Who's Your Peer?

An ABM Exploration of Editors' Strategy in Reviewer Selection

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Why an ABM on peer-review

- Peer-review is the most common selection process in science
- Awareness of its limits and Open Science movement spurred the adoption of several different regimes
- The differences are difficult to explore due to (Feliciani et al., 2019):
  - *data availability* (confidentiality, especially in case of rejections)
  - difficulties in setting up *experiments*
- Use of ABMs to overcome these difficulties and gain at least counterfactual insights on different peer-review regimes

Previous works

Previous ABMs on peer-review:

- Focus on reviewers: Thurner and Hanel (2011), Squazzoni and Gandelli (2012, 2013) and Bianchi and Squazzoni (2022), ...
- Some role of the editors: Cook et al. (2005), Cabotà et al. (2014), Wang et al. (2014), D'Andrea and O'Dwyer (2017)

In general the role of editors and journals is underinvestigated, and simulated fields of research lack *structure* – e.g. common random matching assumption (Feliciani et al., 2019).

"Biased" reviewers' evaluations could be accounted by the fact that reviewers were unsuitably chosen to begin with

Limitations and contribution

Limitations of previous ABMs

- Intrinsic quality of manuscripts as proportional to the author's resources
- Random or systematic (i.e. *bias*) errors not linked to authors' scientific approaches
- No explicit cognitive/epistemic dimension $\rightarrow$ no strategic change in methodological and substantive approaches

Our contribution

- Resources are an enabling factor, but the final quality of a contribution depends on the specific combination of TDM (theory, data, methods etc)
- Both random and systematic errors likely depend on TDM
- Lifecycle of a research field (e.g. priority rule, journals)

How to model the cognitive dimension

All these limitations can be tackled by explicitly representing the space of TDM combinations. To do so, we draw on contributions from ABMs developed in the field of philosophy of science.

- Weisberg and Muldoon (2009): spatial representation of cognitive dimensions of research TDM, epistemic landscape
- Alexander, Himmelreich, and Thompson (2015): generalization to multi-dimensional space (NK) that allows for more complex dynamics
- Avin (2019): dynamic epistemic landscape

How to link these two modeling traditions?

Our model

Main building blocks:

- NK-model (Kauffman & Levin 1987) as epistemic landscape (intrinsic quality)
- (Limited) Resources as an enabling factor
- Distribution of resources (Matthew effect)
- Dynamic epistemic landscape (priority rule)
- Random and systematic error based on epistemic distance
- Explicit representation of journals (evolving)
- Different editorial policies for reviewer selection

