Modelling the effects of self-learning and social influence on the **diversity** of knowledge

a simple toy model

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COMPLEX NETWORKS

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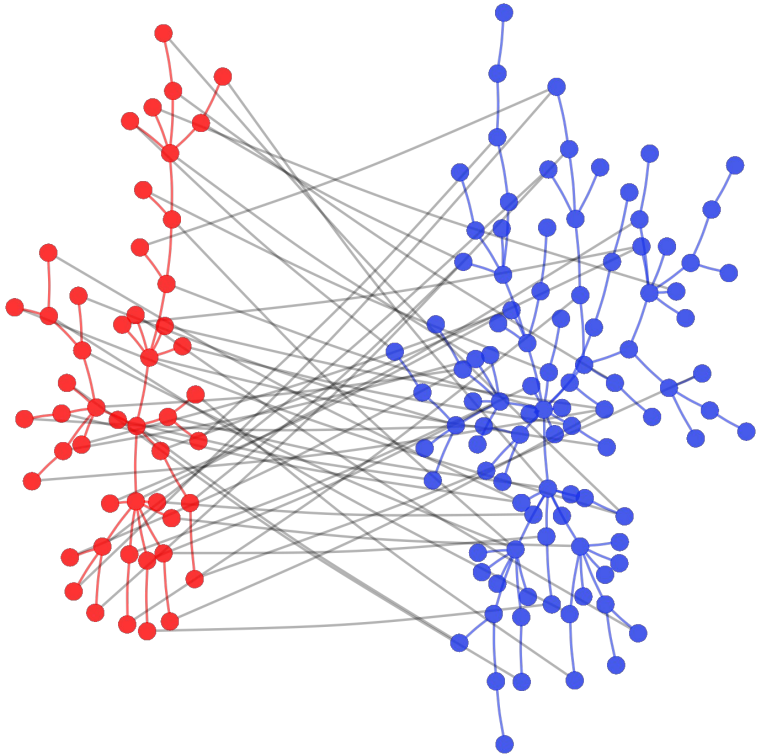
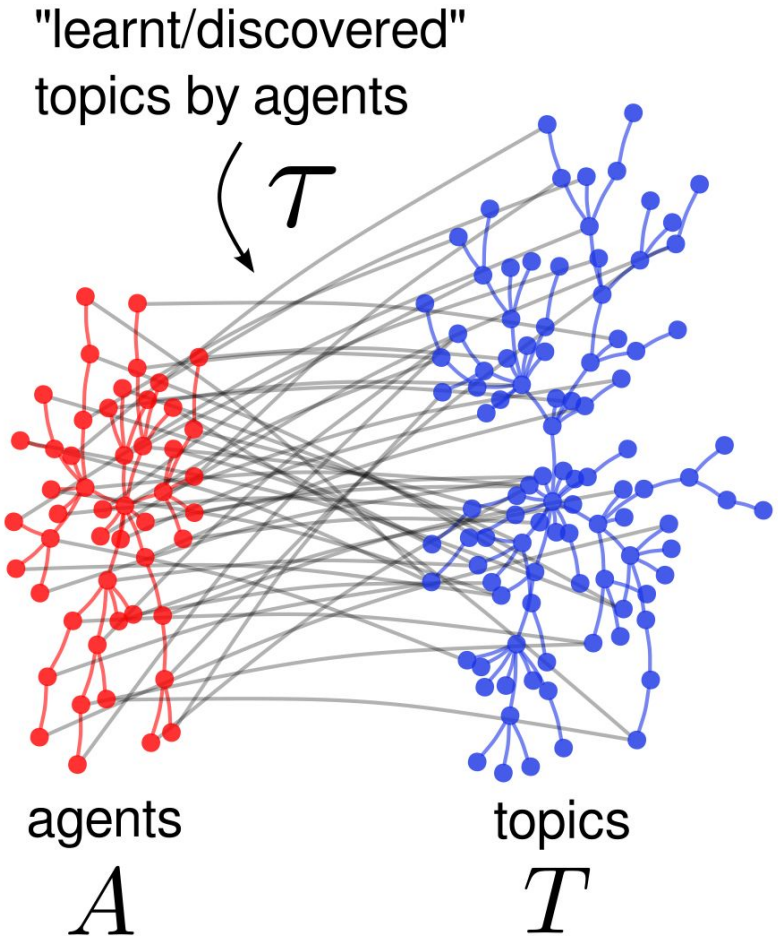
Information Spreading in Social Media



github.com/tuanpham96/topic-diversity

Outline

1. Introduction to model & knowledge acquisition process - self-learning & social influence
2. Diversity indices - population vs individual indices
3. Consideration of *groups* in *intralayer* networks using block models
4. Summary and limitations of model



