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Coherency Models of Belief Change Inferred from Survey Data

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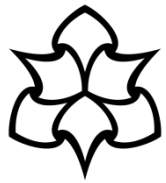
Co-Researchers on this work in progress…



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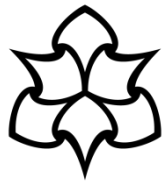
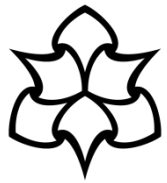
- *Peter Steiglechner*, ZMT Bremen and Constructor University Bremen, Germany
- *Marlene Batzke*, University of Kassel, Germany
- *František Kalvas*, University of Western Bohemian, Czechia

The Rationality Cognitive Model



- The dominant model for individual decision-making is that of rationality
- This states roughly that, when making a decision, actors evaluate the effects of possible choices to get the best utility based on their knowledge (e.g. Elster 1999)
- Knowledge → Conclusion → Action → Utility
- Exceptions and refinements of this are allowed: e.g. non-economic utility functions, bounds on the computations involved, where beliefs come from etc.

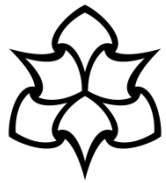
Problems with the Rationality Model



1. It requires unrealistic assumptions (individuals could not think like this)
2. It does not model how people are observed to behave
   - The list of exceptions, called 'biases' is now ***very*** long
   - Even in aggregate it gives the wrong outcomes

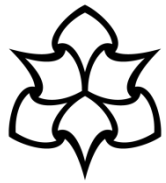
- Many economists now accept its defects but still use it as the base 'reference' model

The Coherency Model of Cognition



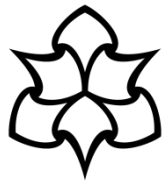
- In this, actors select beliefs, goals etc. that are coherent with their existing set
- And then can act on the basis of these
- This coherency might be that of logical consistency but also might be in terms of style or social influence (e.g. identity)
- For example, one may reject a suggested belief because it would mean changing a cherished goal or action (e.g. deny climate change because of liking driving a car)
- Heider, 1946; Festinger, 1957; Thagard, 2000

Problems with the Coherency Model



- No universally agreed formal model of what ‘coherency’ between beliefs is
- Not very clear how identity, emotion, beliefs etc. all relate to each other
- Any model dealing with particular beliefs/actions has to somehow incorporate all the actor’s other beliefs
- How does social influence work? (lots of micro↔macro interaction)
- How can one start to pin this down with data?

Our approach



1. Chose a formalisable theory of coherence
2. Use survey data to find group-specific models so that:
   - the actors are divided into a set of groups of those with similar coherency patterns
   - a cognitive model is inferred for each such group from the data
3. To find the micro↔macro outcomes we create an agent-based model where the actors are given the different models in their groups as in the survey then 'animated'

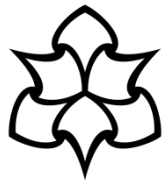
But there are lots of ways of doing this…

European Social Science data

Key	Topic	Scale
euftf	European Union: European unification go further or gone too far	0—10
freehms	Gay and lesbians free to live life as they wish	1—5 inverted
gincdif	Government should reduce differences in income levels	1—5 inverted
lrscale	Placement on left right scale	0—10
impcntr	Allow many/few immigrants from poorer countries outside Europe	1—4 inverted

