



Manchester
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Social and Cognitive Coherence

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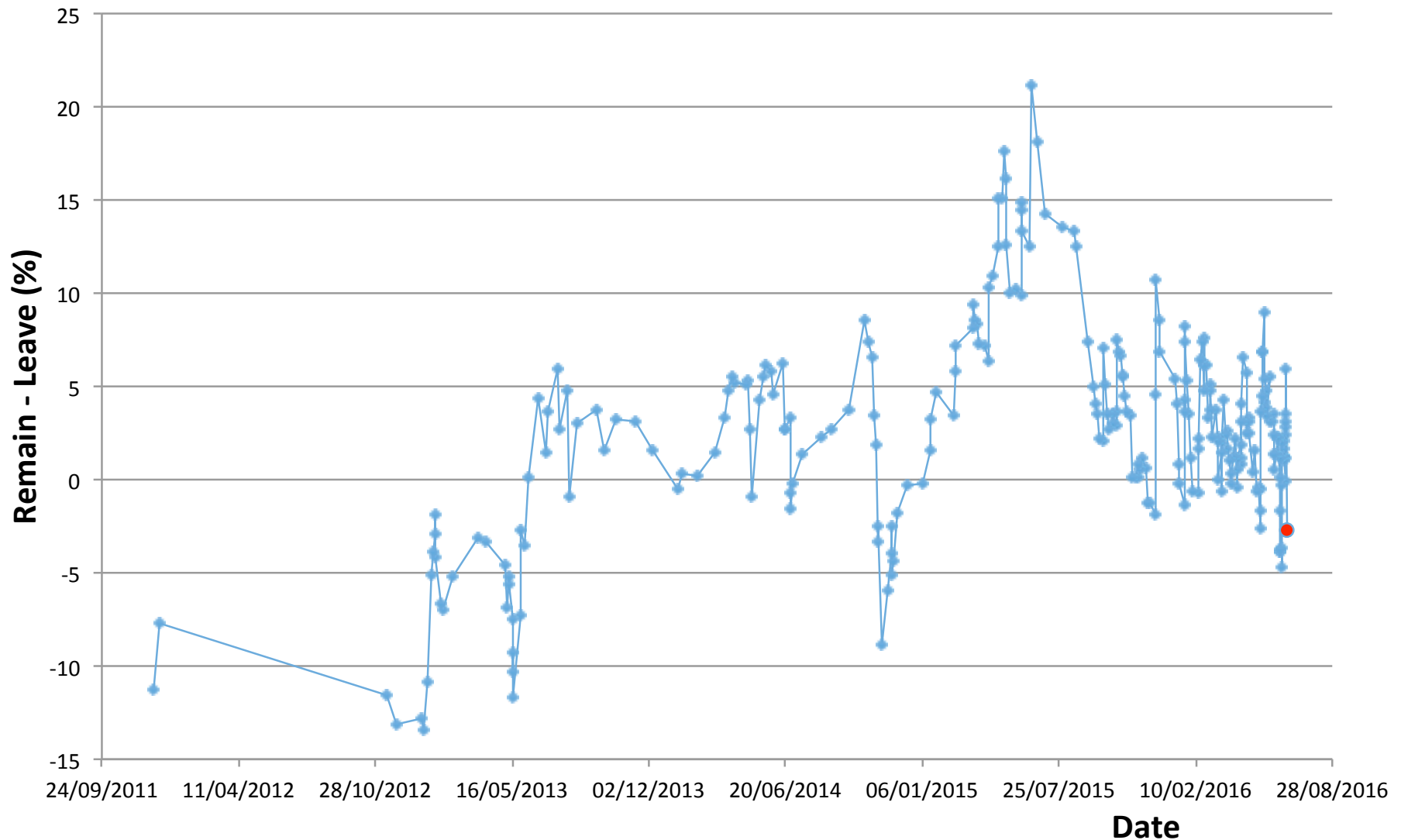
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The Tethered Goat

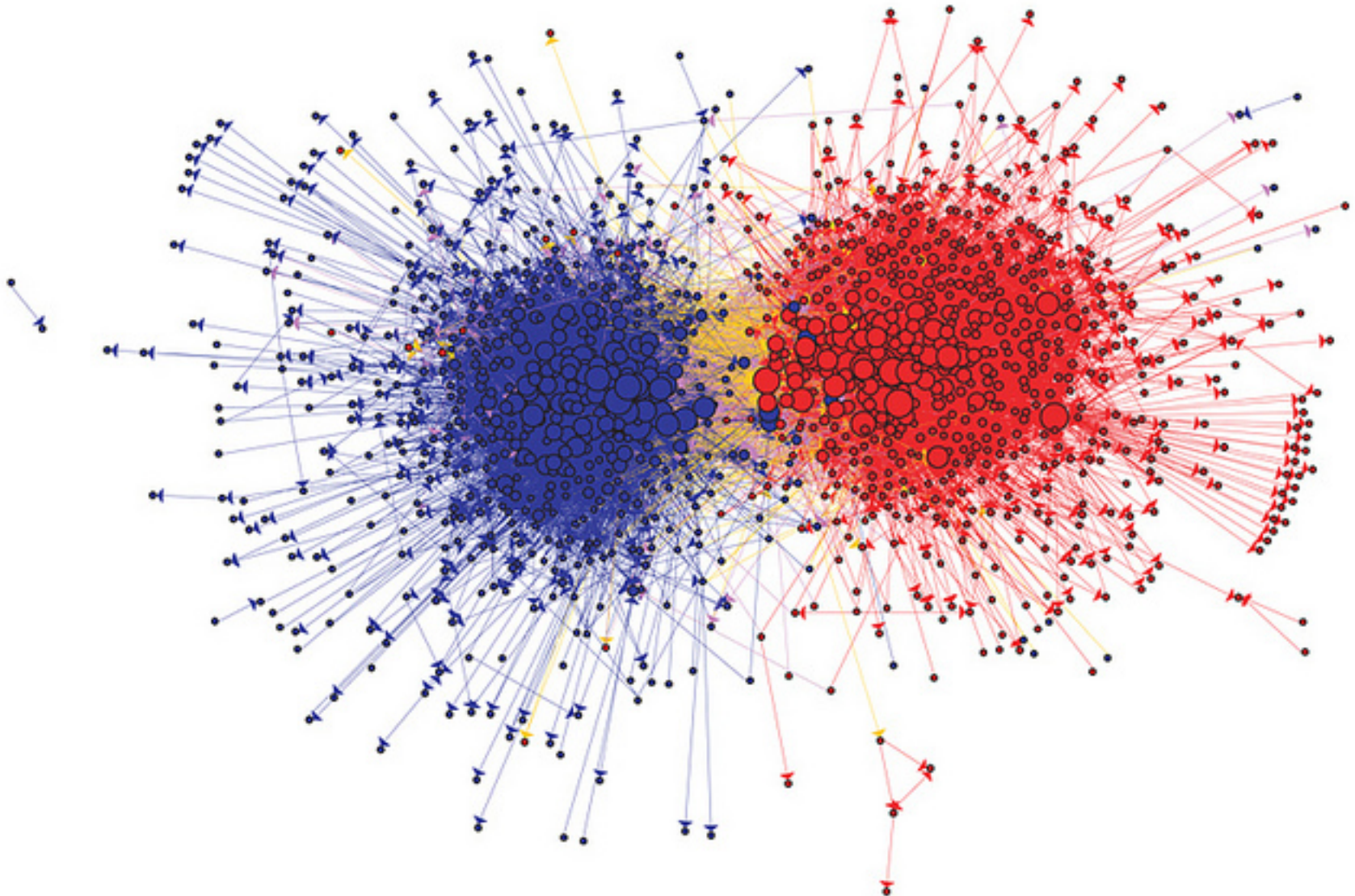


People can ‘wander’ a little way from where they start (in terms of their beliefs) but not very far!