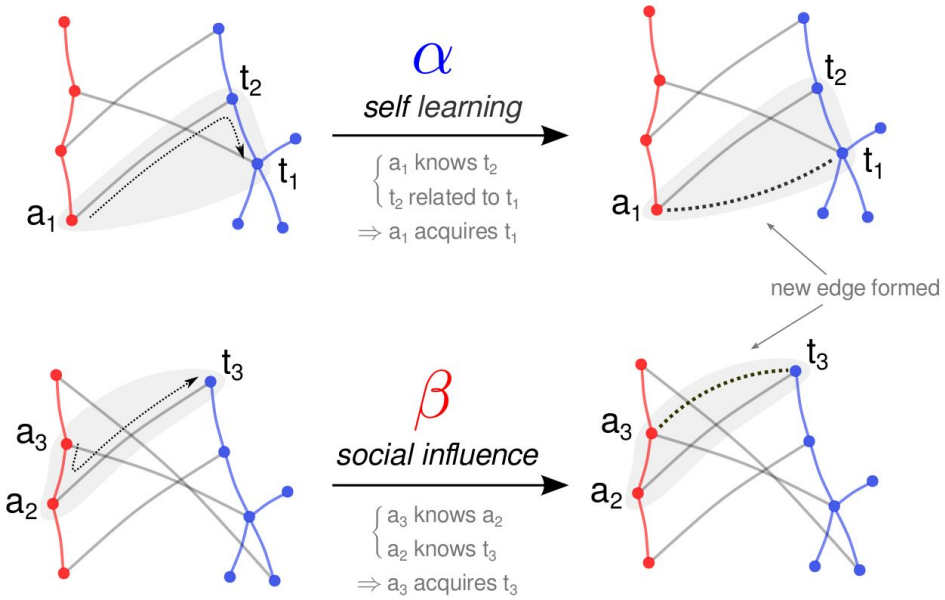
binary undirected

static *intra*layer

dynamic *inter*layer

persistent *inter*layer

Interlayer update



new topic = related to the known topics or learnt from friends

$$P = \alpha\psi\left([[T\tau]_\star - \tau]_\star\right) + \beta\psi\left([[\tau A]_\star - \tau]_\star\right)$$