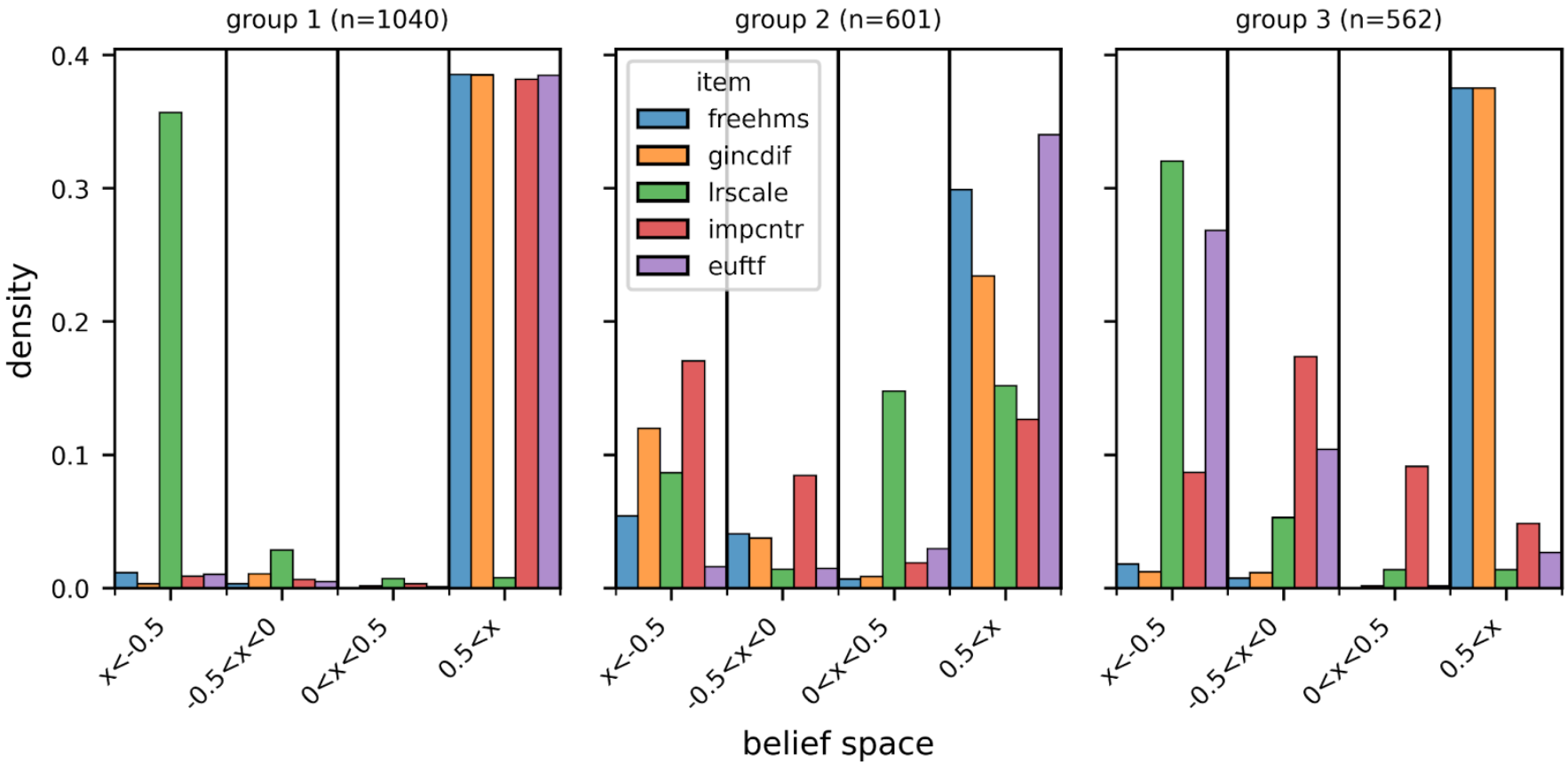
We used the German subset of the 2019 wave of this survey, selecting 5 items from this survey recording interesting political beliefs, N = 2203

Correlational Class Analysis (CCA)



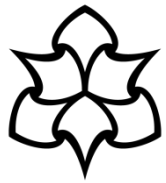
- There are methods that would cluster the individuals according to the (intensity of) their beliefs as recorded by the survey but this does not capture interactions between beliefs
- We used CCA (Boutyline 2017), which produces clusters where there are similar correlations between beliefs of members
- CCA has a single parameter which affects the number of groups that result

