An agent based model of scientific and scholarly research- – modeling the peer review process

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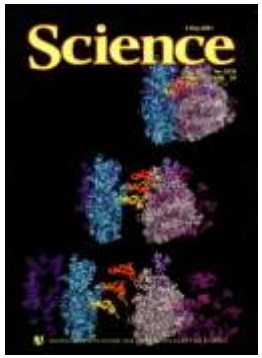
Aims

- Create a very simple model
- Analyze the model thoroughly
- Modify the model to fit certain theoretical assumptions and see if the theory agrees with the model
- Find the parameters or processes responsible for discrepancies

Model

Agent-based model with heterogeneous agents.

2 types of agents:



Researchers (authors, reviewers)

<u>Actions:</u>
live – consume energy
write – new articles
submit – when article is ready
review – when asked by journal
learn – from reviewed articles

Journals

<u>Actions:</u>
ask for reviews – when article is submitted
publish/reject – based on majority of reviews

All agents are heterogeneous – they follow the same rules, but their property values are random at start.

Model

Researcher (author, reviewer)

Properties:
"energy" - needed to live
quality – determine the quality of work and standards for reviewing
tolerance – the tolerance for accepting papers with quality lesser than researcher's
position – in a disciplinary space
vision – the range of interest in a disciplinary space
reputation – gained by publishing

Actions:
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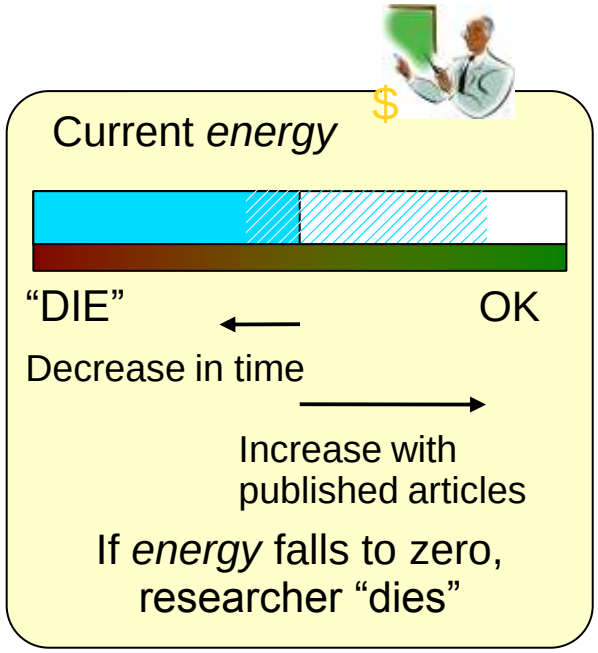
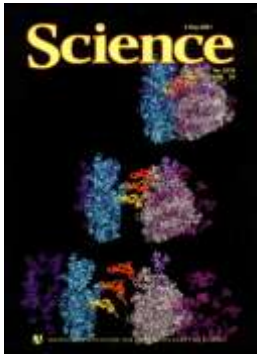