$$\tau(t+1) \leftarrow \tau(t) + \text{sample}(P)$$

$$[x]_\star = 1 \text{ if } x > 0, 0 \text{ otherwise}$$

$\psi(X)$ as column norm. for matrix X

For simplicity $\beta = 1 - \alpha$

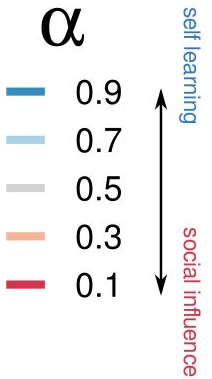
max-capacity 50 topics/agents

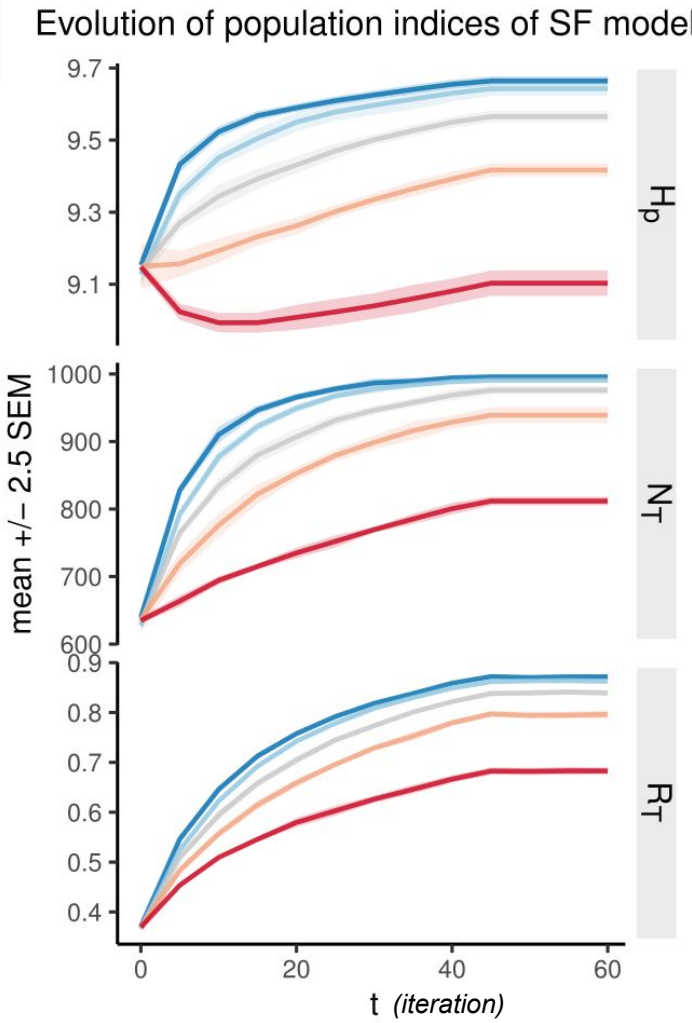
persistent *inter*layer edges

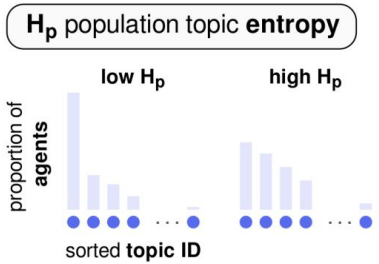
ignore: serendipity, forgetting, strengths, directions, mastering

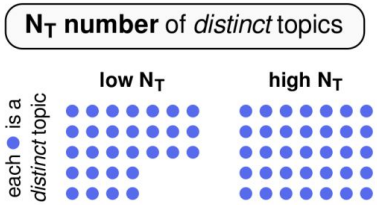
Topic diversity - *population* level

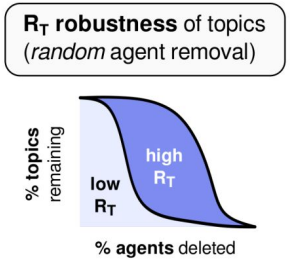
self-learning increases population knowledge diversity





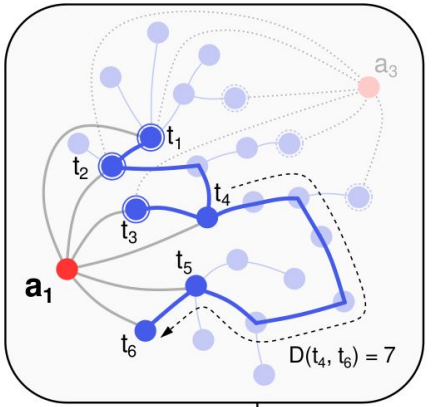






Topic diversity - *individual* level

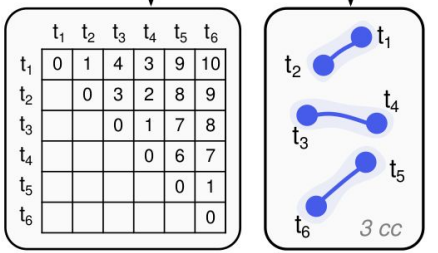
social influence expands individual knowledge diversity

