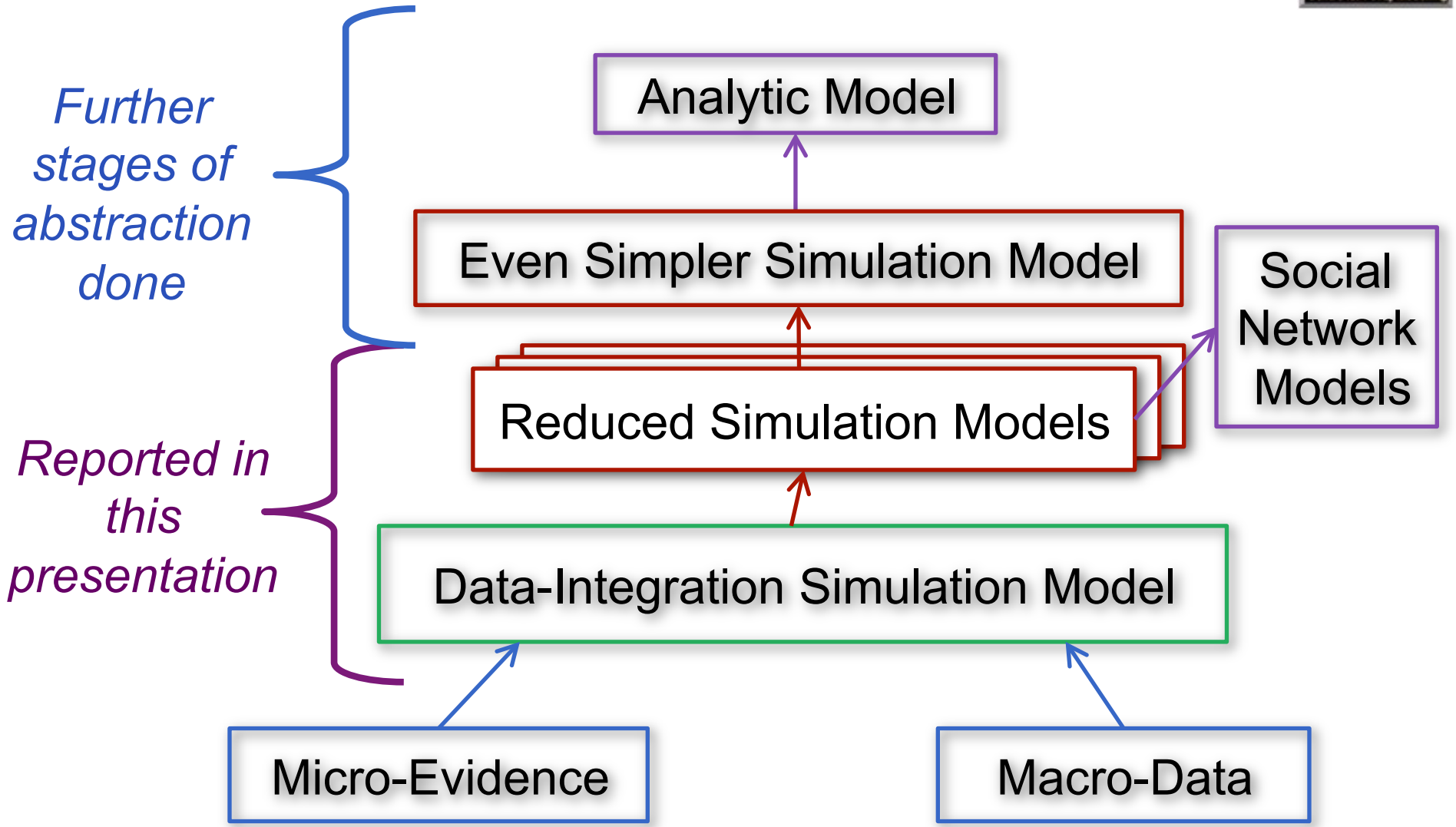
Our Basic Approach…



…is to *stage abstraction* with an intermediate, complex model, that is then, *itself*, modelled (a 'KIDS' approach)

- The Data Integration Model (DIM) includes all that is deemed relevant by social scientists
- The simpler models of the DIM are developed by formal scientists but validated against the DIM

What we did in SCID



An overview of model structure

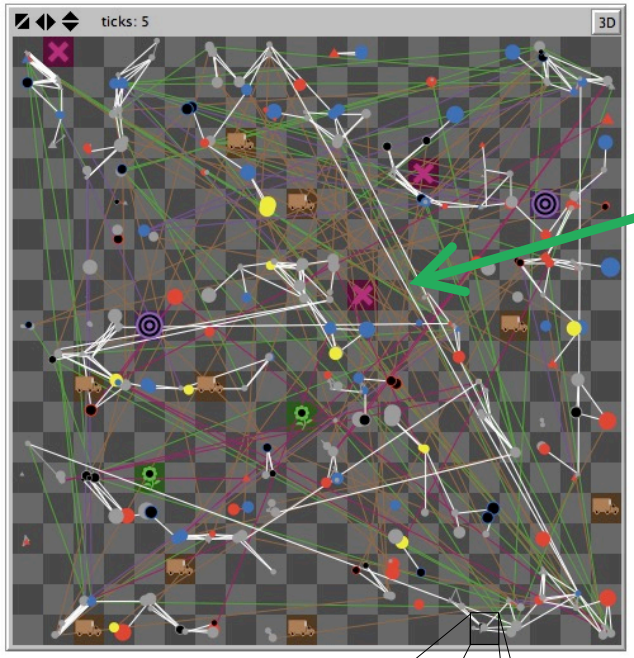
Underlying Data from Surveys about Population Composition etc.

Demographics of people in households (both native and immigrant)

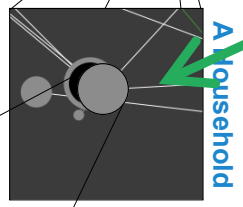
Homophily effects the social network and membership of organisations etc.

Social network effects how individuals influence each other, reinforcing and/or changing existing norms/opinions

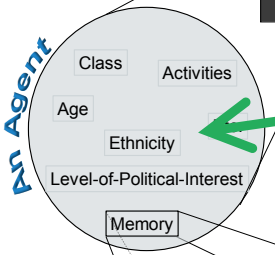
This effect the behaviours of individuals, which can then be extracted from the simulation as model results and compared with evidence etc.