The Road to Brexit (opinion polls) – *a collective shift in opinion*



Lada Adamic's analysis of US political bloggers of the 2004 presidential election



Social Intelligence Hypothesis



- Kummer, H., Daston, L., Gigerenzer, G. and Silk, J. (1997)
- The *crucial* evolutionary advantages that human intelligence gives are due to the social abilities it allows
- Explains specific abilities such as imitation, language, social norm instinct, lying, alliances, gossip, politics etc.
- Social intelligence is not a result of general intelligence, but at the core of human intelligence, “general” intelligence is a side-effect of social intelligence (in particular language and the ability to learn and remember complex beliefs)

An Evolutionary Perspective



Social intelligence implies that:

- Groups of humans can develop their own (sub)cultures of knowledge, technologies, norms etc. (Boyd and Richerson 1985)
- These allow the group *with their culture* to inhabit a *variety* of ecological niches (e.g. the Kalahari, Polynesia) (Reader 1980)
- Thus humans, as a species, are able to survive catastrophes that effect different niches in different ways (specialisation)

Implications of SIH



- That different complex “cultures” of knowledge, skill, habit etc. are significant
- An important part of those cultures is how to socially organise, behave, coordinate etc.
- That these will relate as a complete “package” to a significant extent
- Human cognition is (at least partly) evolved to make this group survival work
- Including the capacity of maintaining a complex set of beliefs that are coherent with others in the group, whilst retaining flexibility

Social Embedding



- Granovetter (1985)
- Contrasts with the under- and over-socialised models of behaviour
- That the particular patterns of social interactions between individuals matter
- In other words, only looking at individual behaviour or aggregate behaviour misses crucial aspects
- To understand the behaviour of individuals one has to understand the complex detail and dynamics of the interactions between them
- Agent-based simulation does this, few other formal techniques do

Context of the Simulation Models Presented Today



- Dissatisfied with representing beliefs at “opinions” as a point on a continuous scale, since this confuses a measured effect with an underlying mechanism
- Wish for some link to the ‘logic’ of beliefs
- Wish to combine something of a cognitive model with social process of influence
- This is quite abstract at the moment, *much* simpler than my usual style of model!
- I am looking for suitable data to enable its assessment and further development



Explanatory Coherence

- Thagard (1989) etc.
- A network in which beliefs are nodes, with different relationships (the arcs) of consonance and dissonance between them
- Leading to a selection of a belief set with more internal coherency (according to the dissonance and consonance relations)
- Can be seen as an internal fitness function on the belief set (but its very possible that individuals have different functions)
- The idea of the presented model is to add a social contagion and network change processes to this

Opinions from Beliefs



- The idea is that a belief may be adopted by an actor from another with whom they are connected, if by doing so it increases the coherency of their set of beliefs
- Thus the adoption process depends on the current belief set of the receiving agent
- Belief revision here is done in a similar basis, beliefs are dropped depending on whether this increases internal coherence
- Opinions can be recovered in a number of ways, e.g. a weighted sum of belief presence

Model Basics



- Fixed network of nodes and arcs
- There are, n , different beliefs $\{A, B, \dots\}$ circulating
- Each node, i , has a (possibly empty) set of these “beliefs” that it holds
- There is a fixed “coherency” function from possible sets of beliefs to $[-1, 1]$
- Beliefs are randomly initialised at the start
- Beliefs are copied along links or dropped by nodes according to the change in coherency that these result in

Coherency Function



- A generalisation of pairwise (in)coherence
- Gives a measure of the extent to which different sets of beliefs are coherent
- Assumes a background of shared beliefs
- Thus $\{A\} \rightarrow 0.5$ and $\{B\} \rightarrow \{0.7\}$ but $\{A, B\} \rightarrow -0.4$ if beliefs A and B are mutually inconsistent
- Different coherency functions will be applicable to different sets of 'foreground' candidate beliefs and backgrounds of shared beliefs
- The probability of gaining a new belief from another or dropping an existing belief in this model is dependent on whether it increases or decreases the coherency of the belief set

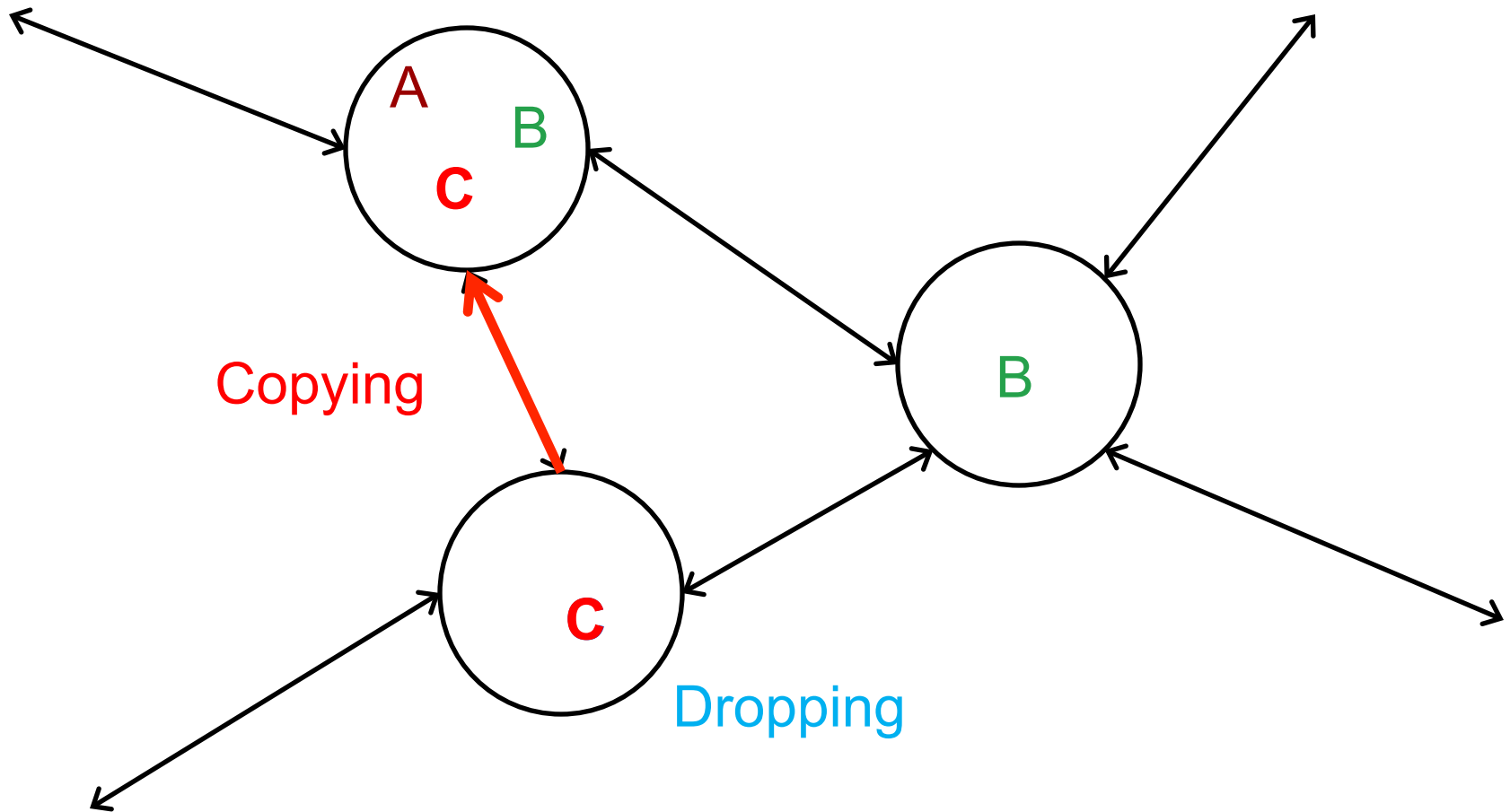
Belief Change Processes



Each iteration the following occurs:

- **Copying**: each arc is selected; a belief at the source randomly selected; then copied to destination with a *probability* related to the change in coherency it would cause
- **Dropping**: each node is selected; a random belief is selected and then dropped with a *probability* related to the change in coherency it would cause
- $-1 \rightarrow 1$ change has probability of 1
- $1 \rightarrow -1$ change has probability of 0
- There are different ways of doing this mapping