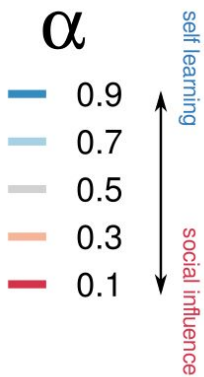


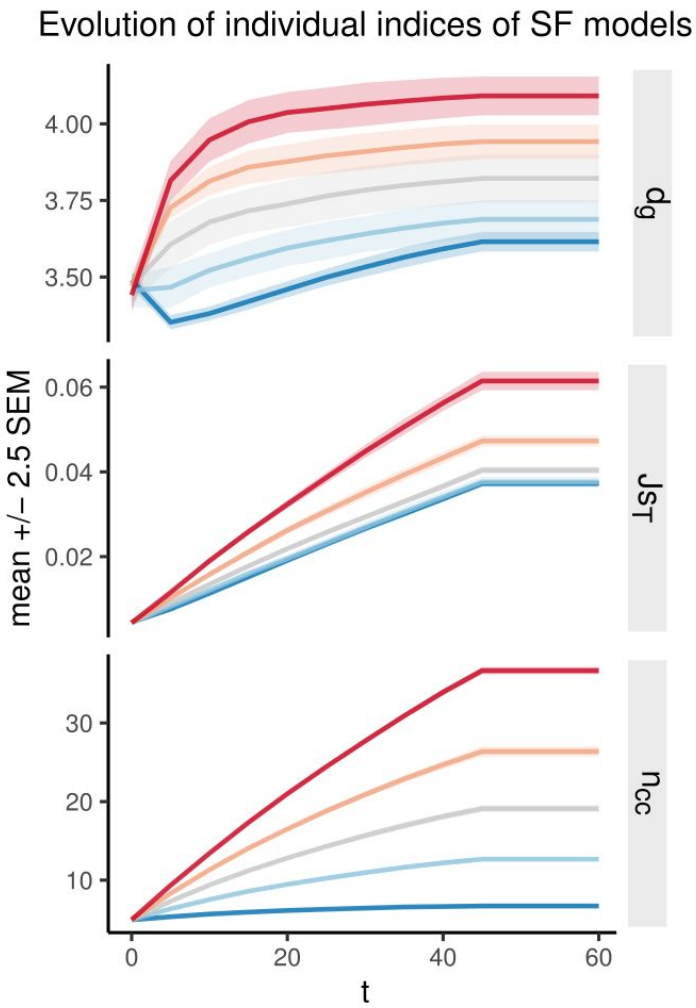
topic *distances* from topic graph

induced subgraph

	t1	t2	t3	t4	t5	t6
t1	0	1	4	3	9	10
t2		0	3	2	8	9
t3			0	1	7	8
t4				0	6	7
t5					0	1
t6						0