CCA applied to the ESS data



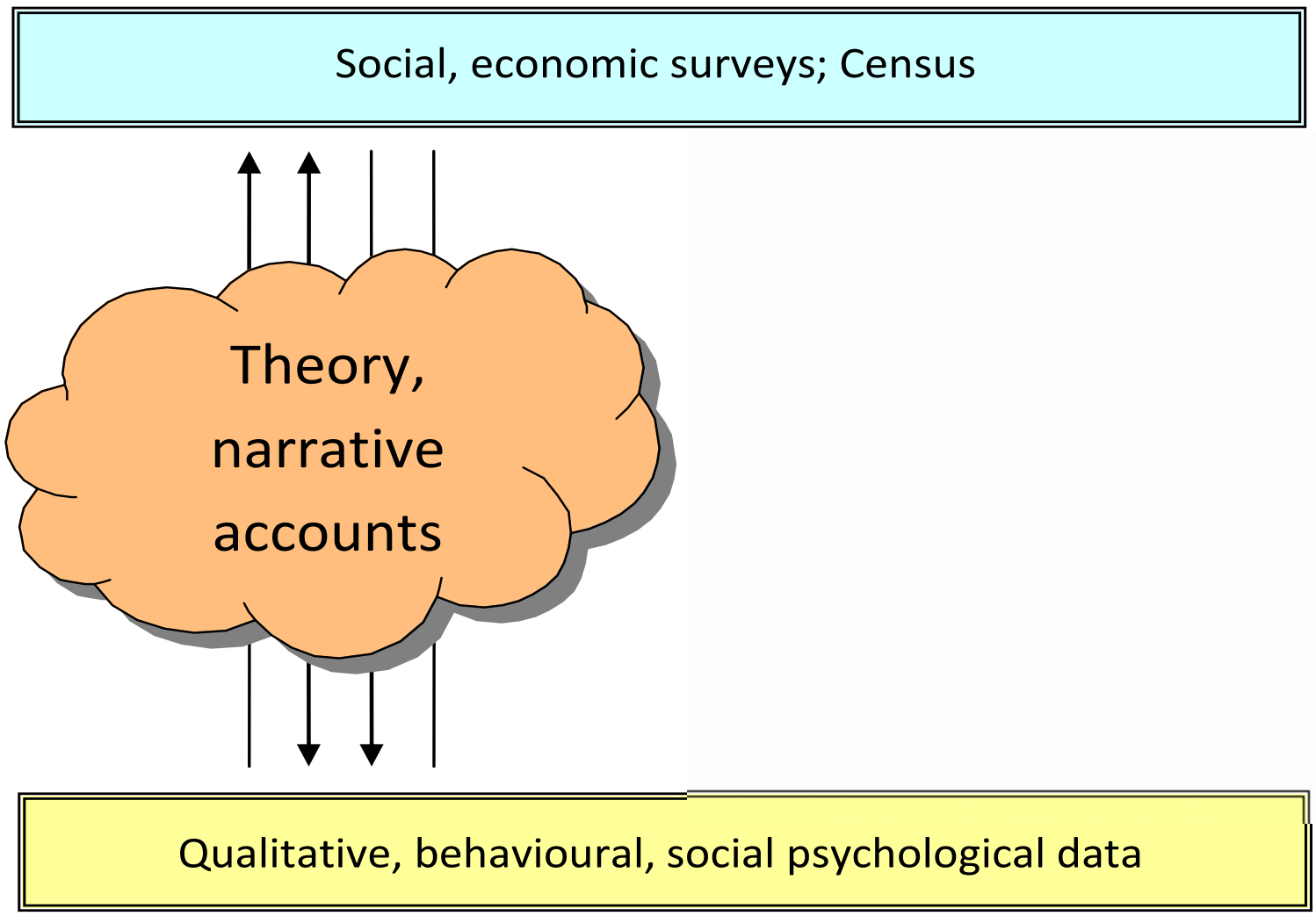
Group 1 is quite consensual about all topics with a nearly unanimous positive stance on all topics. Group 2 is split on most topics, except for its shared support for the EU. Beliefs in group 3 are quite diverse