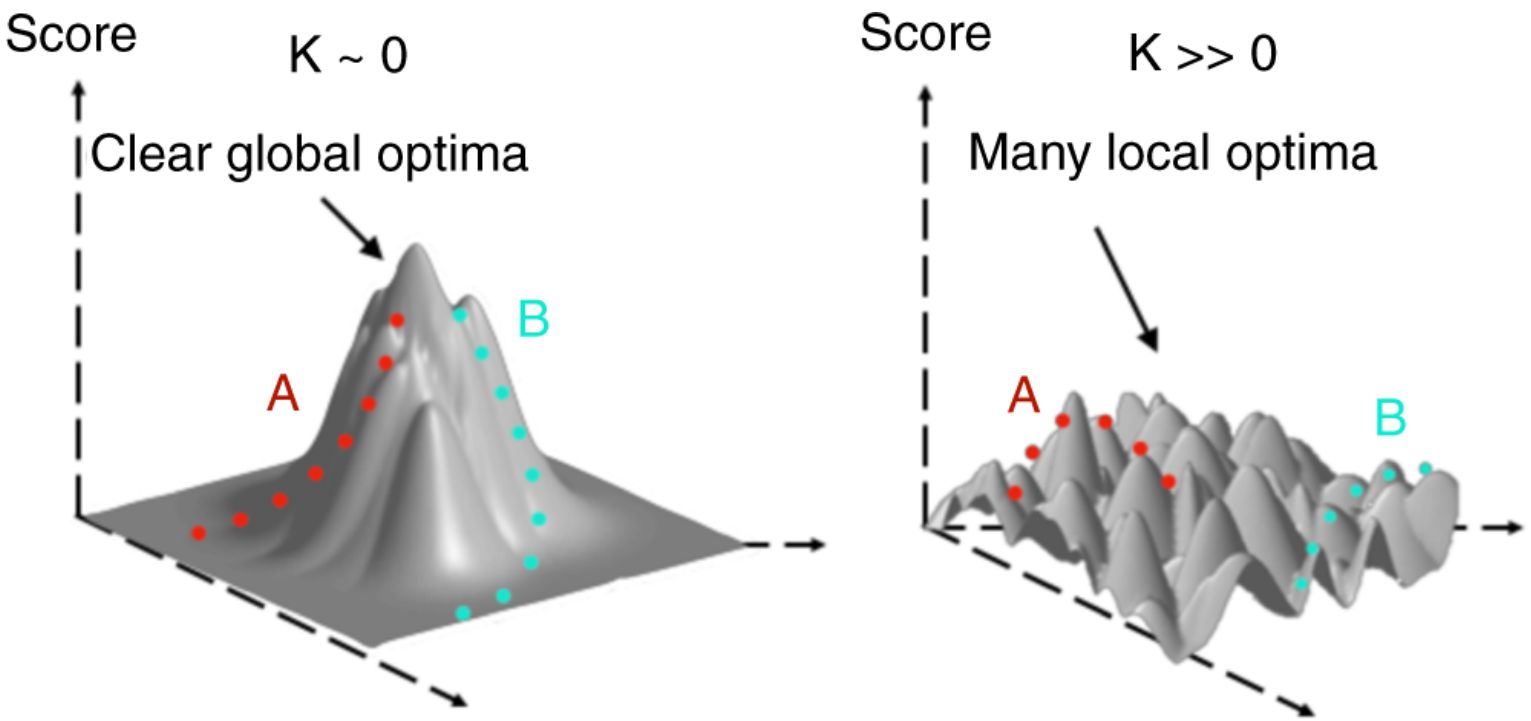
NK-model

Model originally introduced in evolutionary biology (Kauffman & Weinberger 1989), then applied in a handful of research areas like management, organizational studies, ABMs, etc.

Each point in a N-dimensional space is a possible "genome" (TDM-combination) for an agent. Each of the N "genes" contributes to the global fitness (scientific significance) depending on his own value combined with the K-neighbors.

K=0 trivial case of independence. High values of K imply a more rugged landscape, more local optima and a more difficult search process (epistasis).

NK-model



NK fitness landscape

Our model (details)

Algorithm 1 Main Loop of our model

Initialize NK, resources, agents, journals;
while $t \leq T$ **do**
Compute fitness of TDM (manuscripts)
Determine submission to journals
Set submission quality $q_m = min\{fitness, resources\}$
Match author-reviewers according to editor's policy
Set evaluated quality q_e, with random and systematic error (based on epistemic distance)
Publish top-p papers per journal, according to q_e ranking
Update resources distribution (Matthew effect)
Update NK-fitness (priority rule) and journals
Move authors (i.e., change TDM)
end while

Simulation settings

Editorial policies for reviewer selection:

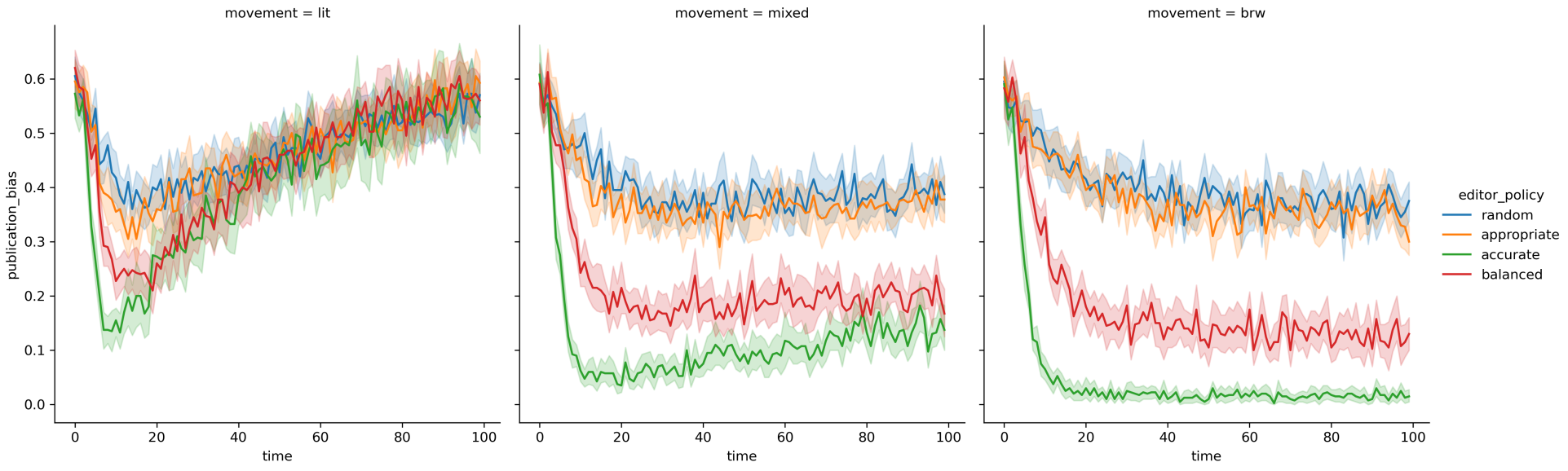
- Random
- Appropriate (close to the journal)
- Accurate (close to the manuscript)
- Balanced (close to both)

Movement rules:

- Biased random walk (local search)
- Literature reading (K)

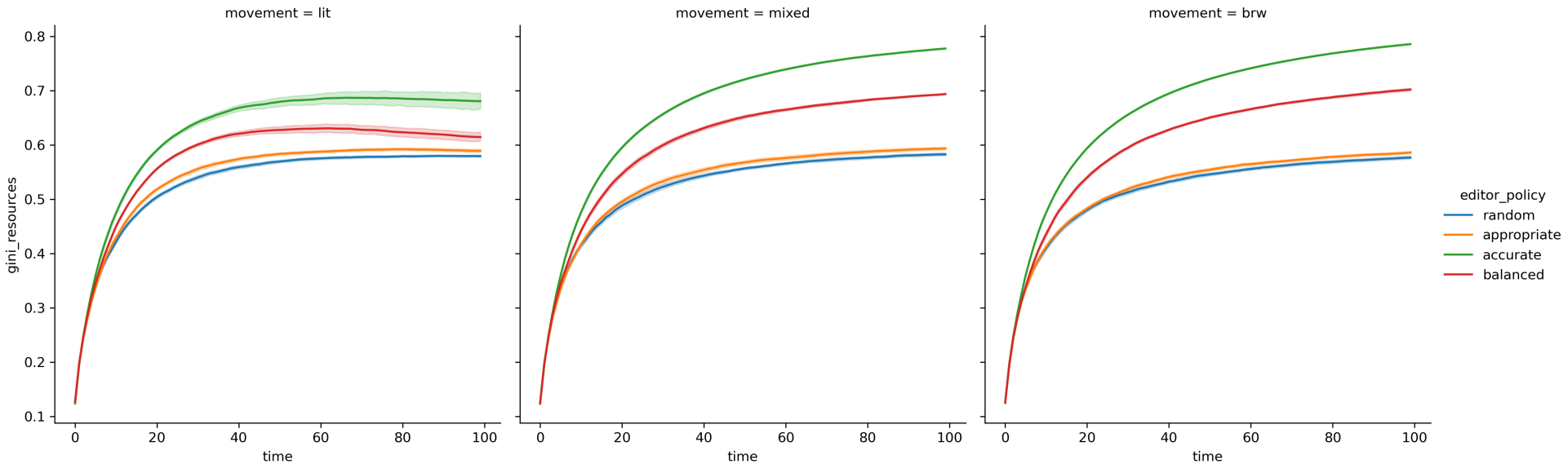
Still idealized setting: single reviewer, two identical journals (except position), uniform initial state