$d_g(a_i)$ topic **distance** for **a_i**

Js_T as topic **overlap** via pairwise Jaccard similarity

$n_{cc}(a_i)$ # conn comp for **a_i**

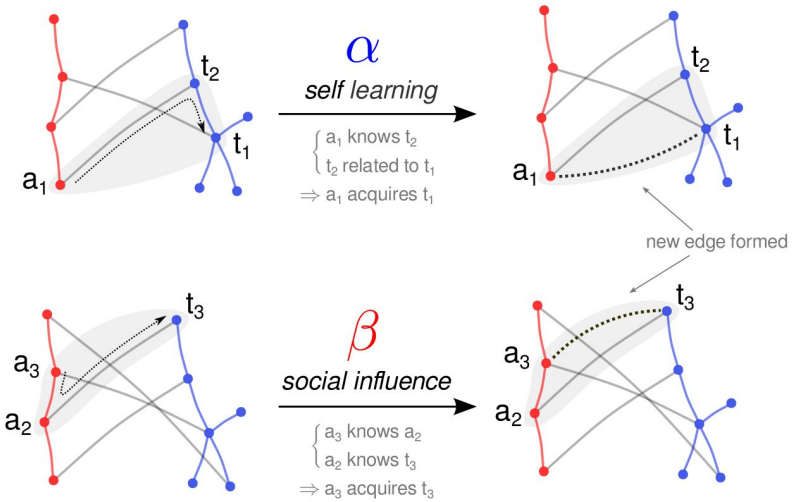
Intralayer *nonblock* models summary

High self-learning increases population diversity

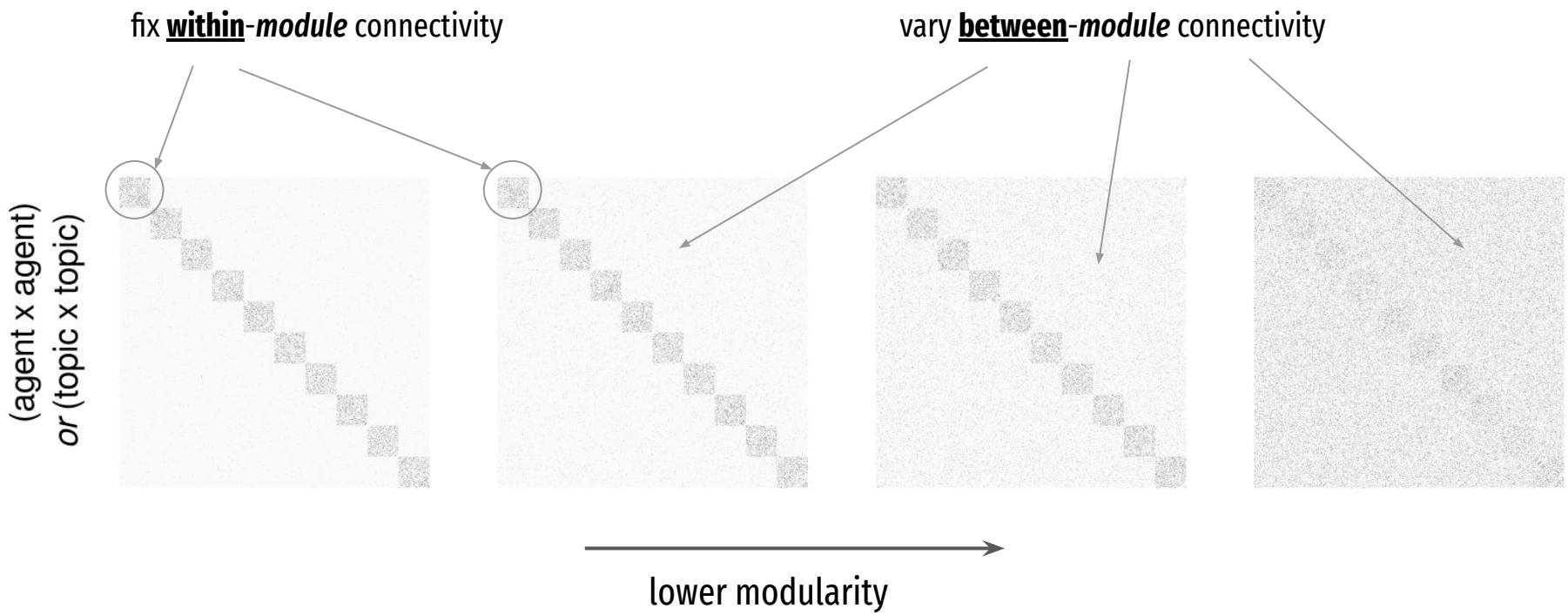
While high social influence expands individual knowledge

Consistent with preferential attachment, Erdős-Rényi, Watts–Strogatz models

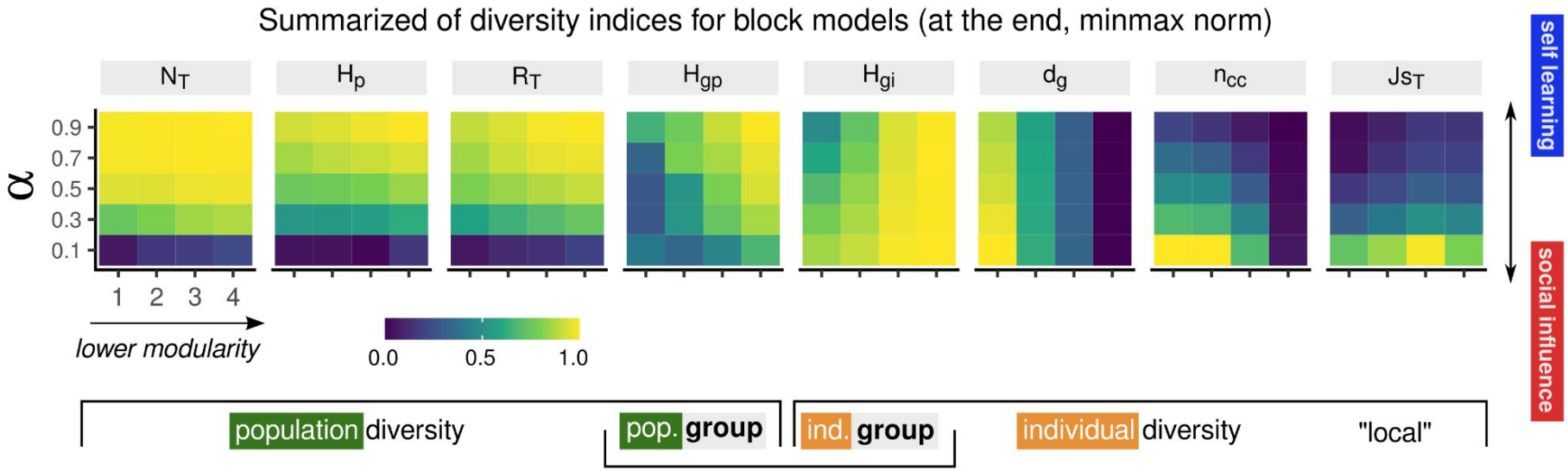
But what about groups (communities) within social and knowledge networks?