Model



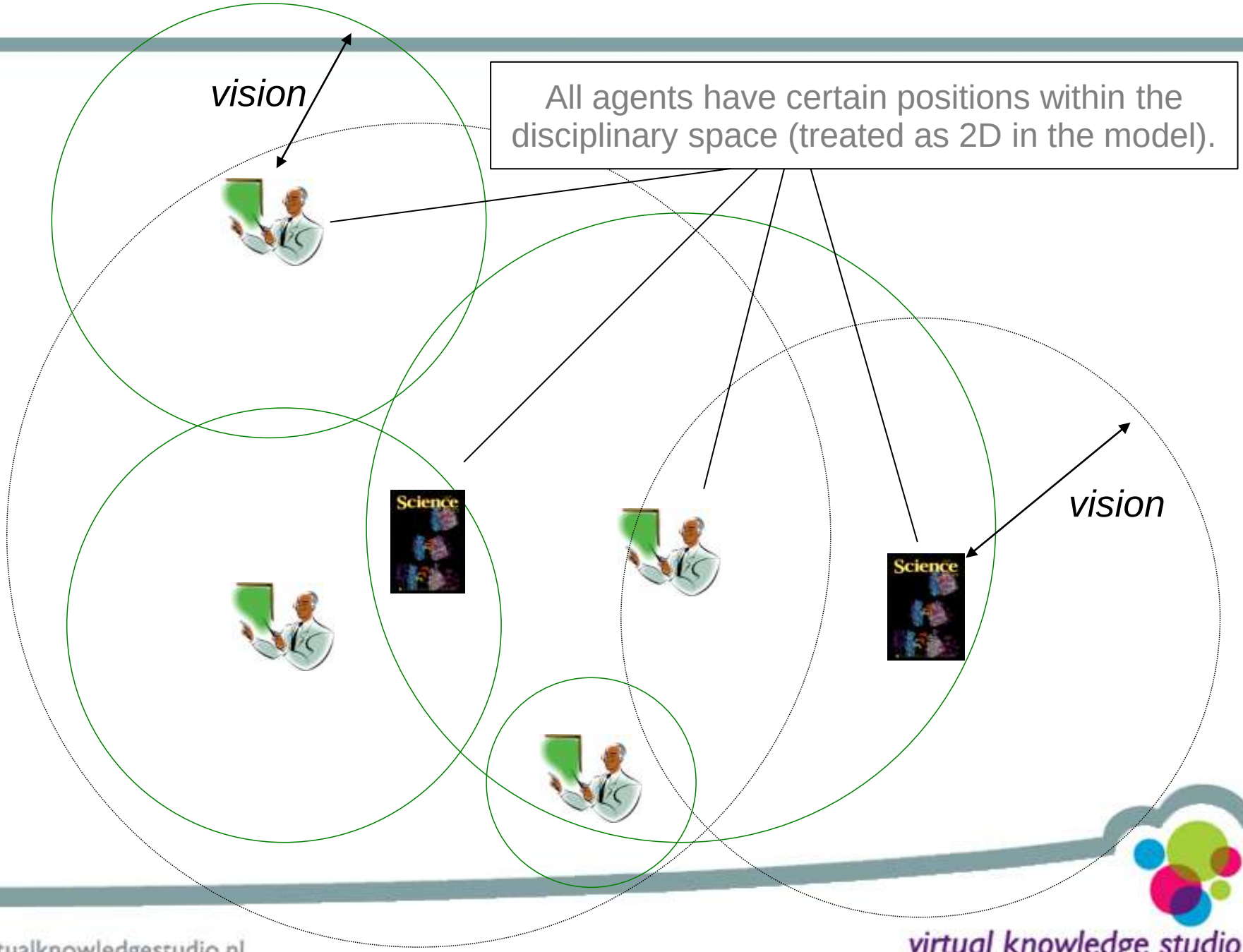
Journal

Properties:
position – in disciplinary space
vision – journal disciplinary scope
reputation – how “good” the journal is