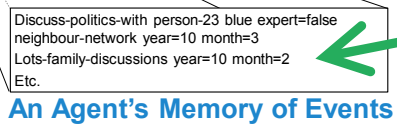
Changing personal networks over which social influence occurs



Composed of households of individuals initialised from detailed survey data



Each agent has a rich variety of individual (heterogeneous) characteristics



Including a (fallible) memory of events and influences

Constraints of interaction put *into* the model

Interaction can occur in the model via any of:

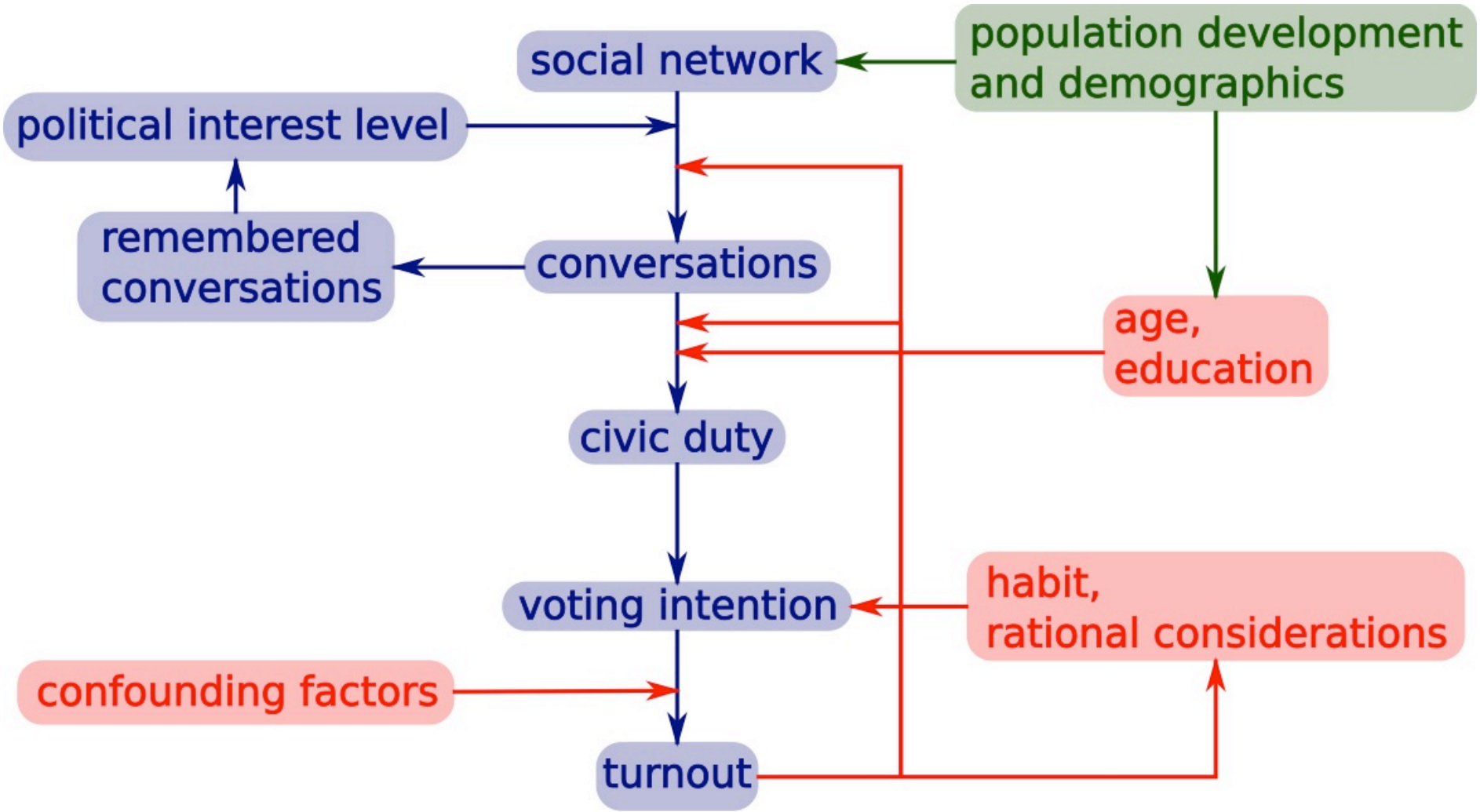
1. the household (incl. most ex-household)
2. nearby neighbours (incl. some ex-neighbours)
3. a shared place of work
4. having kids at the same school
5. shared activities (e.g. place of worship or sports club)

These built-in networks change

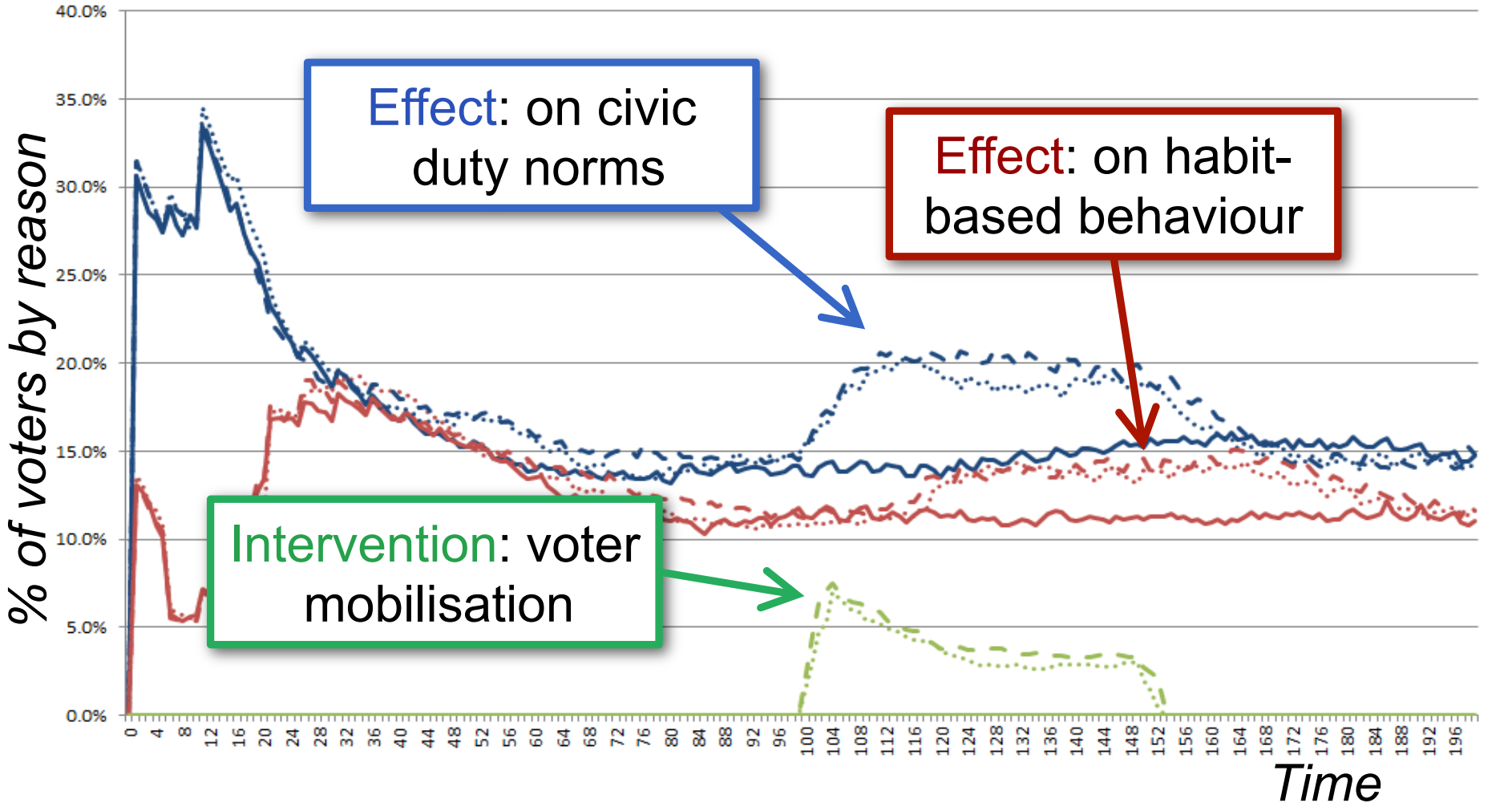
Each kind of interaction route can change, depending on its kind, e.g.:

- If one moves one moves household then keep a connection with most of the old household and some of the old neighbours
- Links can be made or dropped with different probabilities and dependent on different conditions (e.g. homophily)
- New friend-of-a-friend links can be made but only via the same kind of link

Outline of model processes



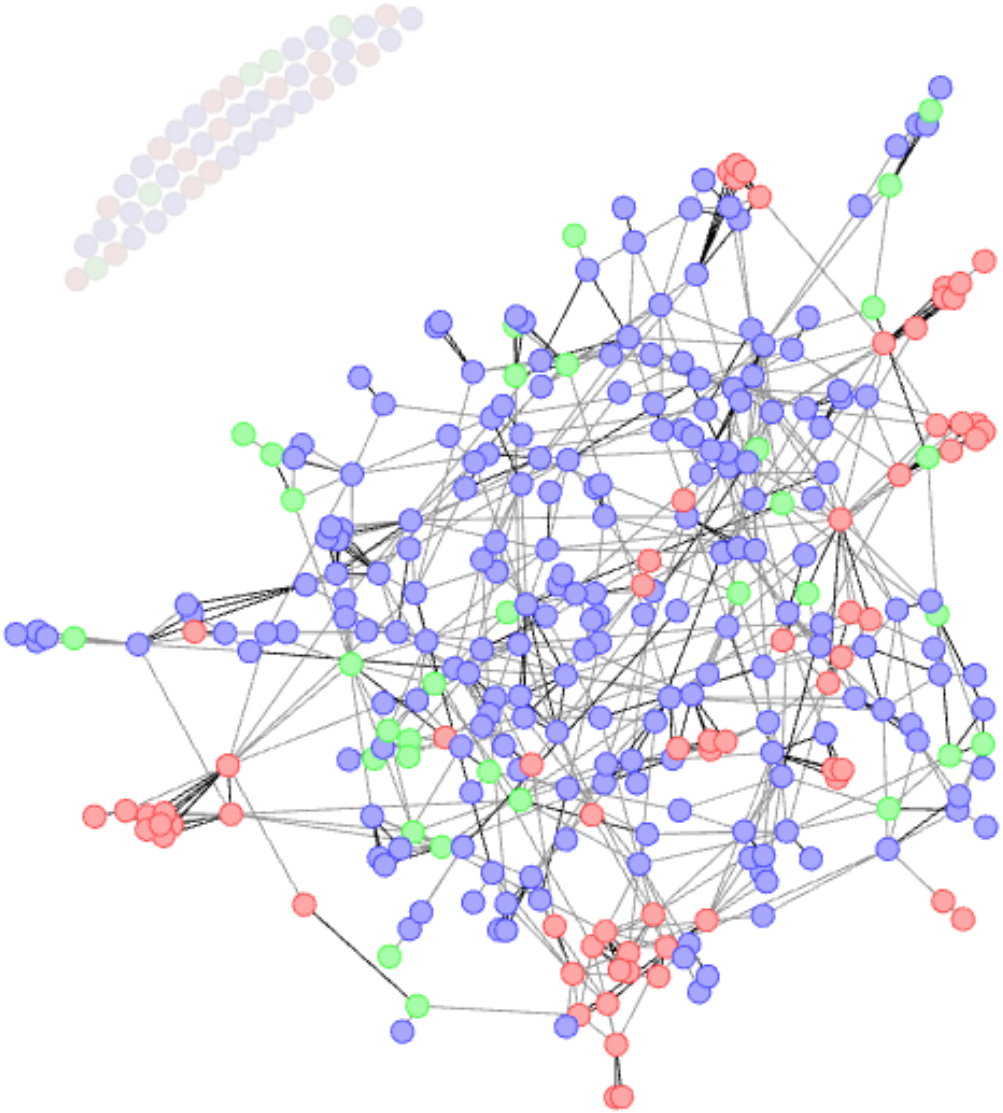
Example Output: why do people vote (if they do)