Preliminary results



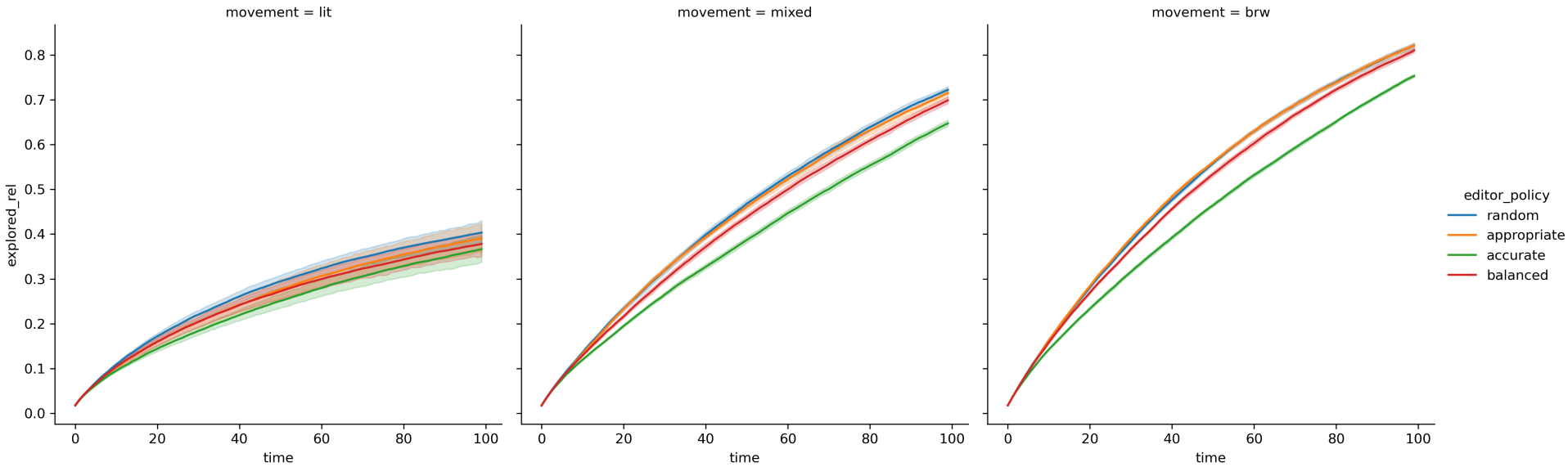
Levels of publication bias vary across movement rules and editorial policies

Preliminary results



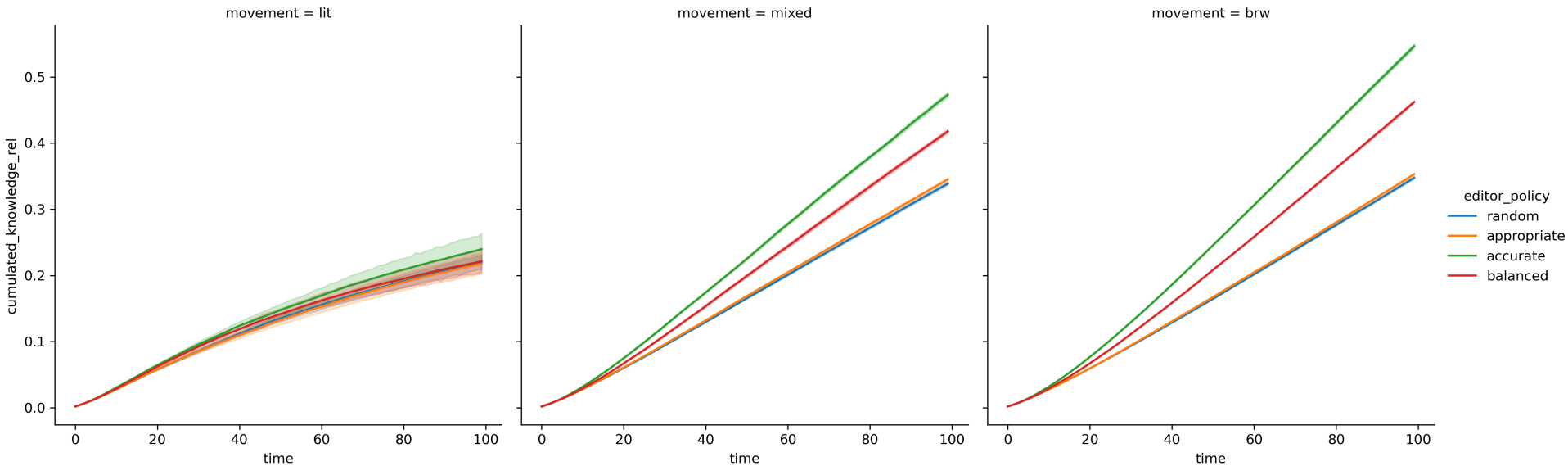
The cost of accuracy is increased inequality
(more selective mechanism)