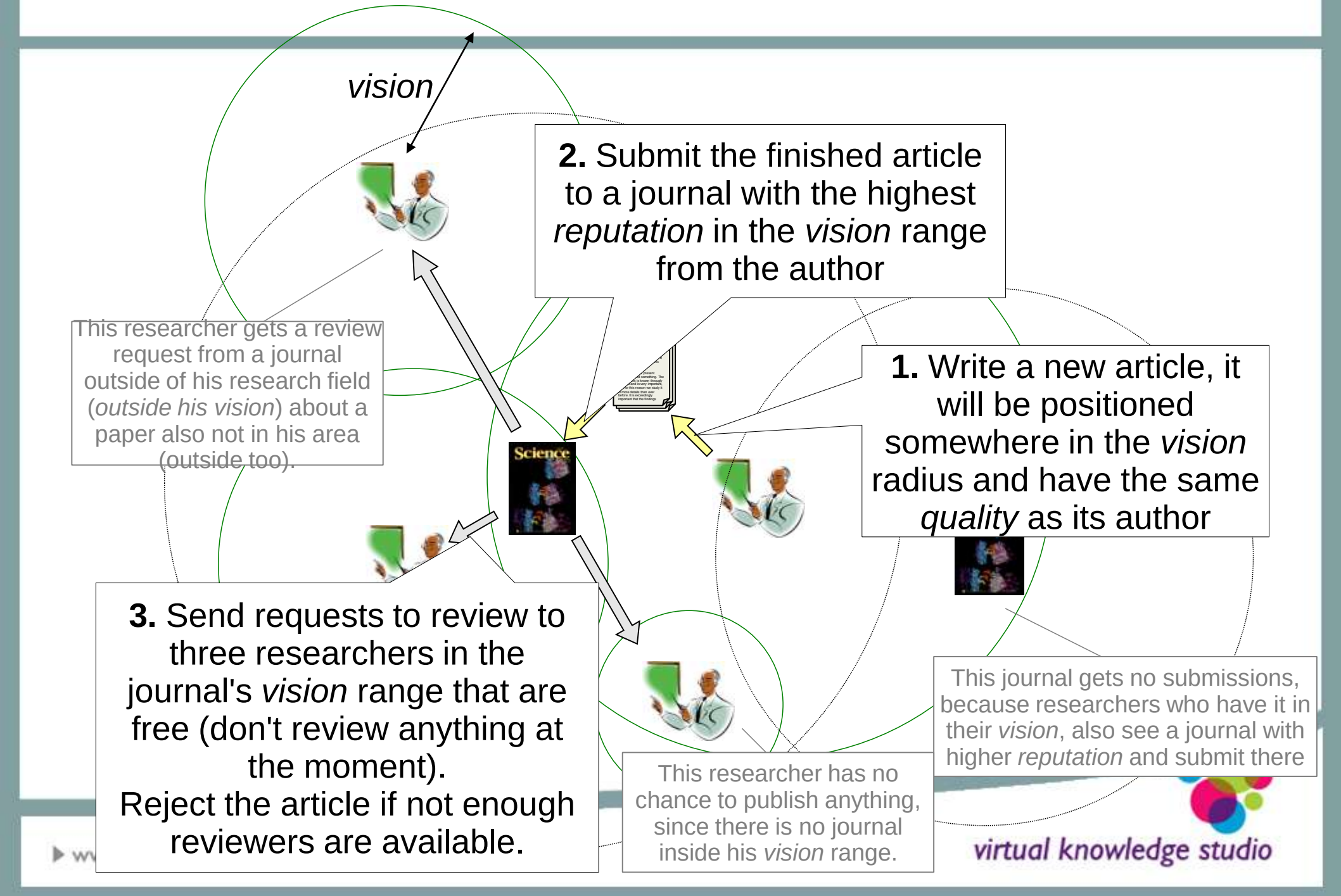
Actions:
ask for reviews – when article is submitted
publish/reject – based on majority of reviews