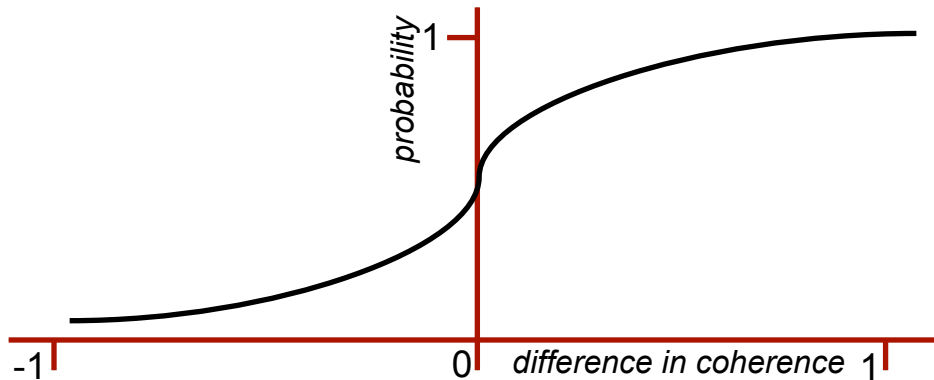
Illustration – *Belief Change*



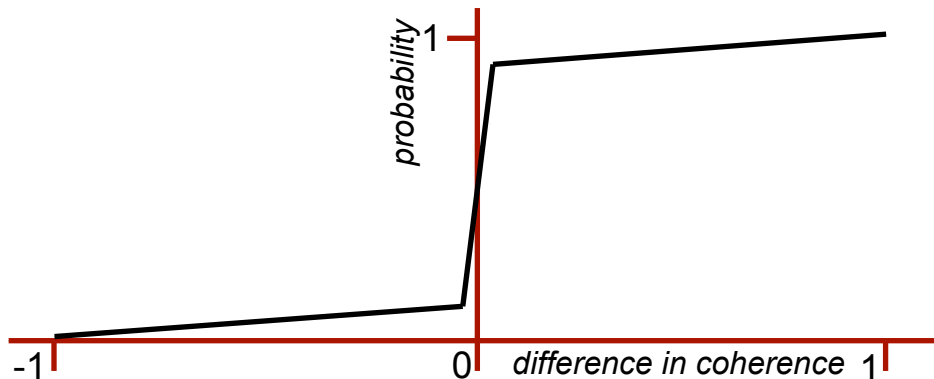
Scaling of Impact of Coherence



- There are a variety of ways to map a change in coherence to a probability (of the change)



A '*weak*' mapping –
probably changes to
increase coherence



A '*strong*' mapping –
almost certainly only
changes to increase
coherence

Network Change Processes

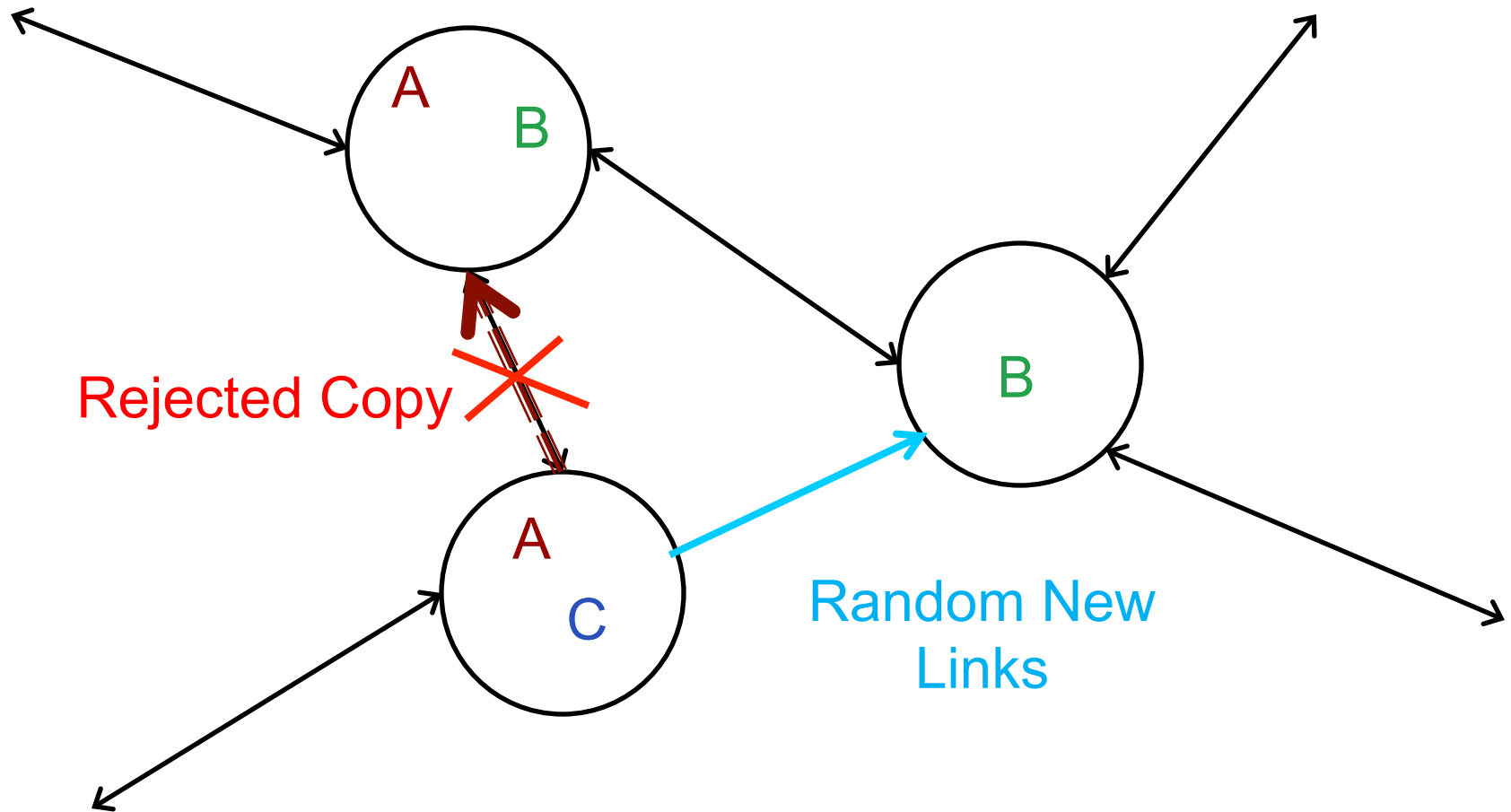


Each iteration the following occurs for each agent:

- **Link Drop**: with a probability: if a belief copy was *rejected* by the recipient, then drop that in-link.
- **New Links**: with another probability, create a new random link with a random other (with a friend of a friend if possible, otherwise any)

In order to maintain the average link density I added the following ‘cludge’: If there are too many links (as set by arcs-per-node) increase the rate of link drop, if there are not enough, reduce the rate of link drop.

Illustration – *Network Change*



A Particular Example



- 20% of agents (stars) are such that the 'yellow' beliefs are attractive and the 'blue' ones unattractive (due to coherence with background beliefs), they are also 'strong minded' in the sense that they only change their mind if it increases their coherence
- 80% of agents (circles) are such that the 'blue' beliefs are attractive and the 'yellow' ones unattractive, they are also 'weak minded' in the sense that they only have a tendency to change their mind if it increases their coherence (more probabilistic in their belief change)
- Both change their links (or not) similarly and both are agnostic with respect to the 'red' belief

The Run Variants



- 10 runs of each variant

Runs with

- no belief change and no link change
- with belief change only
- with link change only
- with both belief and link change

(there is some random chance of changing beliefs)