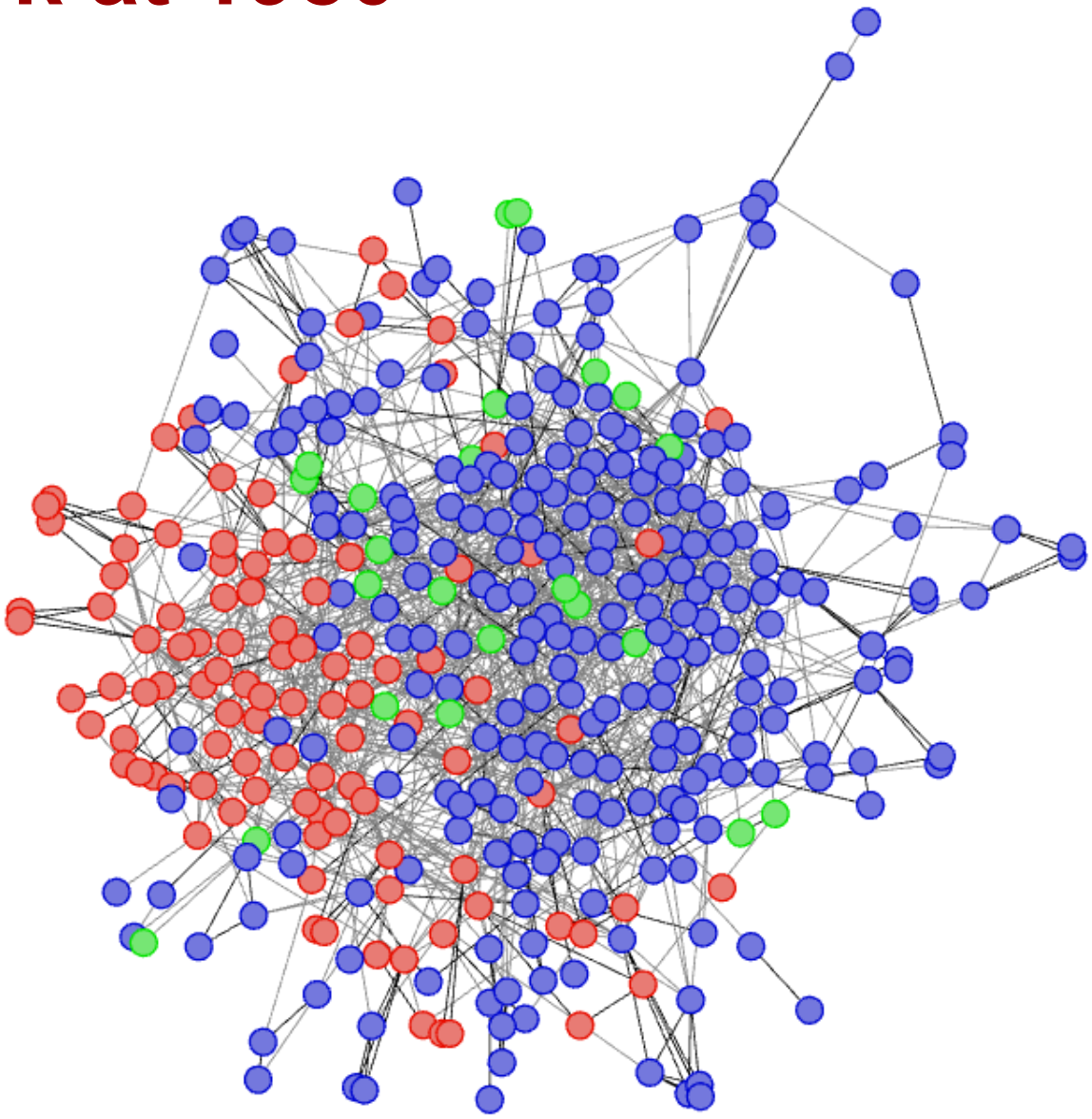
Example Output – one agent

1945: (person 712) did not vote
1946: (person 712) started at (workplace 31)
1947: (person 712)(aged 29) moved from (patch 4 2) to (patch 5 3) due to moving to an empty home
1947: (person 712) partners with (person 698) at (patch 5 3)
1950: (person 712) did not vote
1951: (person 712) separates from (person 698) at (patch 5 3)
1951: (person 712)(aged 33) moved from (patch 5 3) to (patch 4 2) due to moving back to last household after separation
1951: (person 712) did not vote
1952: (person 712) partners with (person 189) at (patch 4 2)
1954: (person 712)(aged 36) moved from (patch 4 2) to (patch 23 15) due to moving to an empty home
1955: (person 712) did not vote
1964: (person 712) started at (activity2-place 71)
1964: (person 712) voted for the red party
1966: (person 712) voted for the red party
1970: (person 712) voted for the red party
1971: (person 712) started at (workplace 9)
1974: (person 712) voted for the red party
1979: (person 712) voted for the red party
1983: (person 712) died at (patch 23 15)