In current model journals have no internal dynamics and no resources like researcher's *energy.* Journals are persistent and never disappear.

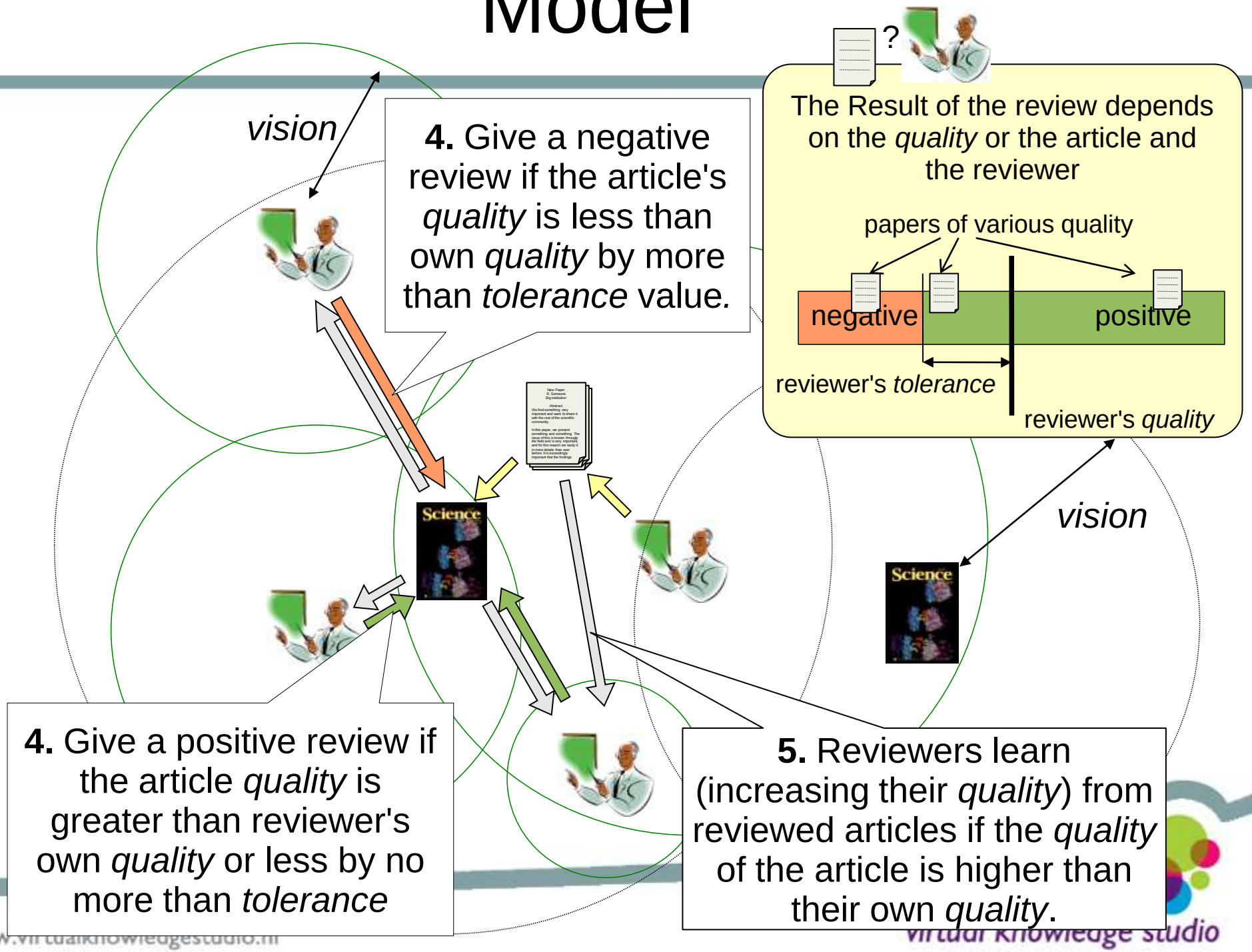
Model


vision
All agents have certain positions within the disciplinary space (treated as 2D in the model).
Science
Science
vision