Agent Based Modelling



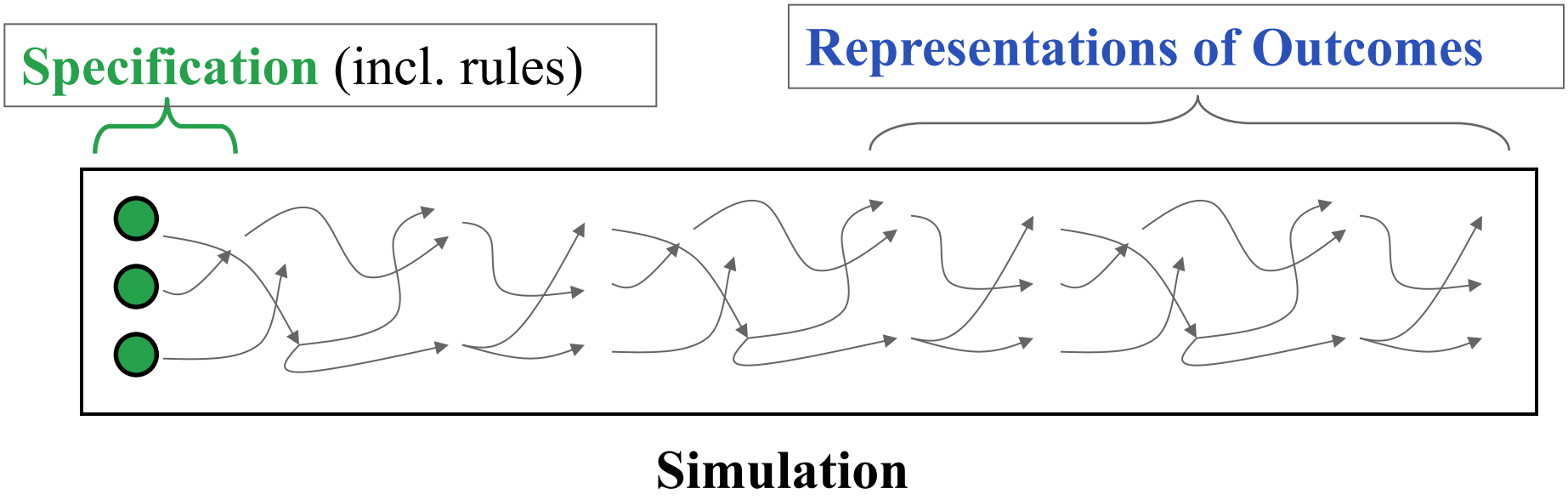
- A computer simulation approach
- Each actor is *separately* represented in the model (by 'agents'), so *each* can have *different* properties and behaviours
- And are usually situated within a network or physical space
- Agents then interact with each other or the environment
- Sort of a cross between AI and sociology!
- Gilbert & Troitsch 2005; Edmonds & Meyer 2017