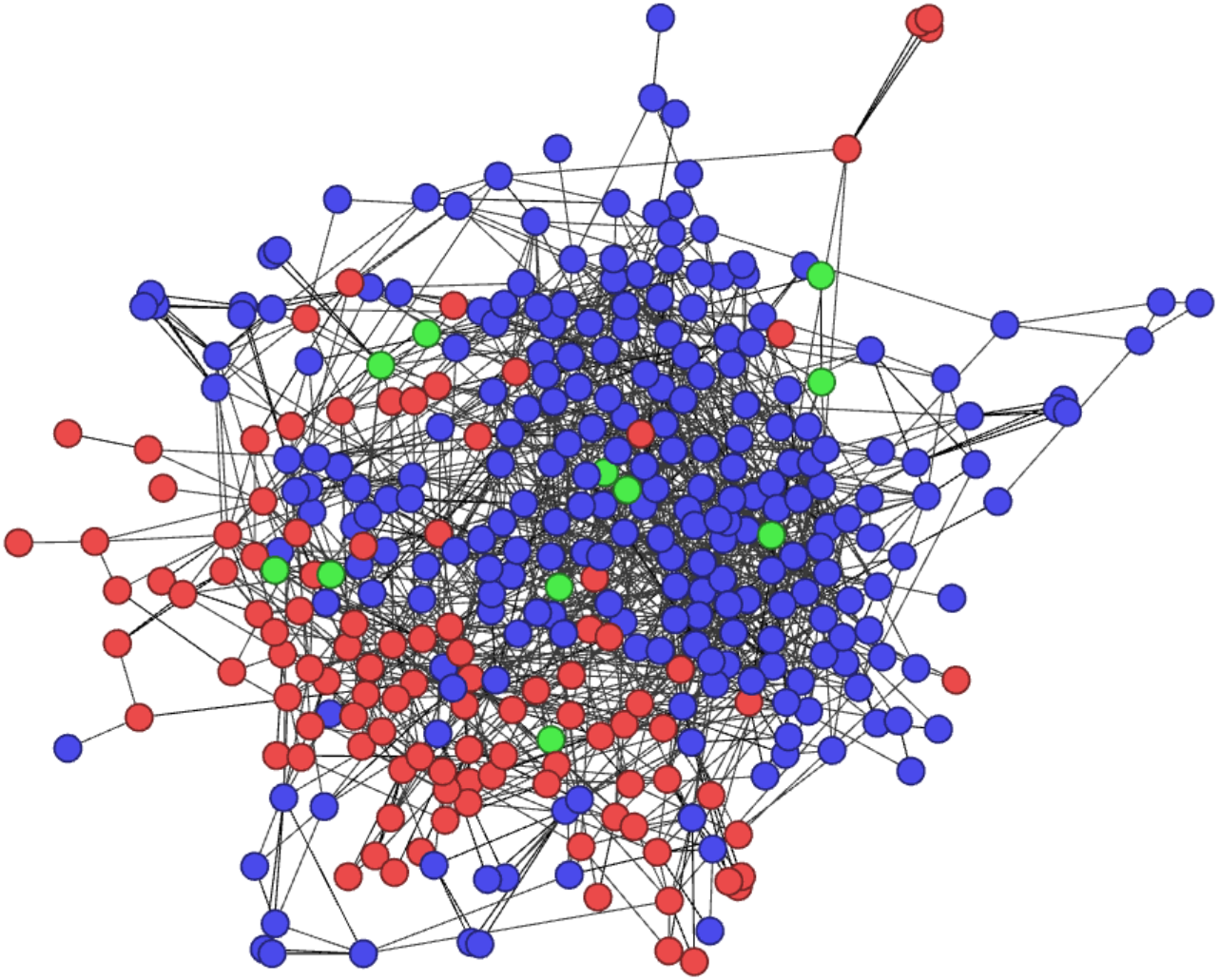
Initialised Social Network at 1950



Example Emergent Social Network at 1980



Example Emergent Social Network at 2010



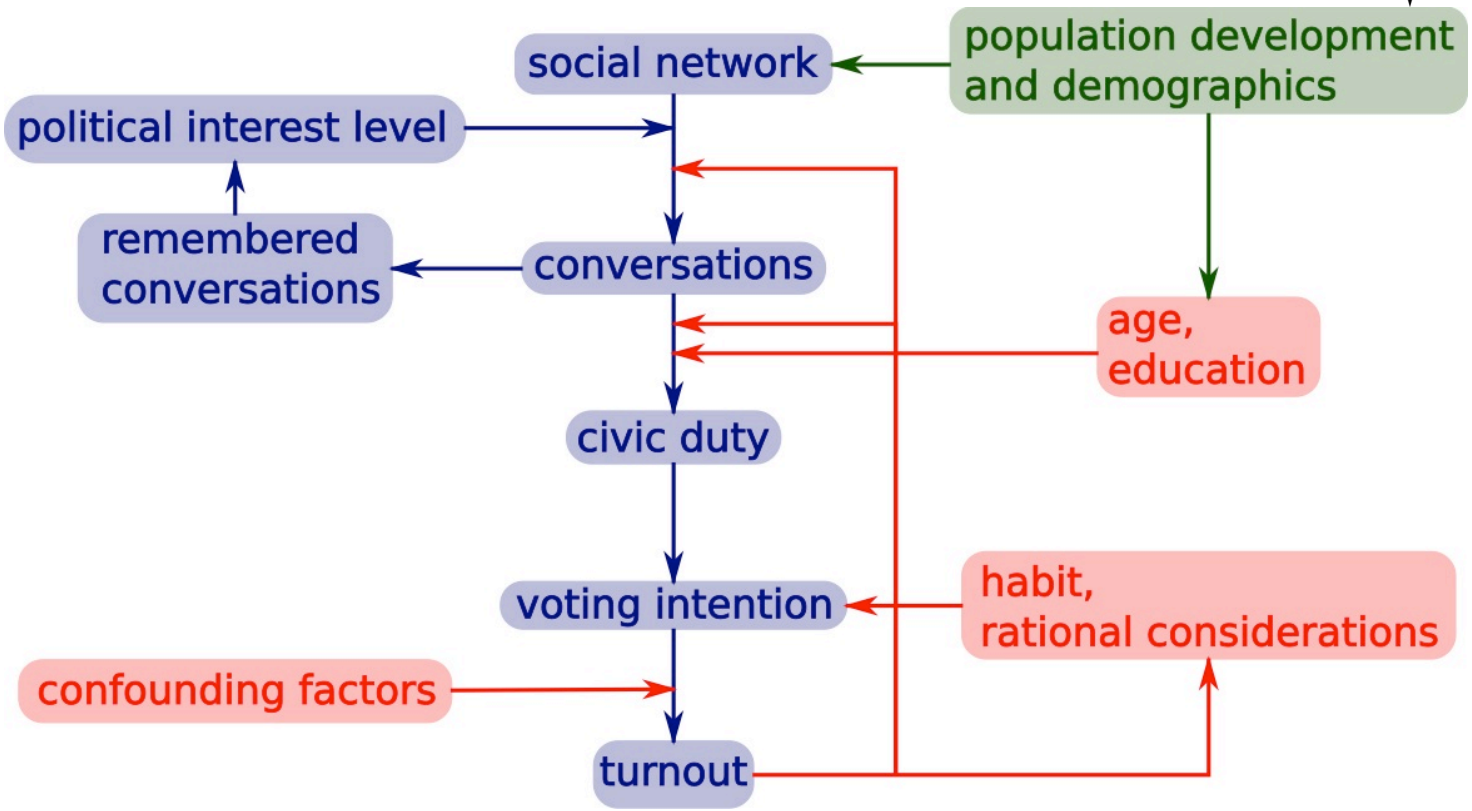
Resulting emergent social networks

- Were complex to understand (a bit like real social networks)
- Were changing all the time
- It was not clear what was important about the networks and what was not

Thus the strategy was to:

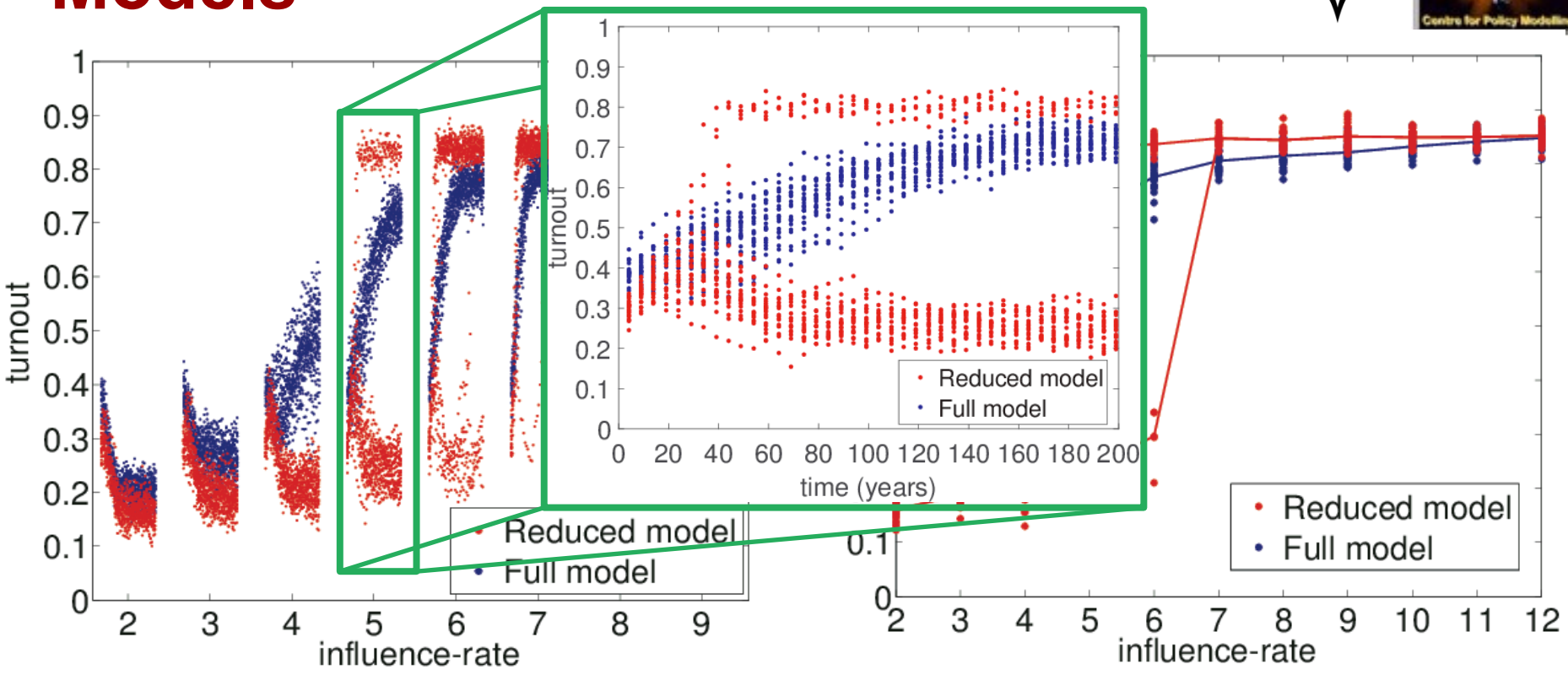
- Try simplified simulations with different network properties
- See which matched full model in terms of patterns of voter turnout