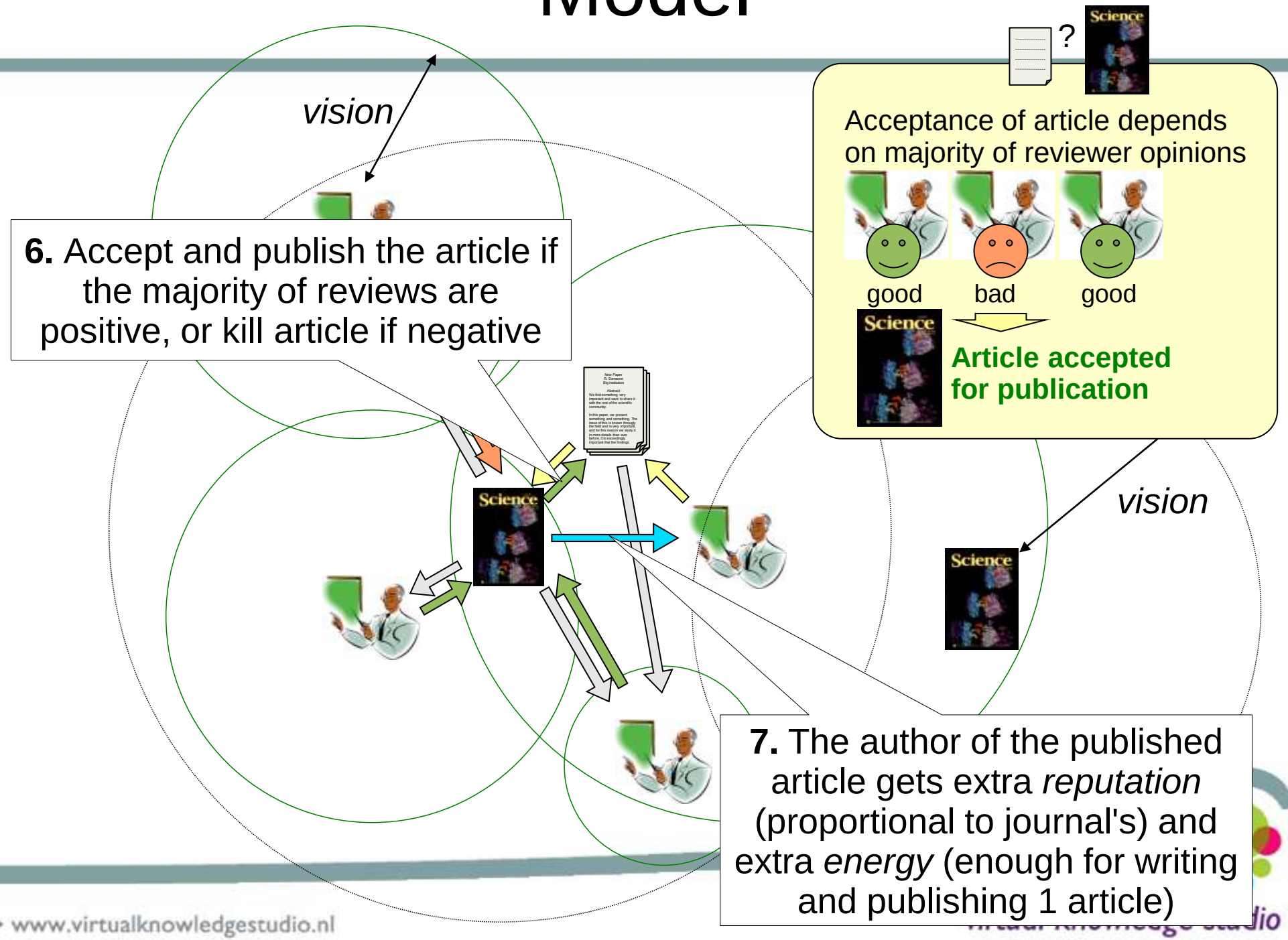
Model


vision
2. Submit the finished article to a journal with the highest reputation in the vision range from the author
This researcher gets a review request from a journal outside of his research field (outside his vision) about a paper also not in his area (outside too).
1. Write a new article, it will be positioned somewhere in the vision radius and have the same quality as its author
Science
3. Send requests to review to three researchers in the journal's vision range that are free (don't review anything at the moment).
Reject the article if not enough reviewers are available.
This researcher has no chance to publish anything, since there is no journal inside his vision range.
This journal gets no submissions, because researchers who have it in their vision, also see a journal with higher reputation and submit there

Model

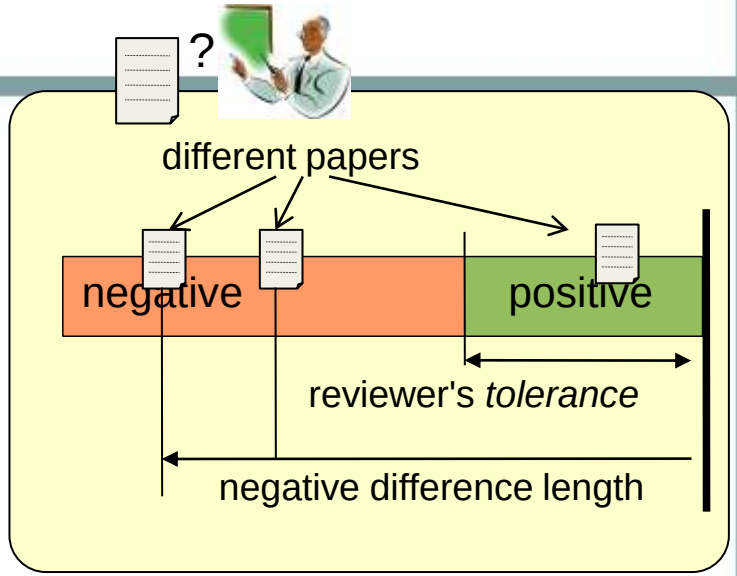

vision
4. Give a negative review if the article's quality is less than own quality by more than tolerance value.
The Result of the review depends on the quality or the article and the reviewer
papers of various quality
negative
positive
reviewer's tolerance
reviewer's quality
vision
Science
Science
4. Give a positive review if the article quality is greater than reviewer's own quality or less by no more than tolerance
5. Reviewers learn (increasing their quality) from reviewed articles if the quality of the article is higher than their own quality.

Model


vision
6. Accept and publish the article if the majority of reviews are positive, or kill article if negative
Science
?
Science
Acceptance of article depends on majority of reviewer opinions
good
bad
good
Science
Article accepted for publication
vision
Science
7. The author of the published article gets extra *reputation* (proportional to journal's) and extra *energy* (enough for writing and publishing 1 article)