Micro-Macro Relationships

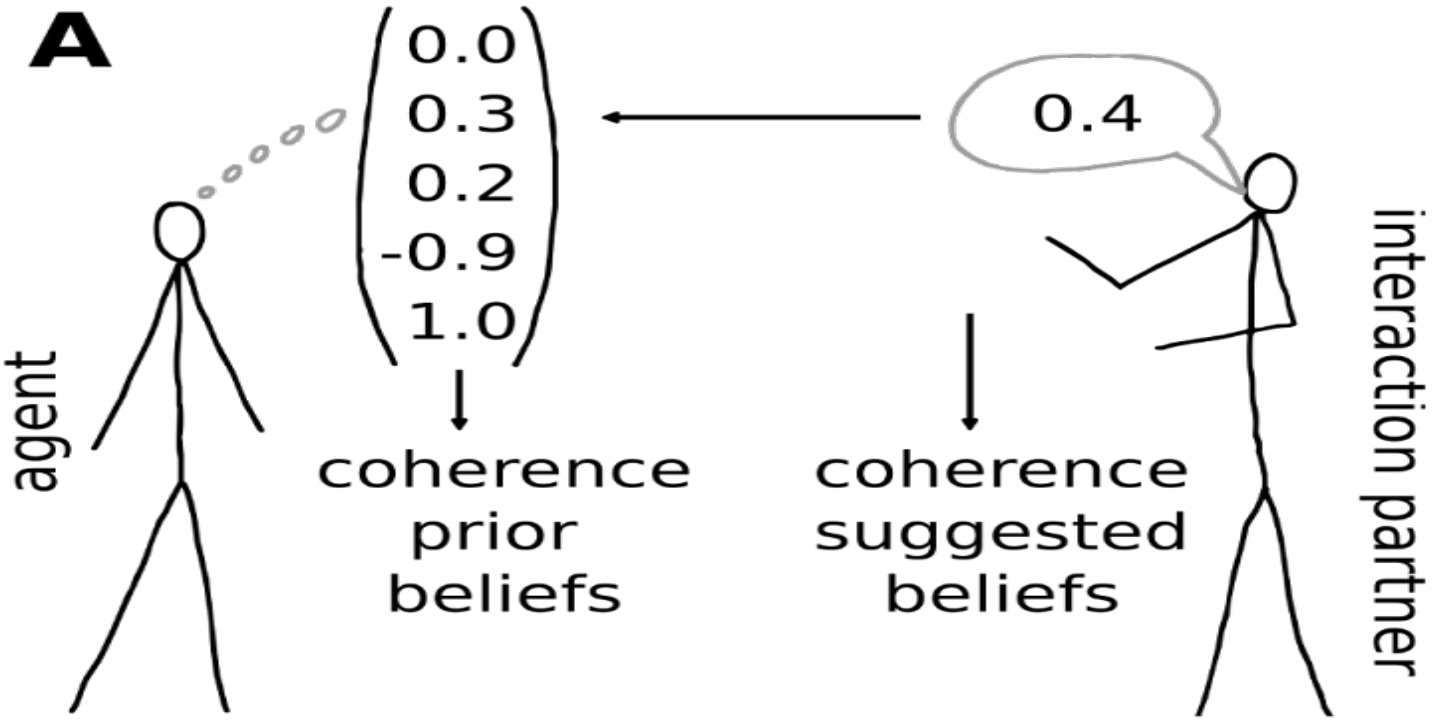


What happens in ABSS

- Entities in simulation are decided upon
- Behavioural Rules for each agent specified (e.g. sets of rules like: if *this has happened* then *do this*)
- Repeatedly evaluated in parallel to see what happens
- Outcomes are inspected, graphed, pictured, measured and interpreted in different ways

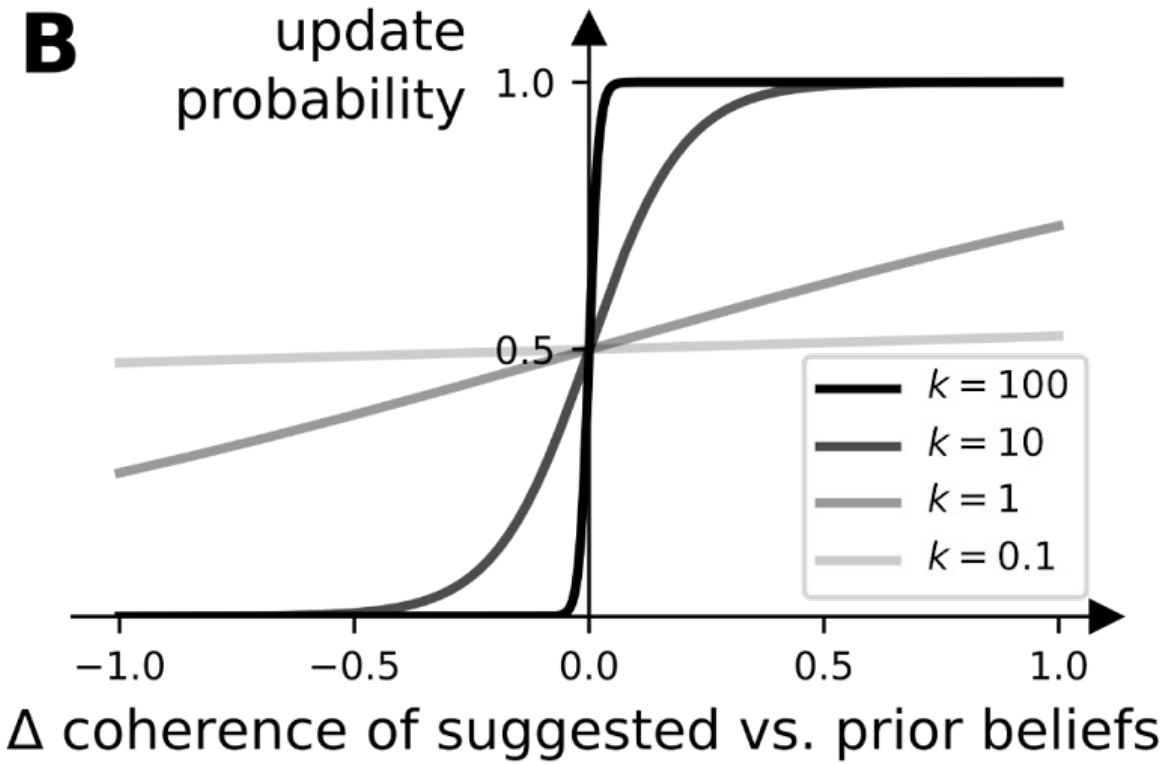


What happens with interaction in the model



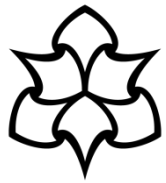
Change in coherency of belief vector before and after is calculated. In this case how much the suggested new belief (intensity) would be suggested by applying the receiver group's correlation matrix given the other beliefs