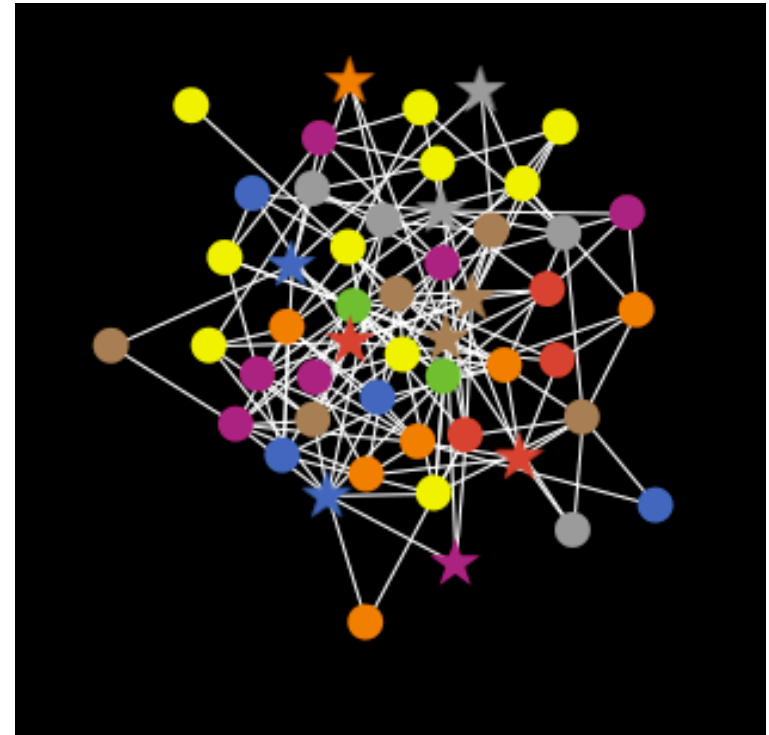
Output shown in terms of:

- Animations
- Average results over the 10 runs for each option

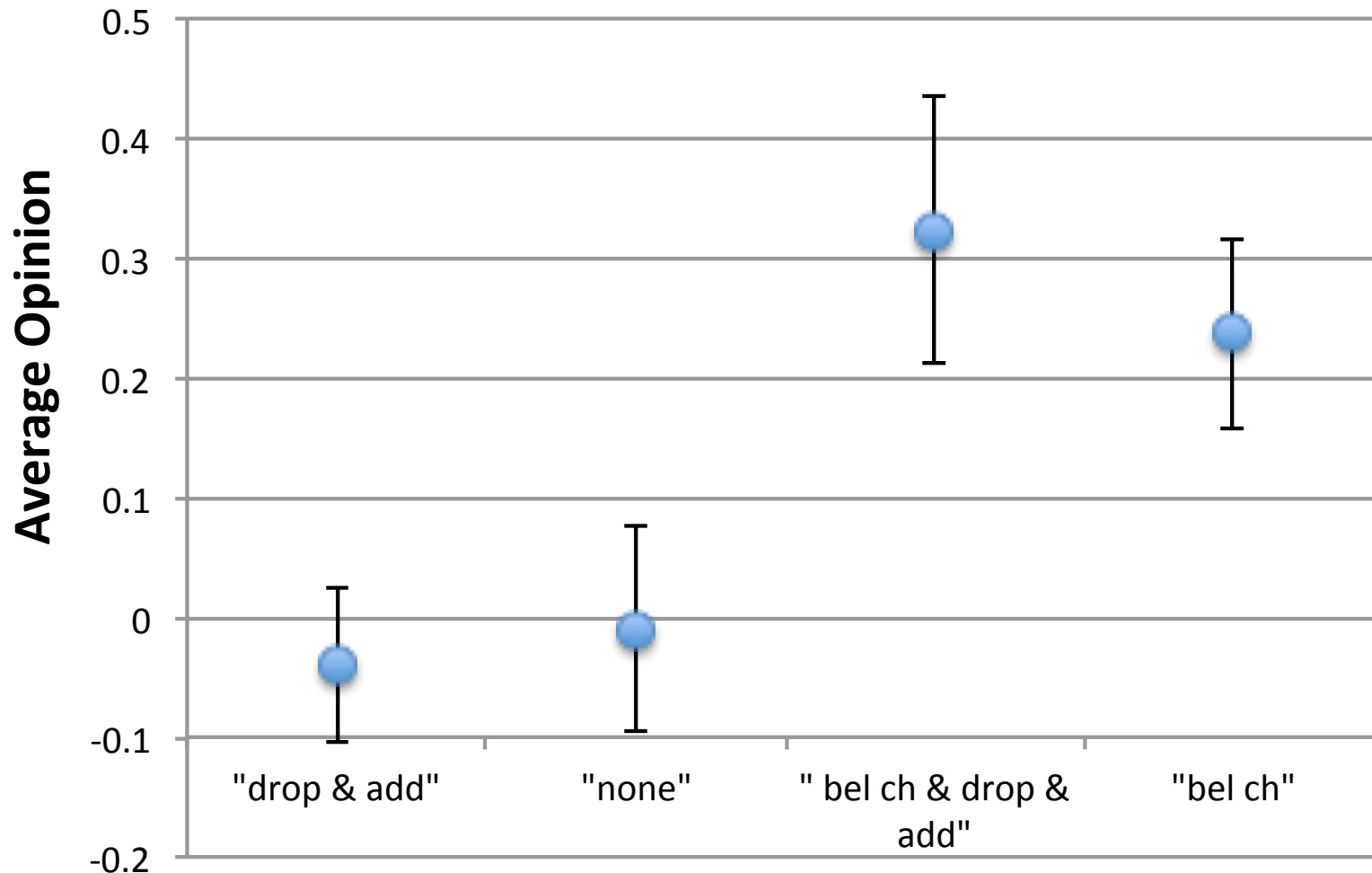
Animations



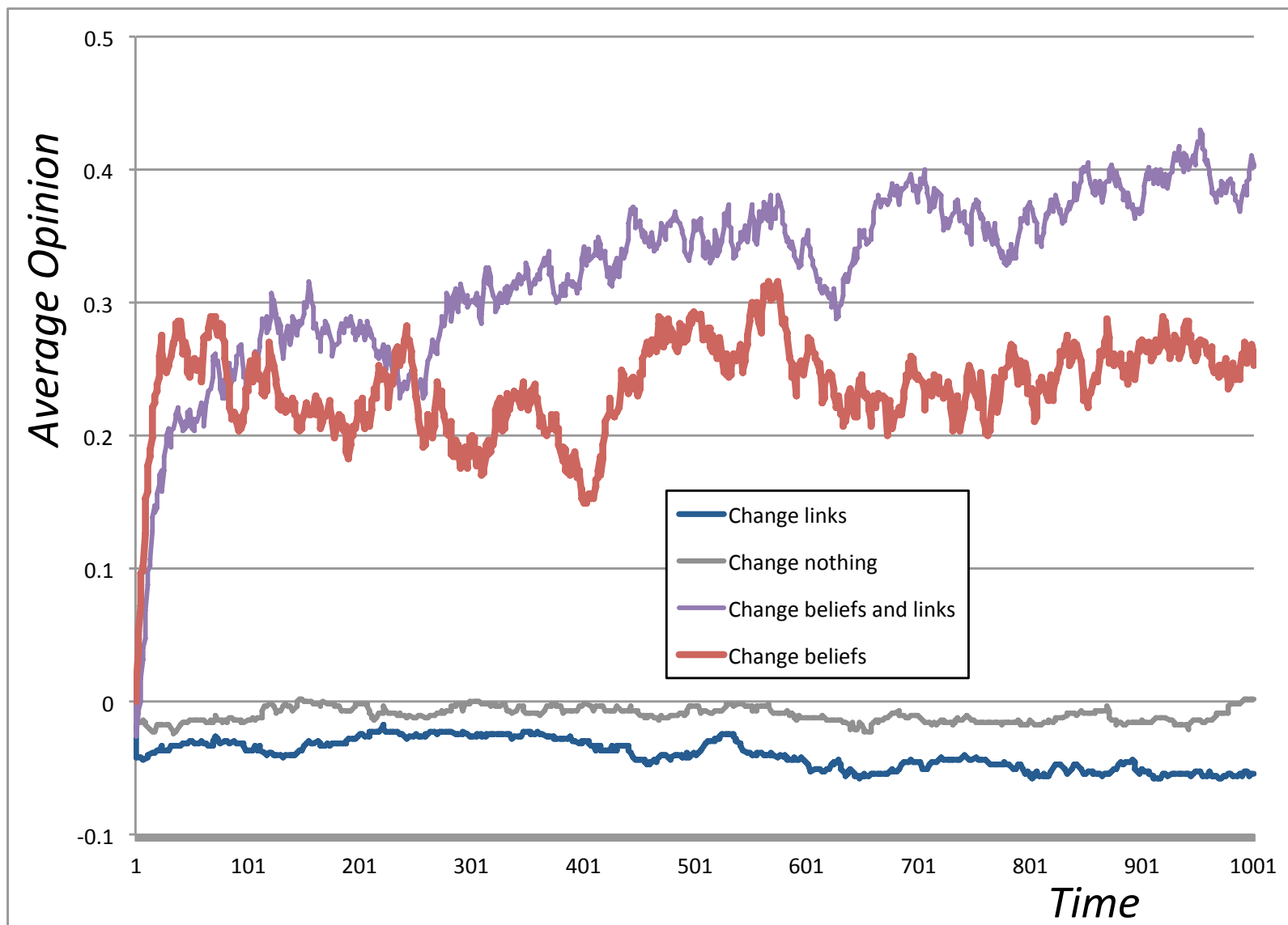
- Atomic beliefs: yellow, red, blue
- Agents shown in colours indicating the mixture of beliefs held (or if none, grey)
- Links are relationships such that the beliefs of one might be adopted by the other
- Star nodes or triangle nodes are minorities
- Circle nodes are of the majority