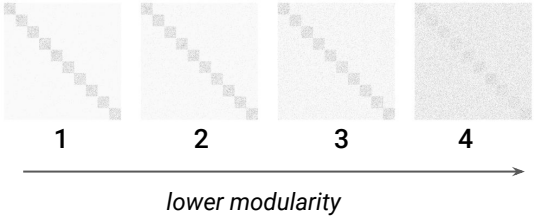


Intralayer *block* model generation



Intralayer *block* models topic diversity





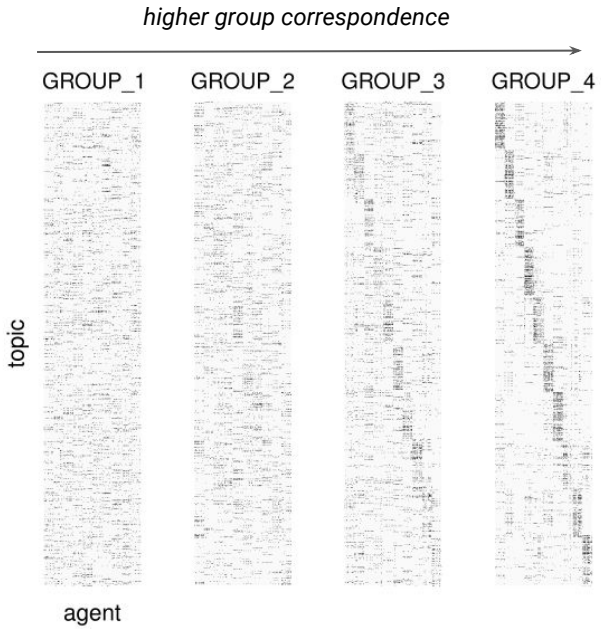
self-learning increases population knowledge diversity

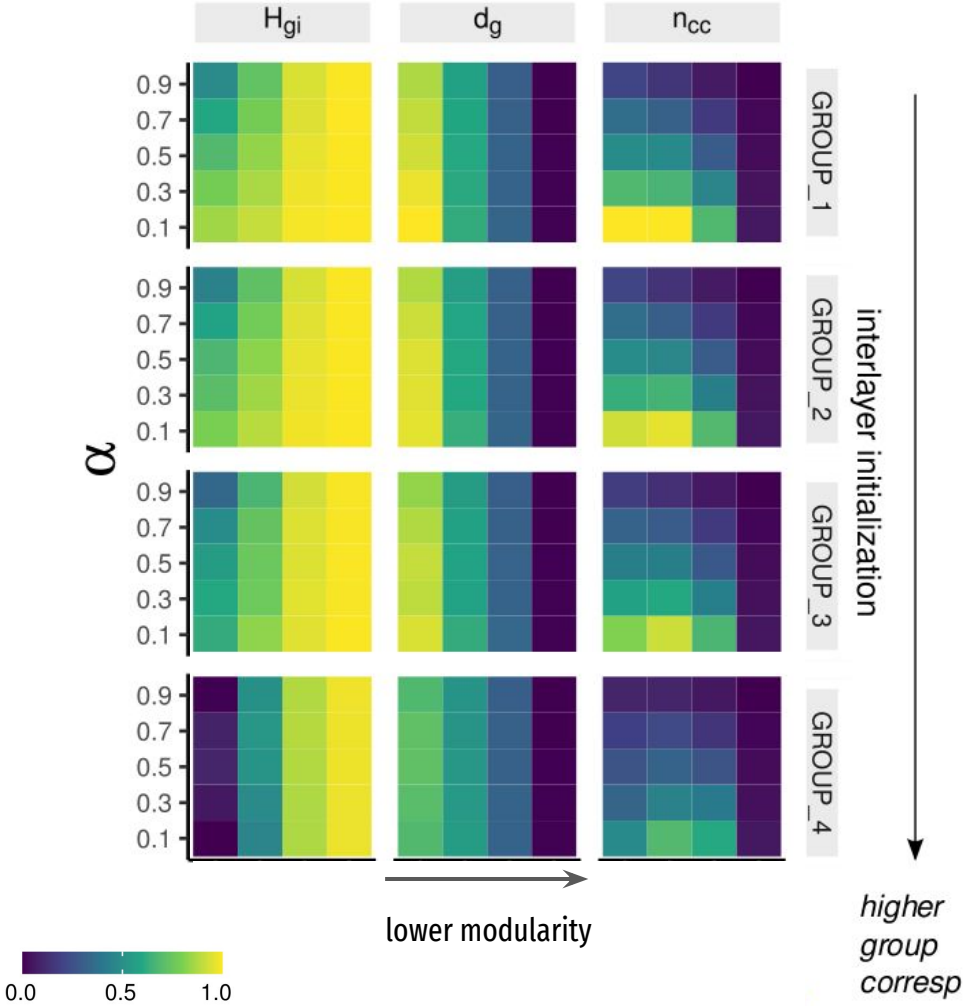
social influence expands individual knowledge diversity