How the coherence change affects probability of change



Big k means the coherency mechanism is more important, small k means it is more random (not modelled)

The simulation

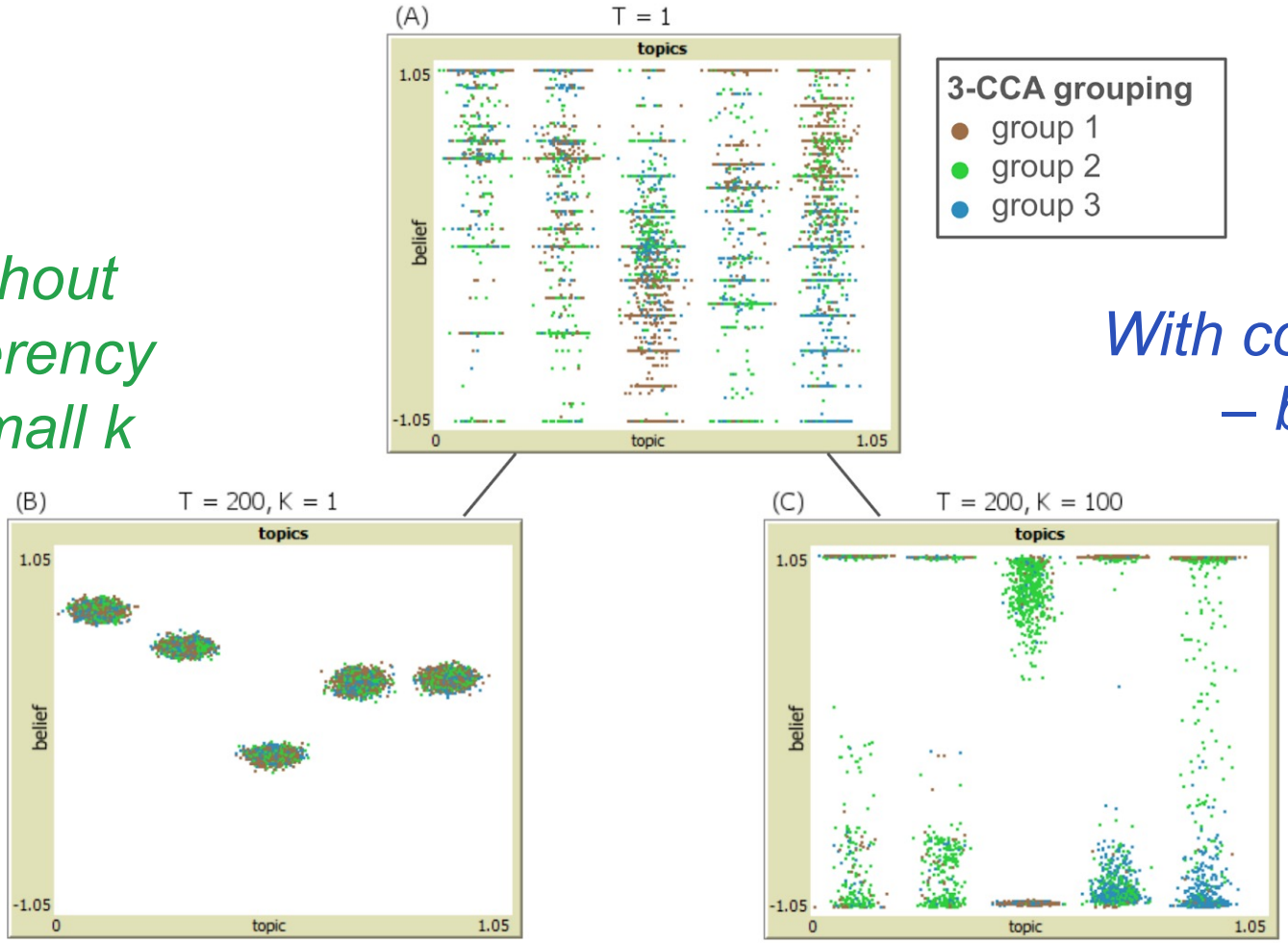


- Same number of agents as subjects in the survey used, initialised using the beliefs in that survey, in a random network

Each time click (in the simulation) agents:

- consider a belief (randomly selected) from another in their social network and accept depending on the probability of change
- consider randomly changing an existing belief and change depending on the probability of change