Preliminary results



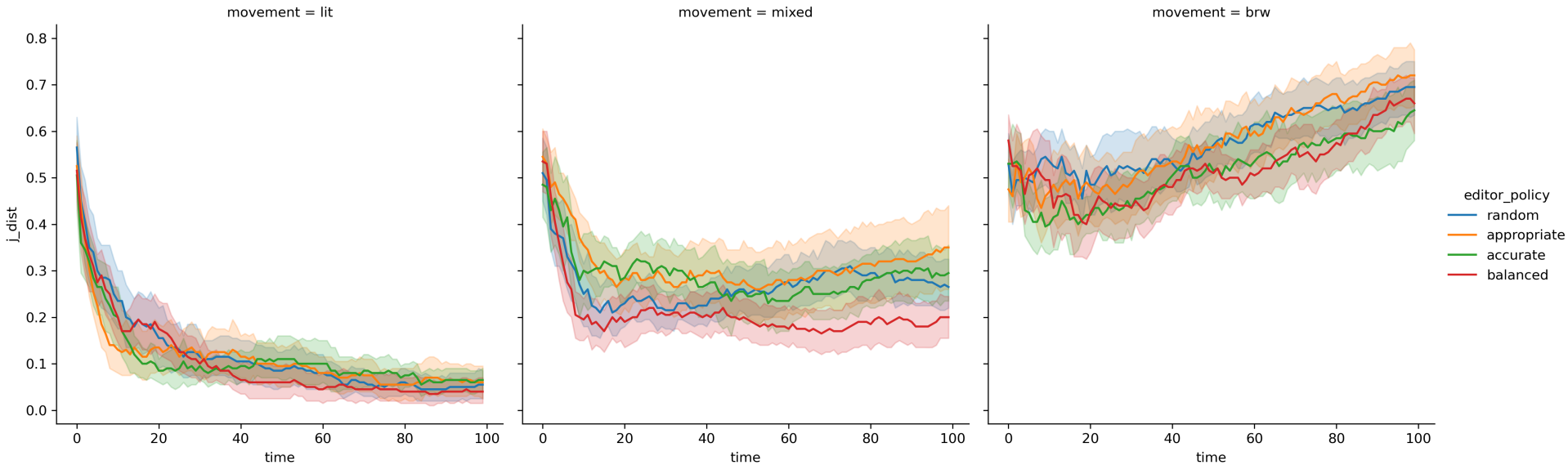
Accuracy also means less diversity

Preliminary results



Less alternatives but more valuable

Preliminary results



Convergence vs divergence of the community

To Sum Up

Main insights:

- The selection of reviewers can attenuate or amplify biases
- The "accurate" strategy performs well provided that there is enough diversity *per se*
- The lifecycle of the research area matters
- Second order dynamics (e.g. distance of reviewers depends on divergence/convenrgence of journals)

We reproduce *stylized facts*, but what about hypothetical calibration? E.g. movement distance, journal diversity, range of fitness values, ...

Limitations and future developments

Current limitations:

- Only one reviewer (sidestep aggregation problem)
- No scientific collaboration (e.g. co-authorship)
- No strategic behaviour

Planned developments:

- Inform movement rules (role of K and Z)
- Ground aspects of the NK-landscape (NLP)

Thanks for your attention

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