Outline of Model Reduction



- Iterative process of inspection of DIM, formulating simpler models, and comparing them with output from the DIM
- **Red** and **green** processes were simplified, also parties and imposed social network

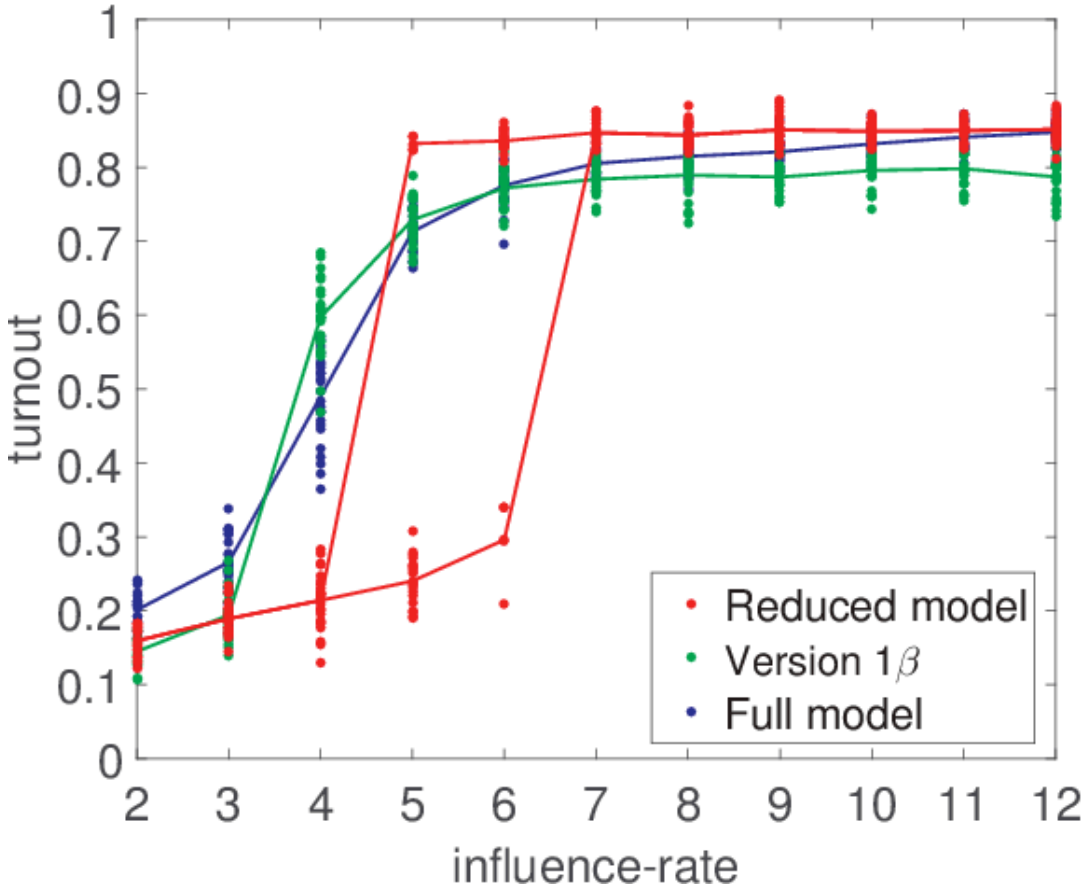
Comparison of Reduced and DIM Models



Low and high turnout regimes

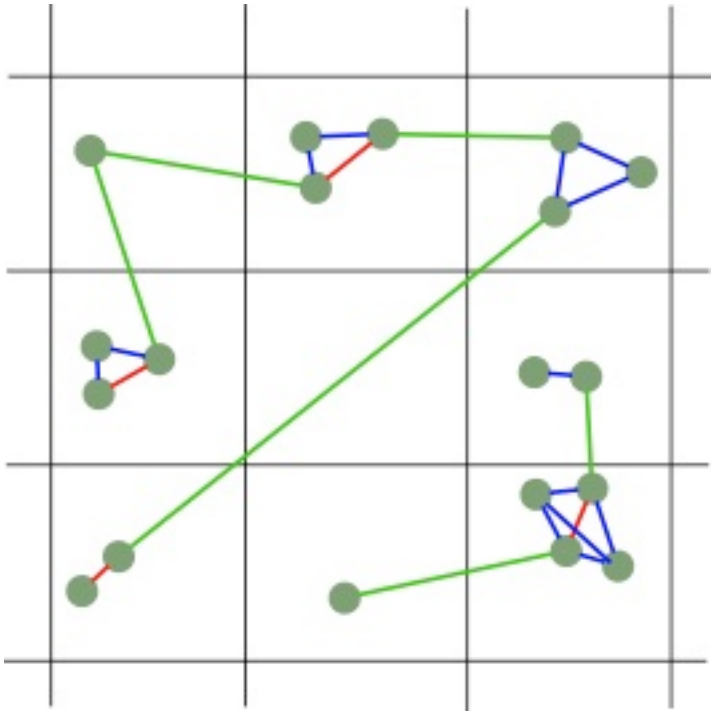
Broad agreement between models, but different levels and different dynamics in transition region