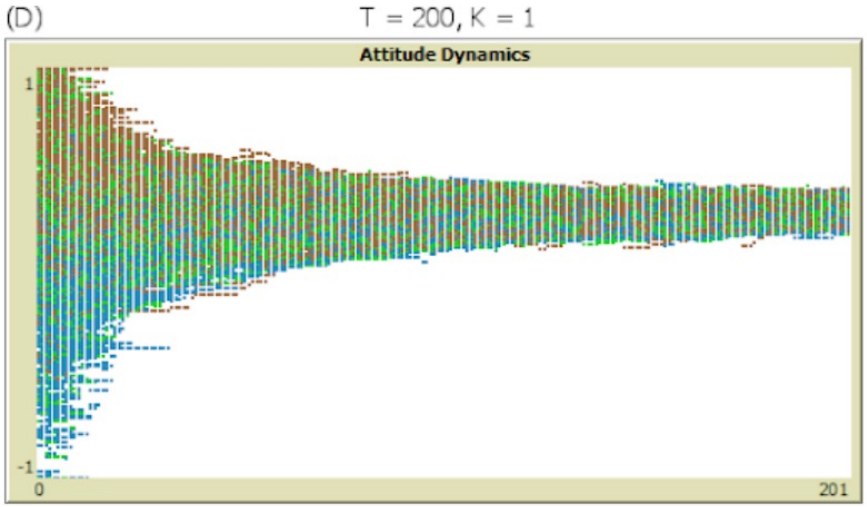
Start by initialising beliefs using survey values, then with low coherency vs. high coherency

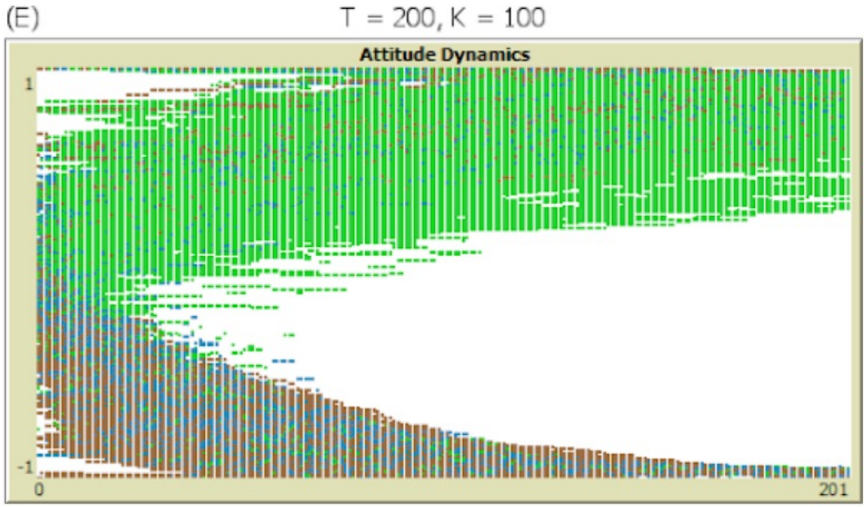


Without coherency – small k

With coherency – big k

Illustration of Dynamics over time





Without coherency – small k

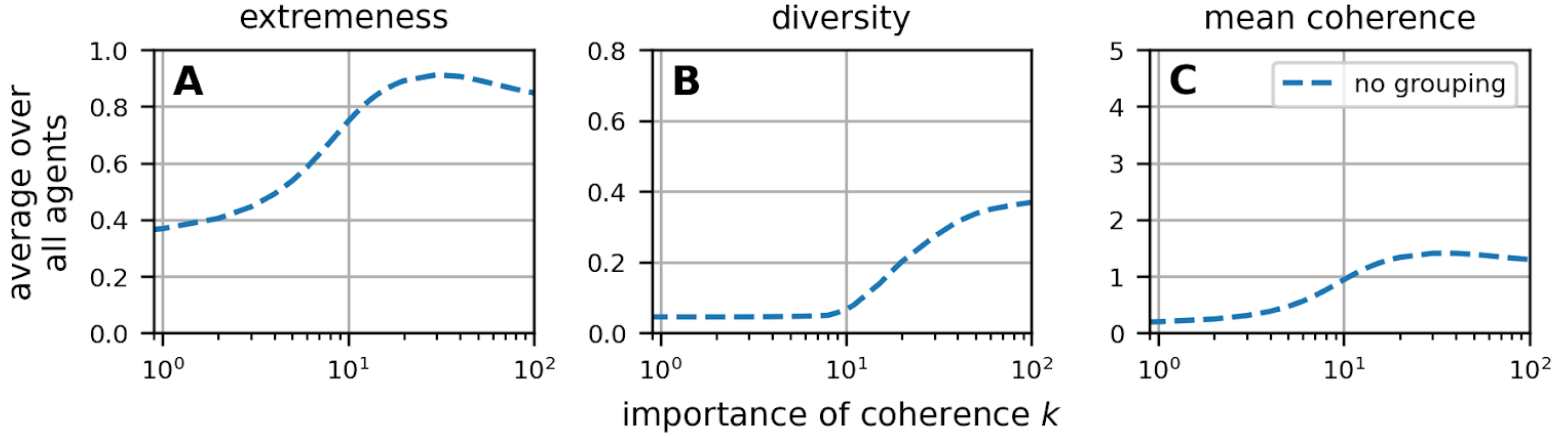
3-CCA grouping
- group 1
- group 2
- group 3