Quality

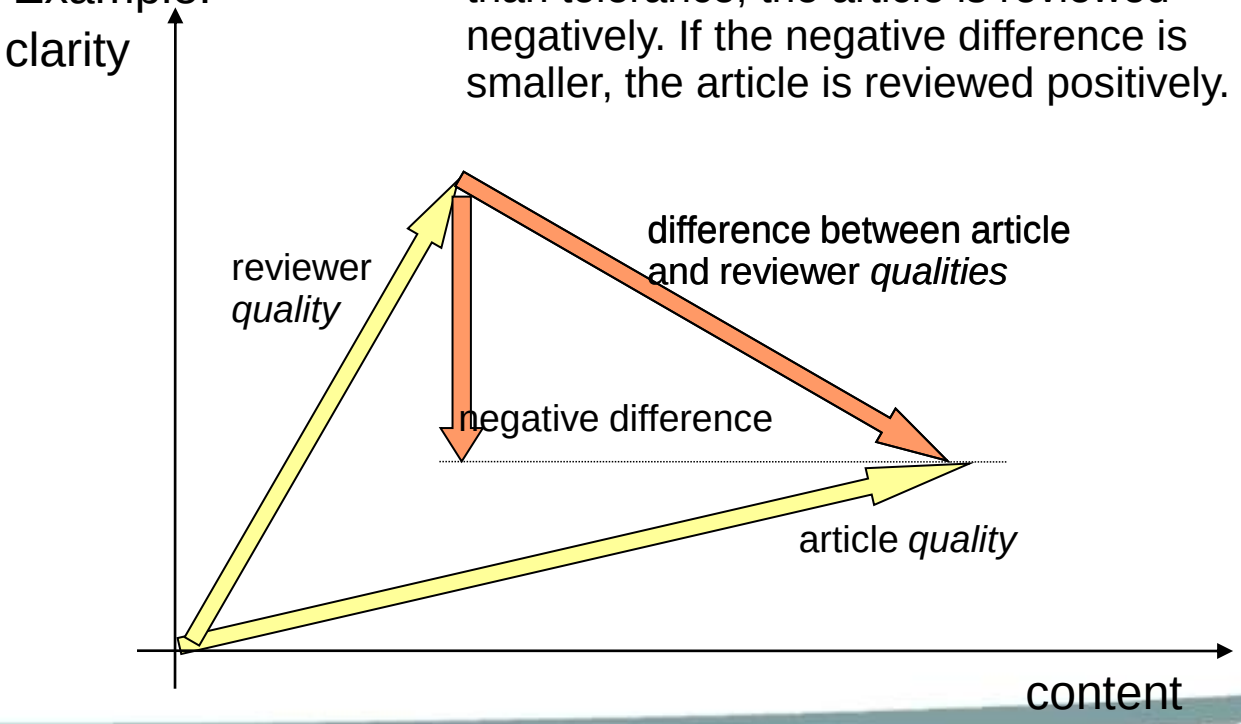
Quality is represented as a multi-dimensional vector, each dimension representing one aspect of quality.
Quality comparison is a difference between *quality* vectors, but only taking the negative part into account.



Full mechanics behind reviewer decisions

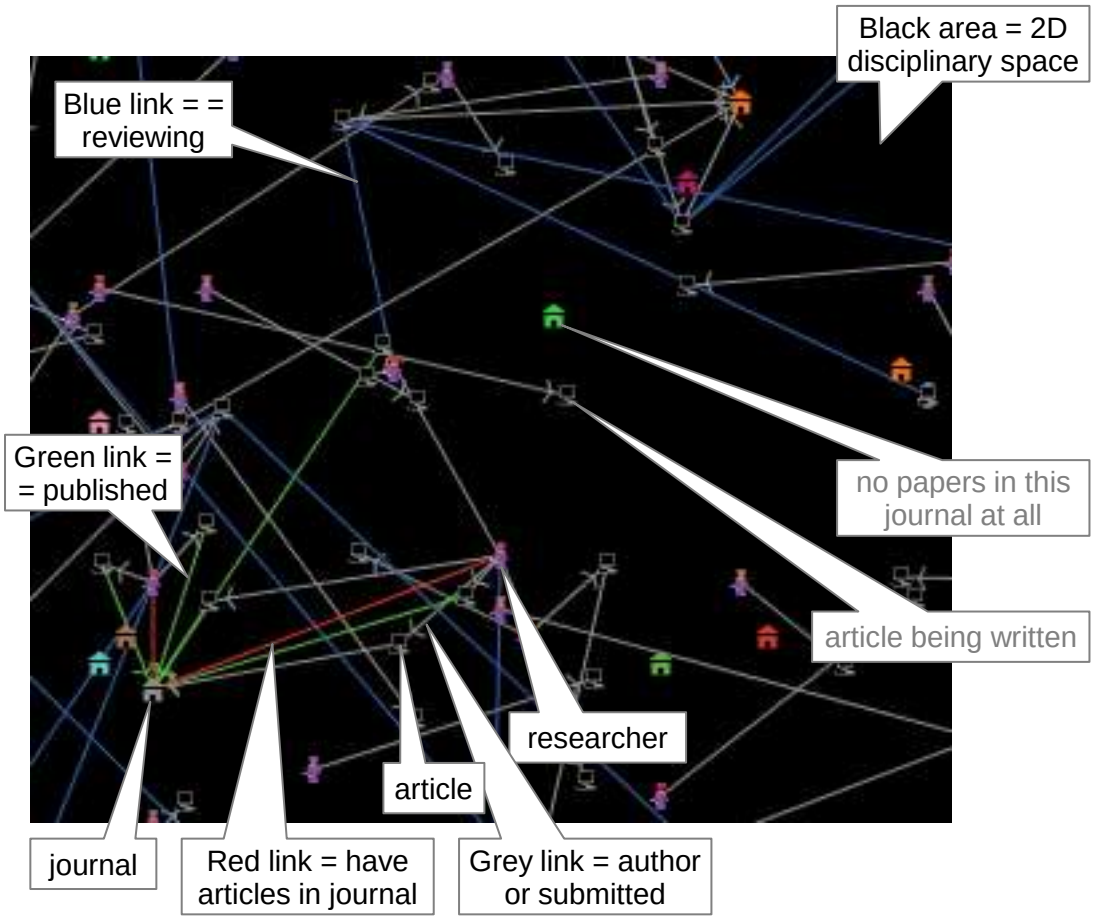
Negative difference is compared with tolerance. If negative difference is larger than tolerance, the article is reviewed negatively. If the negative difference is smaller, the article is reviewed positively.