With Different Kinds of Network

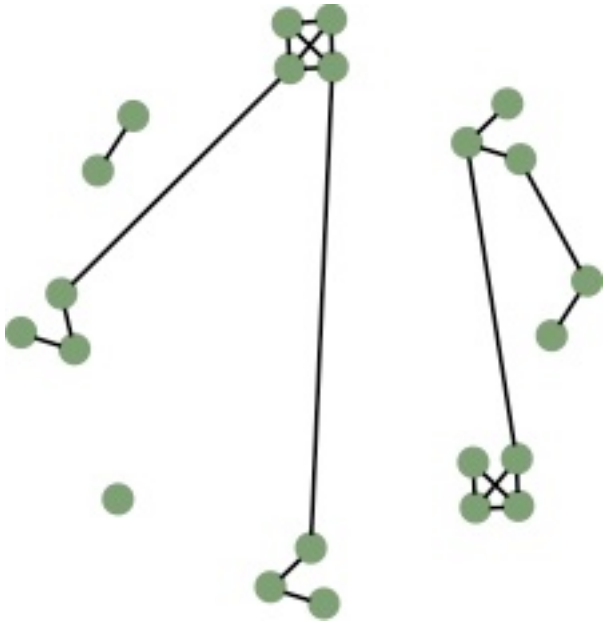


Blue = Full model, **Green** = With "clumped" network, **Red** = well mixed (random interaction)

Kinds of network



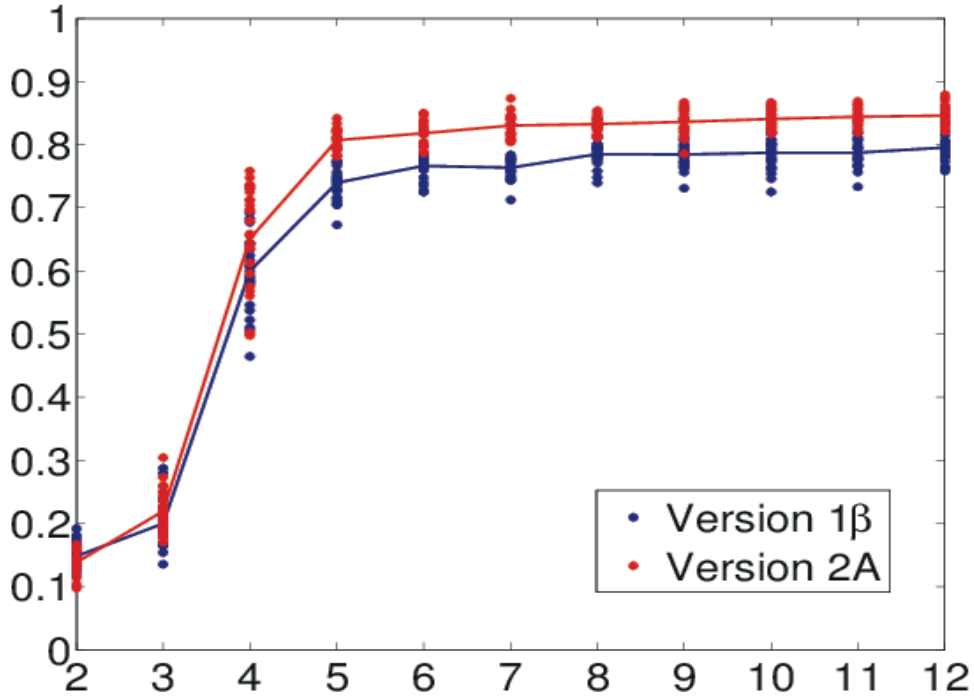
Network in DIM



Synthetic Network

A synthetic network that is composed of small groups with some random inter-group connections resulted in better fit of dynamics

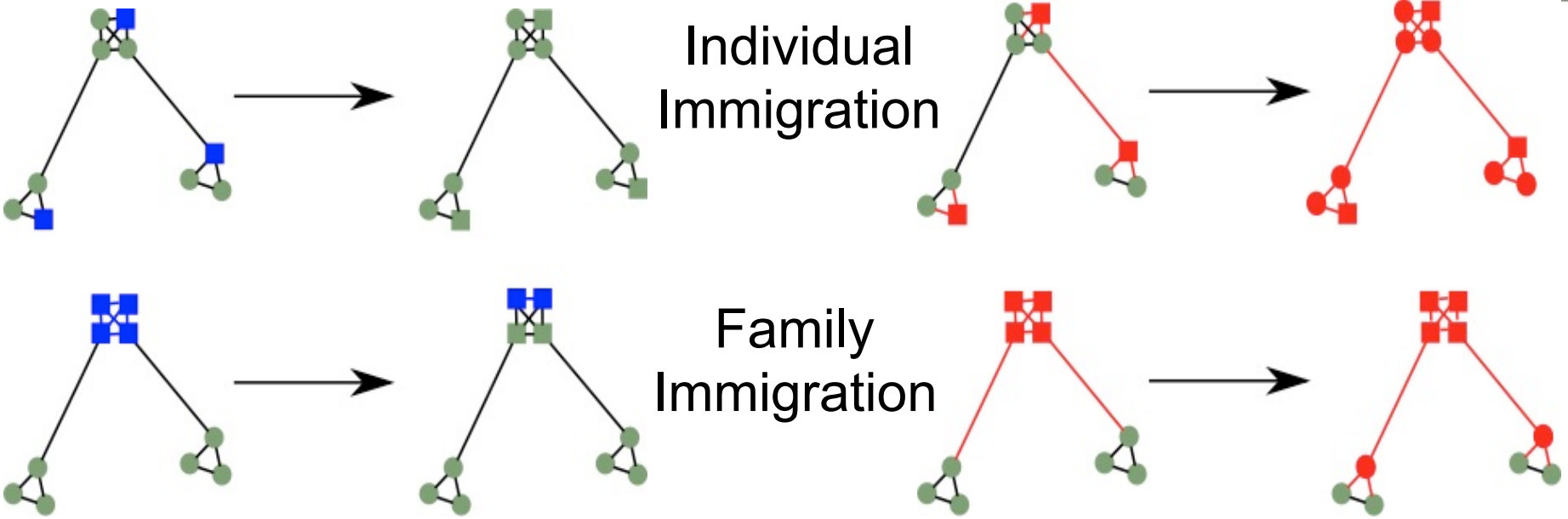
Fixed vs. Dynamic Networks



Reduced models with fixed 'clumped' network (**blue**) and with a dynamic network where links between households change (**red**)

Dynamism increases turnout due to diversity of links over time allowing wider influence