With coherency – big k

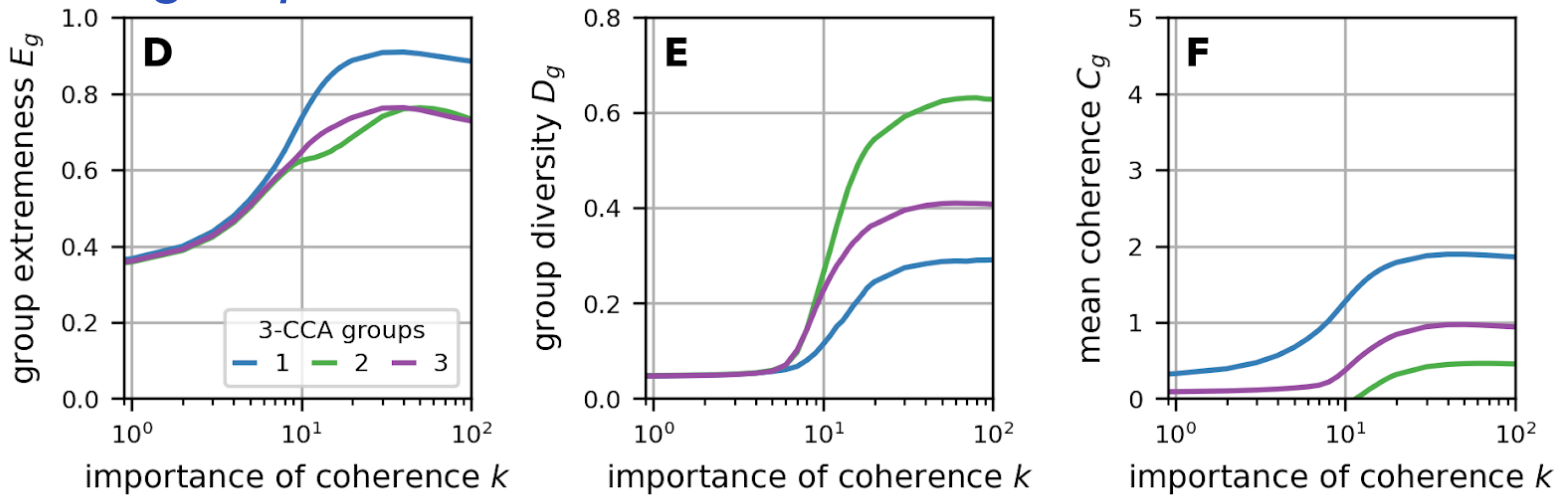
Vertical axis is belief intensity [-1,1], horizontal is time, each colour shows agents of a different group, dimension show is for left-right split (*lrscale*)

Final outcomes for different k

All one group using a single global correlation matrix

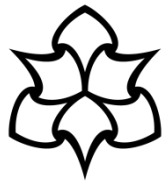


3 CCA groups each with own matrix



Each point is a statistic of all the distributions at time=200 in simulations

Concluding discussion



- Methods represents a move towards a more group-based approach, between global aggregate and individual level
- It is a step towards a more data-lead simulation approach
- It shows that the strength of the coherency mechanism can make a difference on macro-level outcomes
- The approach maintains more inter-group diversity, even if group members converge in terms of their beliefs in their group

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Thank you!

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