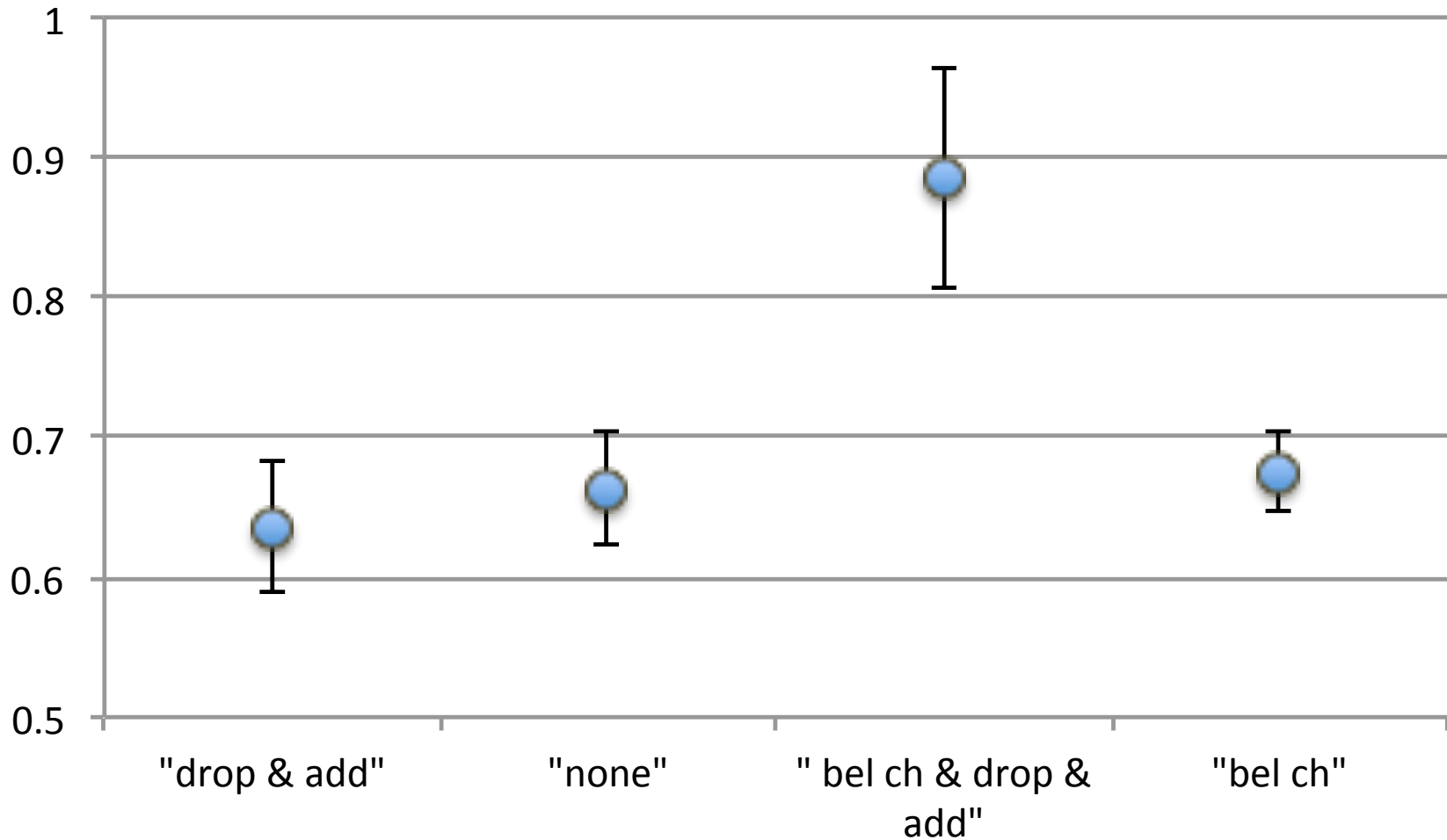
Average Opinion at End



With and without changing links and beliefs (average over 10 runs)



Proportion of same kinds linked together



Towards a 'Brexit' example

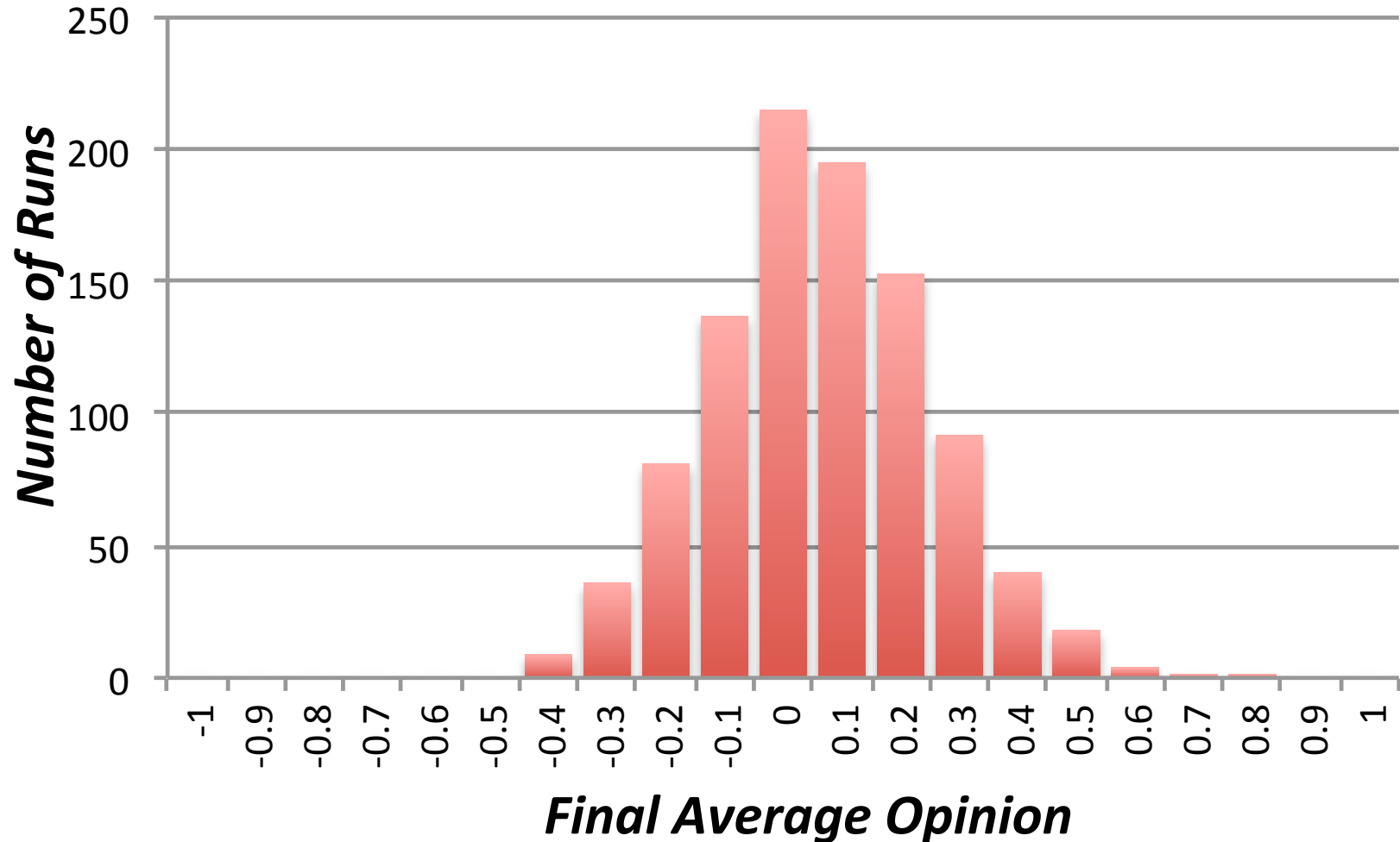


3 groups: floaters, yellows and blues

1. 70% Floaters, (circles) towards either yellow or blue (but not both) beliefs, weak scaling function
2. 10% Yellows, (stars) are for yellow and against blue with a strong scaling function
3. 20% Blues (triangles) are for blue and against yellow, with a medium scaling function