Individual vs. Household Immigration

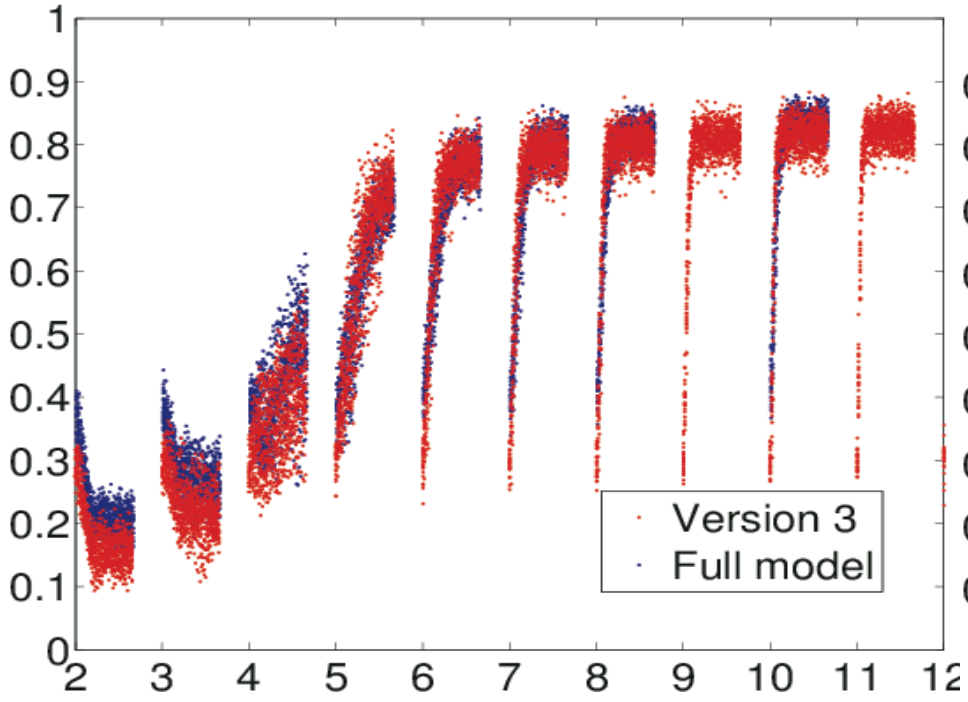


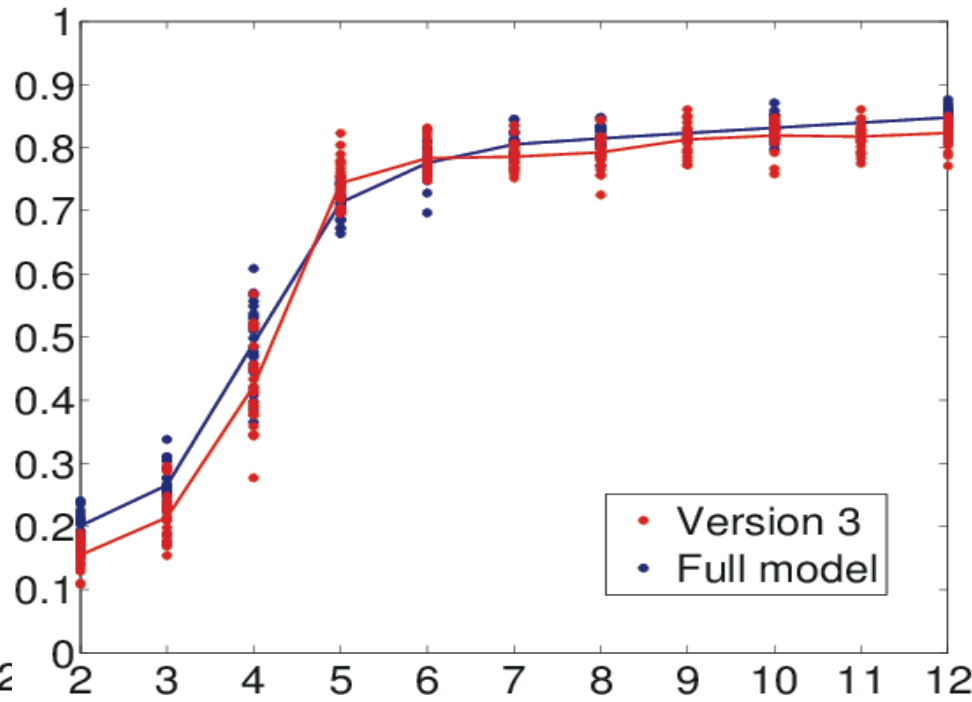
Low Interest Immigrants

High Interest Immigrants

With immigrants of either a lower or higher political interest than natives, individual immigration resulted in higher level of turnout than household immigration, due to asymmetry of influence process

Final Comparison





Reduced model + dynamic ‘clumped’ network + household immigration has good fit to **DIM** turnout dynamics *but* amenable to complete checking and much simpler and easier to experiment with

What was Learnt?

The comparisons suggested that the following was important about the emergent networks:

1. Random mixing was not right, it had a social network structure
2. This structure needed to be ‘clumped’
3. A better fit was obtained via a dynamic network
4. And there was a significant difference between immigration via households and via individuals

Key References

Formulation and exploration of DIM:

Fieldhouse, E., Lessard-Phillips, L. & Edmonds, B. (2016) Cascade or echo chamber? A complex agent-based simulation of voter turnout. *Party Politics*. 22(2):241-256. DOI: 10.1177/1354068815605671

Analysis step described here:

Lafuerza LF, Dyson L, Edmonds B, & McKane AJ (2016) Staged Models for Interdisciplinary Research. *PLoS ONE*, 11(6): e0157261. DOI:10.1371/journal.pone.0157261 (but please note the correction since PLoS messed up the formatting and they don't fix the main paper after publication!. A better formatted version is at: http://arxiv.org/abs/1604.00903)

Further simplification and analysis:

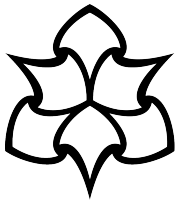
Lafuerza, LF, Dyson, L, Edmonds, B & McKane, AJ (2016) Simplification and analysis of a model of social interaction in voting, *European Physical Journal B*, 89:159. DOI:10.1140/epjb/e2016-70062-2

KISS vs KIDS argument:

Edmonds, B. and Moss, S. (2005) From KISS to KIDS – an 'anti-simplistic' modelling approach. In P. Davidsson et al. (Eds.): Multi Agent Based Simulation 2004. Springer, Lecture Notes in Artificial Intelligence, 3415:130–144. (http://cfpm.org/cpmrep132.html)

Basic approach for Building DIM:

Moss, S. and Edmonds, B. (2005) Sociology and Simulation: - Statistical and Qualitative Cross-Validation, American Journal of Sociology, 110(4) 1095-1131. Previous version accessible as (http://cfpm.org/cpmrep105.html).



Thanks!

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Centre for Policy Modelling: http://cfpm.org

The Full Voter Model:
http://comses.net/codebases/4368

These slides at: http://cfpm.org/slides

Copy of SCID Website: http://cfpm.org/scid