Example:



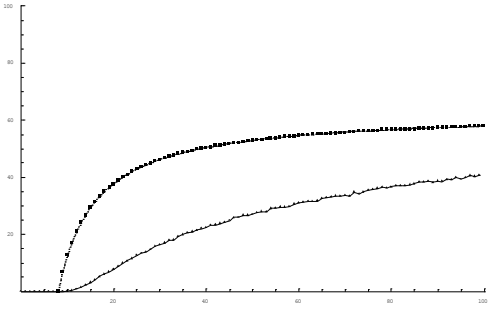
Taking negative difference instead of difference means that reviewers pay attention only to deficiencies (according to them) of the article, but do not see or pay attention to extraordinarily good aspects of the article. For example, if reviewer finds article unclear, he will review it negatively, even if the scientific content was great.

Implementation

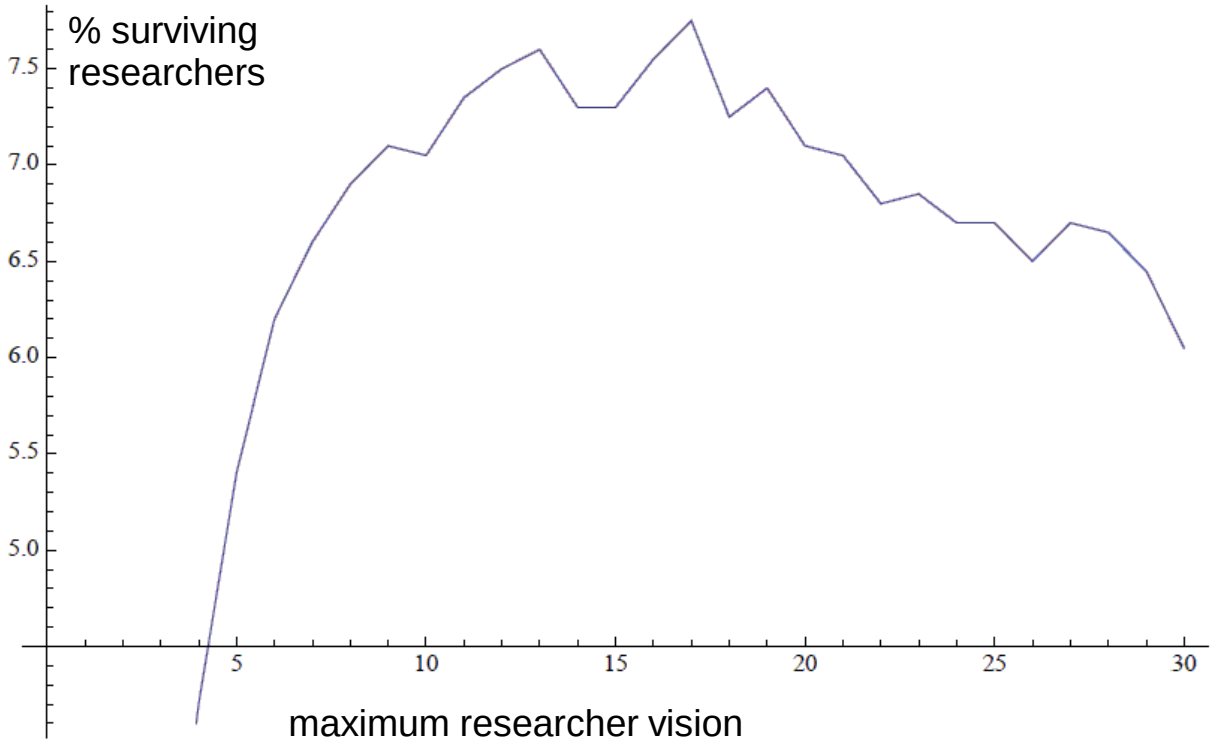


Model visualization in NetLogo

The results (always from many repeated simulations) are directly fed into Mathematica, where statistics are calculated and graphs are drawn.