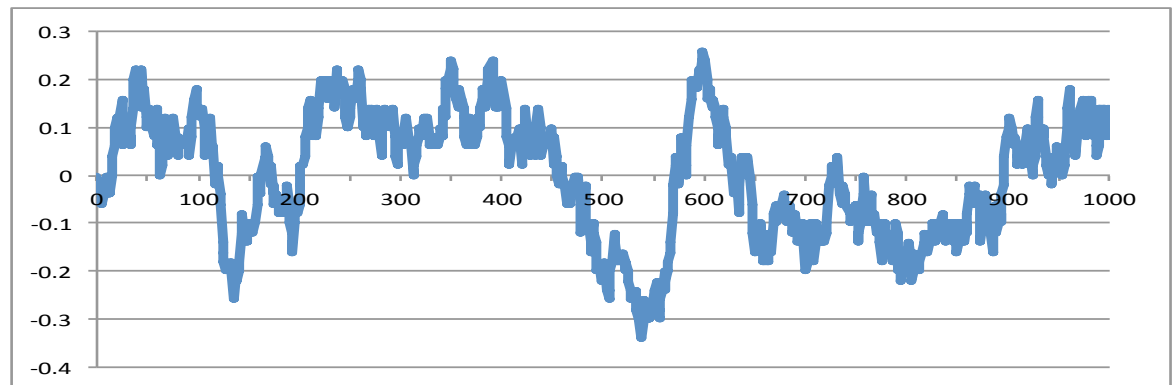
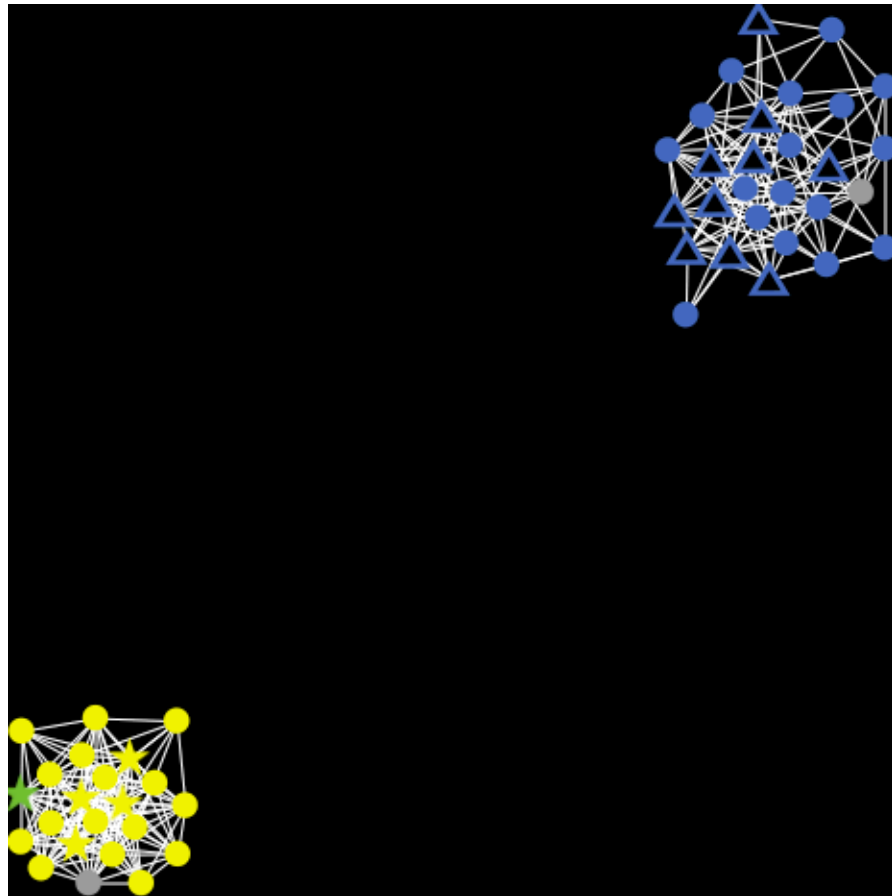
Groups start separate (to allow for self-reinforcement), with random beliefs, but then both network and beliefs co-develop

Distribution of Final Average Opinions (1000 runs)



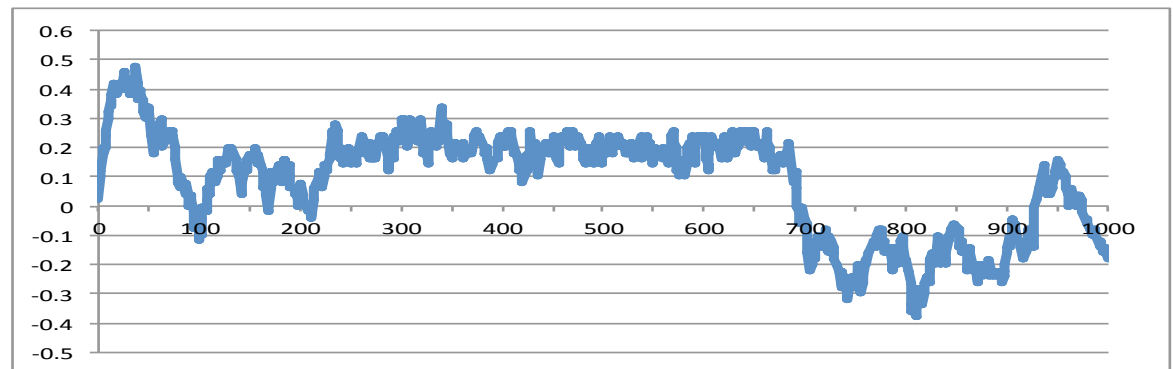
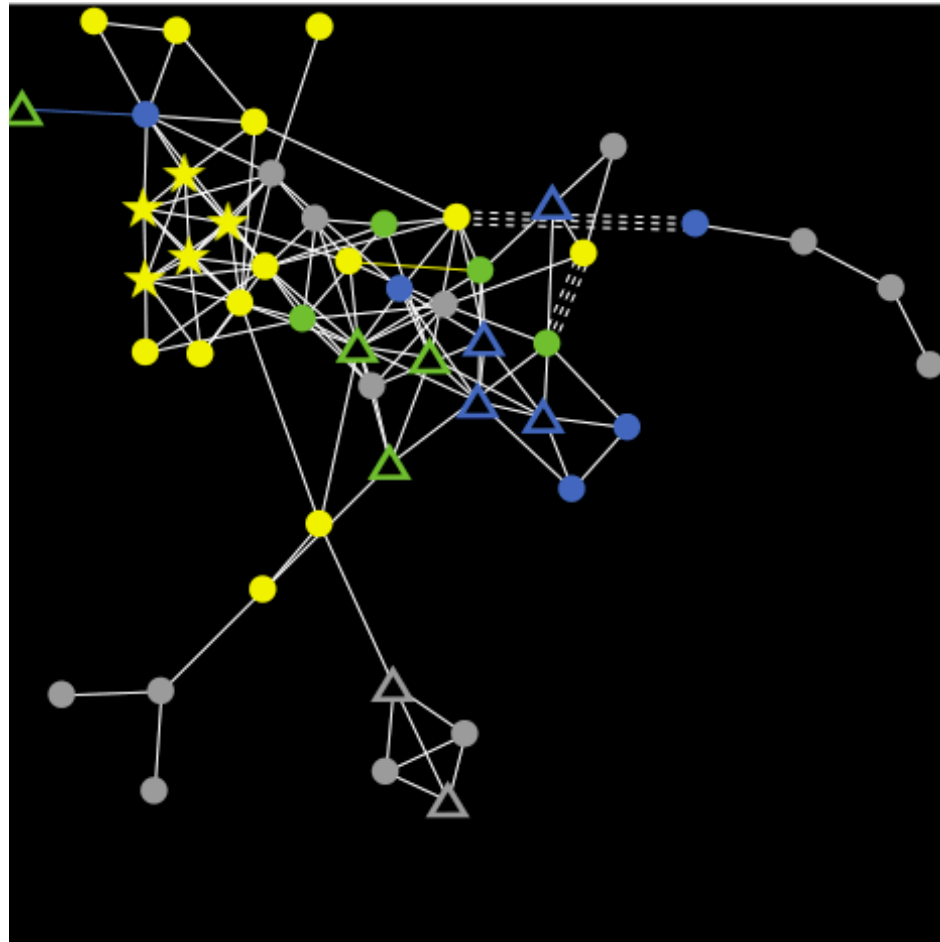
Example run 1