modularity ↓ population & *group* but ↑ individual diversity

Does initialization matter?
Group correspondence

Initial ***group correspondence*** ↓
individual knowledge diversity

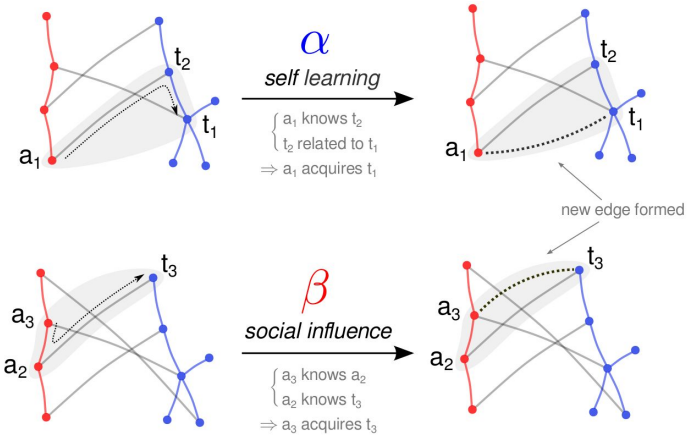




Summary

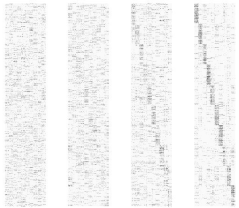
self-learning ⟶ ↑population diversity

social influence ⟶ ↑ individual knowledge



Intralayer group modularity ⟶ ↑ individual *but* ↓ population indices + group diversities

Initial group correspondence ⟶ ↓ multiple individual diversity

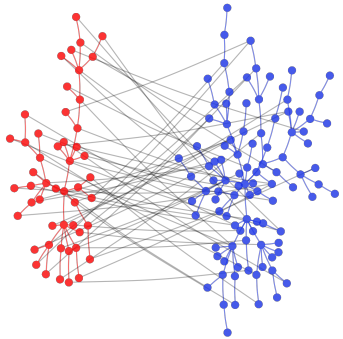


Limitations and future directions

To name a few ...

- Static intralayer networks without realistic statistics and assumption of similar model types
- Need to incorporate realistic networks to relieve assumption and potentially growing networks
- Balance edge density when comparing block models
- Include directionality & weights in models, along with other probabilities for interlayer update rules (serendipity, forgetting, mastering, ...) to relieve persistent binary edges
- Include other costs such as cost for learning new subjects & delays
- Include & parameterize accessibility (memorization versus looking things up)
- Quantify distribution of specialists and generalists + communities in projected graph
- Relationships between agents' properties and acquired topic sets' properties

Thank you!



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