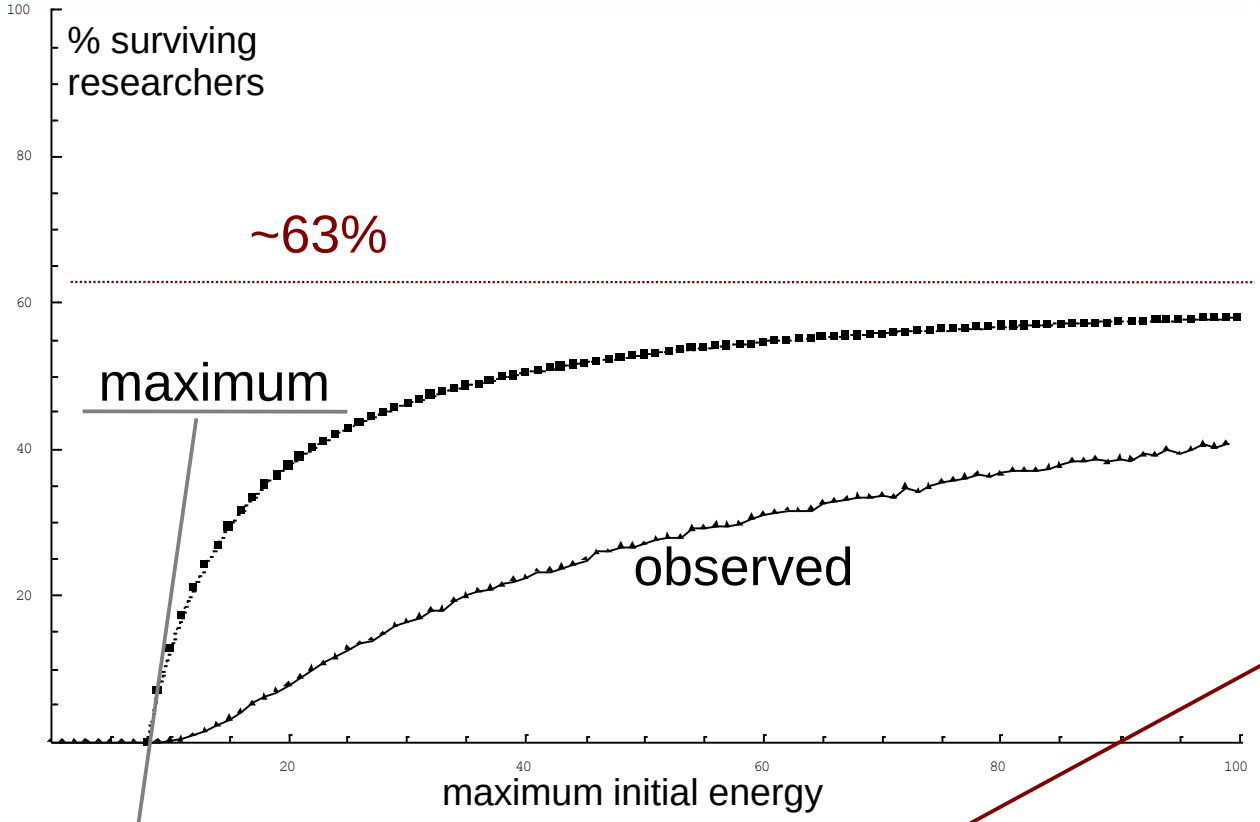


Interesting results so far



The researcher vision value has an optimum.
If the researchers see too far (too broad disciplinary interest), they compete for very few good journals and thus fail more often, which leads to “death”.
If the researchers see not far enough, there may be no journals for them to publish in, which means quick “death”.

Interesting results so far



The statistical maximal chance of survival can be calculated. The observed results are within this maximum.

The survival chance is tied to having at least one journal within your sight, the journal having enough potential referees and you having enough energy to complete at least 1 publication (so you can get more).

max%survival = (1-% not enough journals)·(1-% not enough energy)·(1-% not enough reviewers)

$$100 \left(1 - \frac{\sqrt{\frac{\text{worldsize}}{\text{numj}}}}{\sqrt{\pi}\ \text{vision}}\right) \left(1 - \frac{\sqrt{\frac{\text{numreviewers worldsize}}{\text{numresearchers}}}}{\text{journalvision}\ \sqrt{\pi}}\right) \left(1 - \frac{1 + \text{reviewtime} + \text{writingtime}}{\text{energy}}\right)$$

Further on

- Pick theories to test
- Modify the model to fit the theory assumptions
- Test if the outcome of the model is consistent with the theory tested