Yellow connects with floaters first, followed by the blues, these polarise the floaters, which then separate off into two groups, which then slowly convert the floaters to their own colours



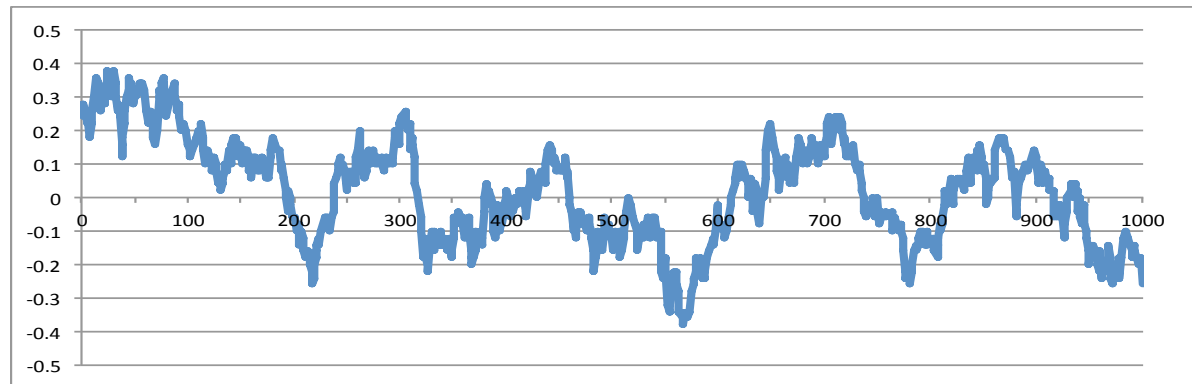
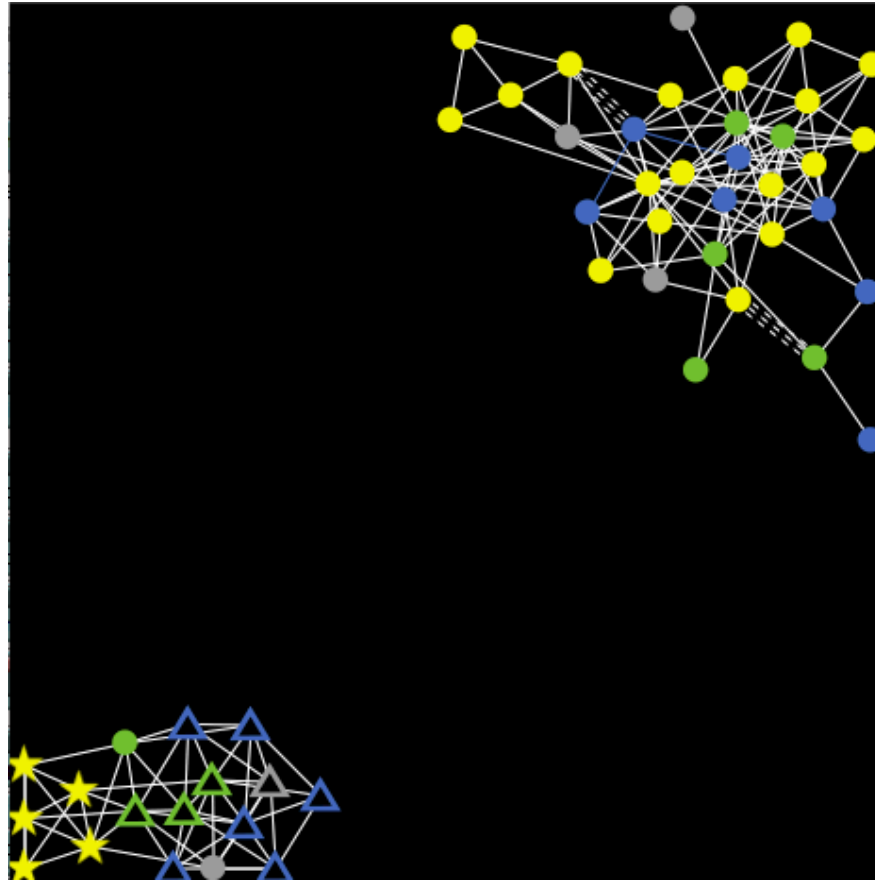
Example run 2

both integrate and polarise floaters, then a period of islands (blue more), then some yellow mutate in blue island, which then spreads pulls apart, then yellow integrates into other and converts more



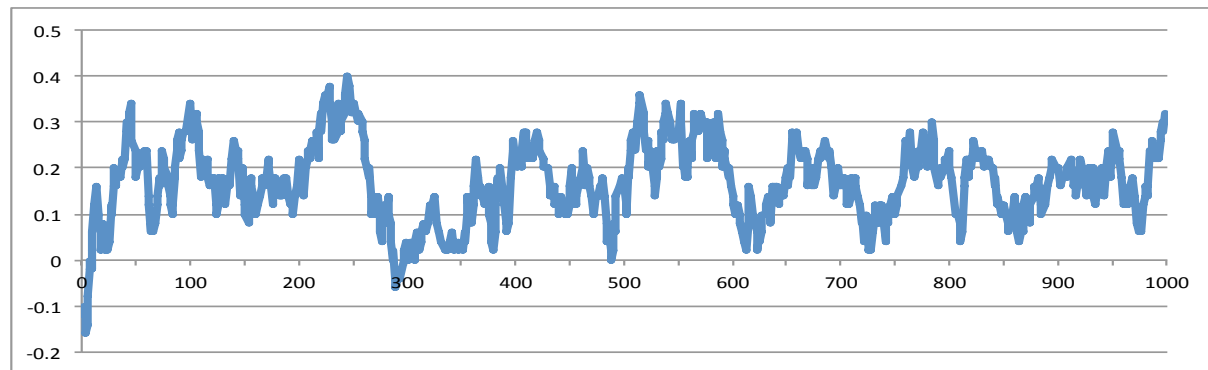
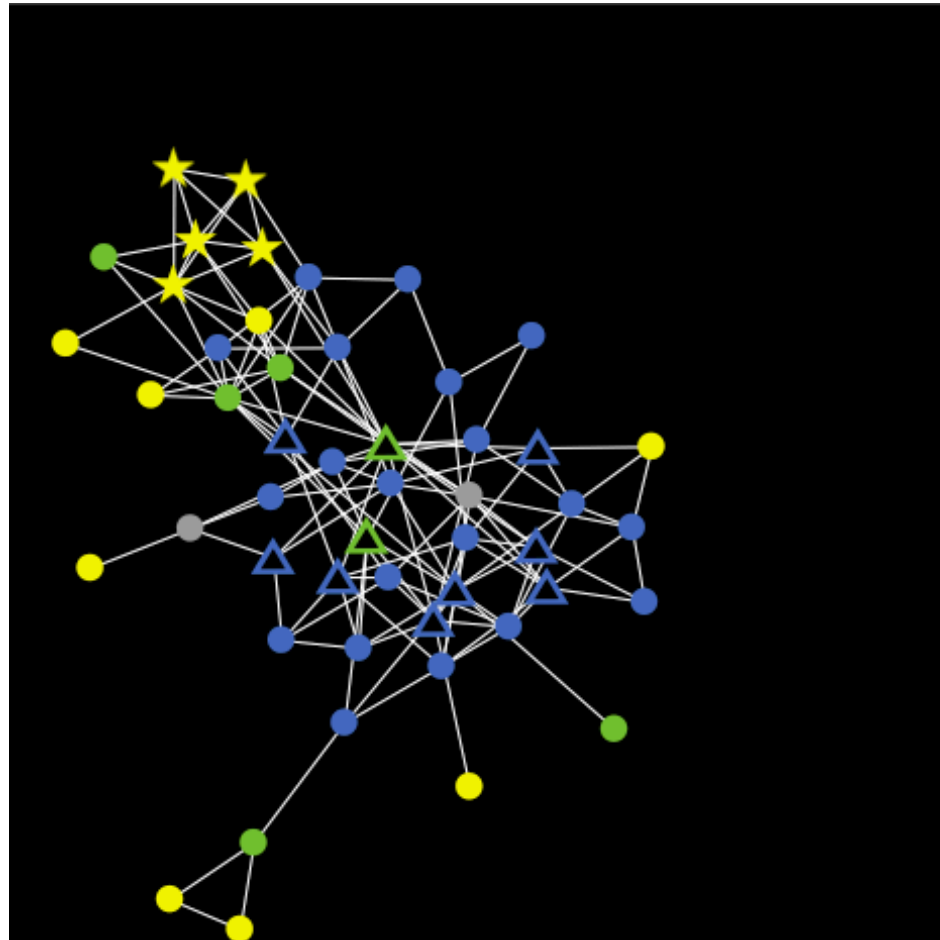
Example run 3

‘Westminster bubble’ of blues and yellows separate from floaters forms, separately floaters flip each other back and forth but in a random walk which happens to end with more yellow

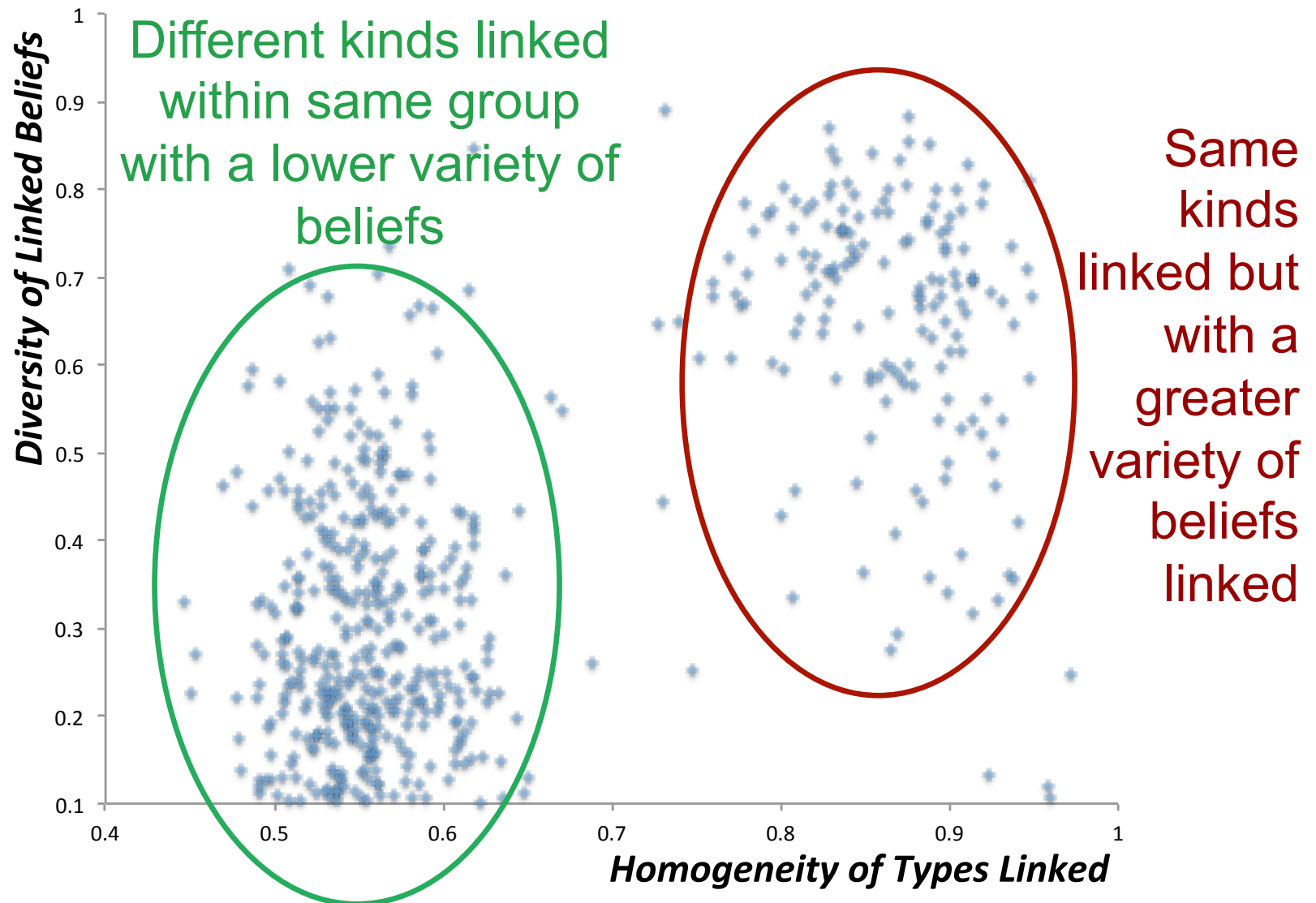


Example run 4

Both connect with floaters, but blues more intimately, yellows always on the peripheral, yellow connects again and again, but does not ever gain enough influence to convert many floaters



(At least) two clusters of results



Suggested Issues/Hypotheses



There are ‘competing’ processes of:

- Social influence (suggestion) vs. internal coherence with existing set of beliefs
- Social influence vs. social linking
 - An ‘extreme’ group may be good at convincing another group when connected but groups tend to disconnect from those with very different views to themselves

How processes actually happen may matter a lot:

- e.g. what influences people’s change of links – do people have a ‘whitelist’ of those they are willing to allow to influence them?

This model does not touch upon the development of people’s belief structures within their society

The Complexity of Socio-Cognitive Coherence



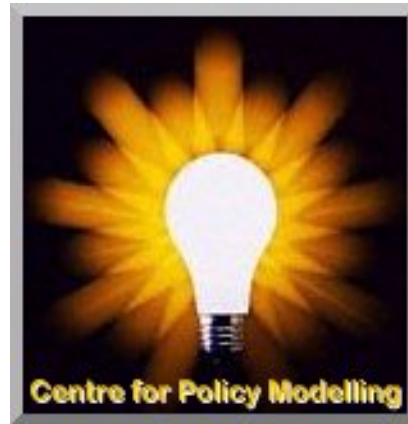
- Much cognition (including belief coherence) makes more sense in a social setting
- But also the possible social structures are affected by our cognitive abilities/limitations/biases
- To understand such phenomena one needs to see how the cognitive, interactive and social levels relate to each other
- Just looking at global statistics and hoping to tease out what is happening will often be insufficient
- Just looking at individuals outside their real, messy social contexts will also be insufficient

A Plea For 'FAT Data'



- Often we have different kinds of data originating from different sets of events or people
 - a time series about a certain series of events
 - an experiment for a particular set of people in a particular context
 - some qualitative research observing people in another particular situation
 - 'big data' streams of records of position, urls etc.
- Rather I need lots of data at all levels with consistent IDs over this data, e.g.: repeated surveys, interviews, time-series data about the *same* people and events!

The End



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

A version of these slides (without movies) is at:

<http://slideshare.com/BruceEdmonds>

The simulation is at:

<http://openabm.org>