Theory Choice

Epistemic lessons from simple artificial agent models?

André C. R. Martins

NISC – EACH – Universidade de São Paulo

amartins@usp.br

SSPS - Simulating the Social Processes of Science

Lorentz Center, Leiden

How to choose between theories?

(or any ideas)

- Better tools and practices not always easy to pick
- Logic, induction, inference (etc) were created to work (and correct) at the individual level: one cognitive agent.
- What other tools might be needed at an aggregate macroscopic level?

A problem in recursion?

- Open problem: different points of views on best practices.
- Do we need the answer to know we got the best answer?

Social effects in Science

- Peer review, certainly, but not only
- Mechanisms of convincing
- Majority decisions
- New ideas
- Crowd effects

Limits

- Human rationality: we are **much** dumber than we think (biases, heuristics, etc.) (my own take on it at www.unbindprometheus.blogspot.com)
- Unexpected interaction effects
  - Reasoning is always limited: finite amount of extra knowledge can be harmful sometimes

Views on Scientific Knowledge

A caricature

- **Natural Scientists**
  - Knowledge can be objective.
  - Science is self-correcting and the only way to obtain reliable knowledge.
  - Scientific knowledge is determined by Nature.
- **Social Science**
  - Knowledge is completelly subjective.
  - Science is another form of knowledge, as acceptable as any other.
  - Scientific knowledge is simply a social construct.

Incomplete views?

- Scientific knowledge works better
- But social effects exist and are unavoidable for many reasons:
  - Social pressure
  - Finite individual abilities
  - Funding
  - Political preferences
- What is really going on?

How to decide?

- Each person might have a different opinion on this matter.
- How to decide who is right?

How to decide?

- Each person will have a different opinion on this matter.
- How to decide who is right?
- We should check under which circumstances can people be expected to get closer to the Truth and when will that fail.

How to decide?

- Each person might have a different opinion on this matter.
- How to decide who is right?
- We should check under which circumstances can people be expected to get closer to the Truth and when will that fail.
- To decide who will get us closer to truth, we need to know where it is BEFOREHAND?

We need to be

- Good at knowing the real truth
- Obtain evidence on which strategy will get us closer
- Decide on these strategies, to make Science better.

We need to be

- G
- O
- D

We need to be

- GOD

- Can we?

Not in the real world, but...

- In artificial, simulated societies, it is the programmer who decides what is true and what is not.
- Some questions are much easier to test:
  - Which behaviors are more likely to lead the agents to the best explanation?
  - Are there circumstances where social effects are crucial and others when their influence is smaller?

Scientists and Beliefs

- Opinions on a theory can be described as a subjective probability a scientist assigns to the assumption that the theory is true (or the best available one).
- If theories make predictions about the world, we can use results of experiments to update the subjective probability: Bayes Theorem (this assumes rationality!).

Confirmation Theory

- It might be a decent approximation, but it is descriptively wrong
  - Psychological biases (PT, confirmation biases, heuristics, bare rate neglect, just to name a few)
  - Prior problems
- A decent normative framework, though.

My toy model for Social Effects

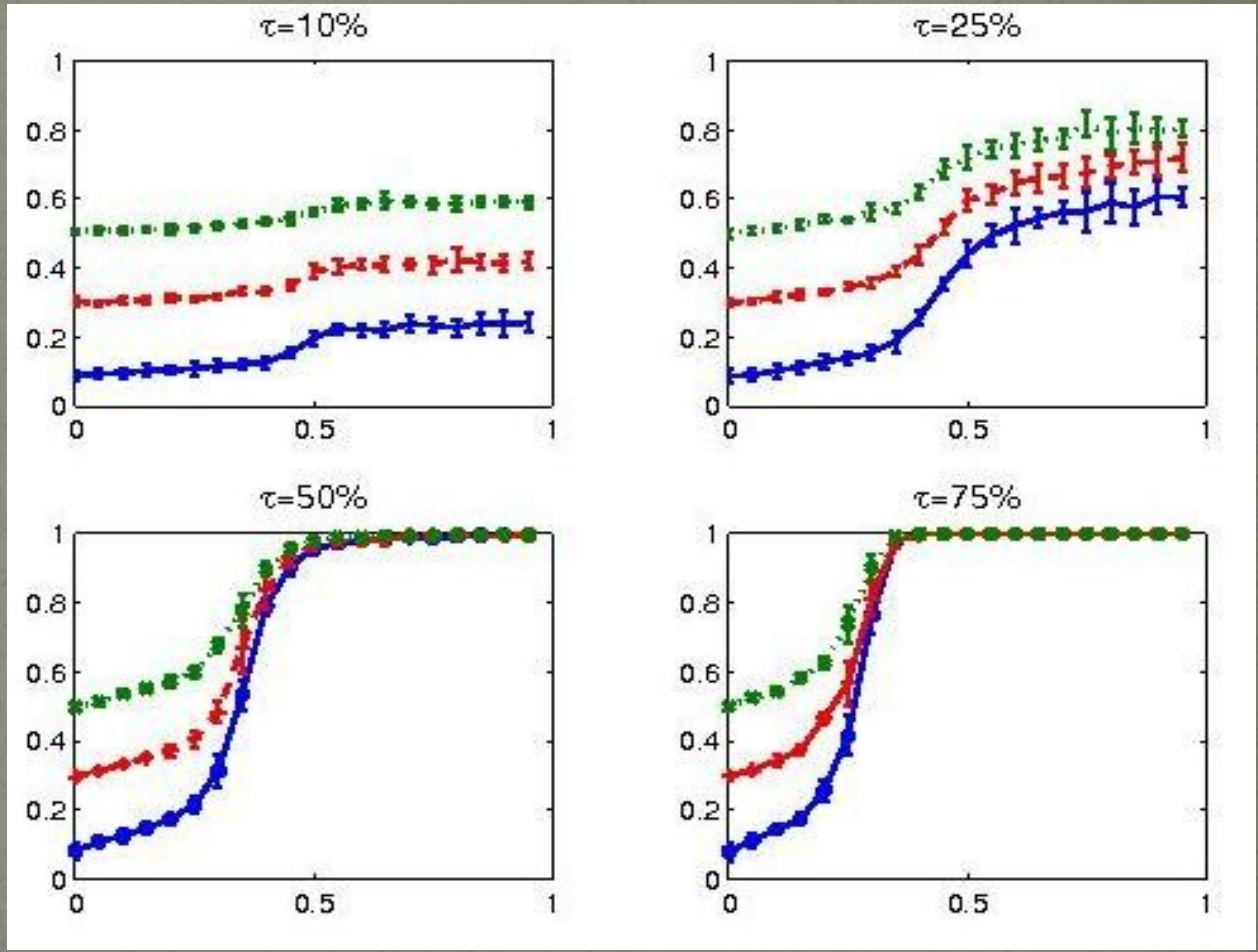
- Besides observing the world, people influence each other.
- Opinion Dynamics: spread of opinions.
- We can use a Bayesian inspired formalism to account for social influence (Continuous Opinions and Discrete Actions model – Probabilistic Opinion Dynamics).

Scientists and Beliefs

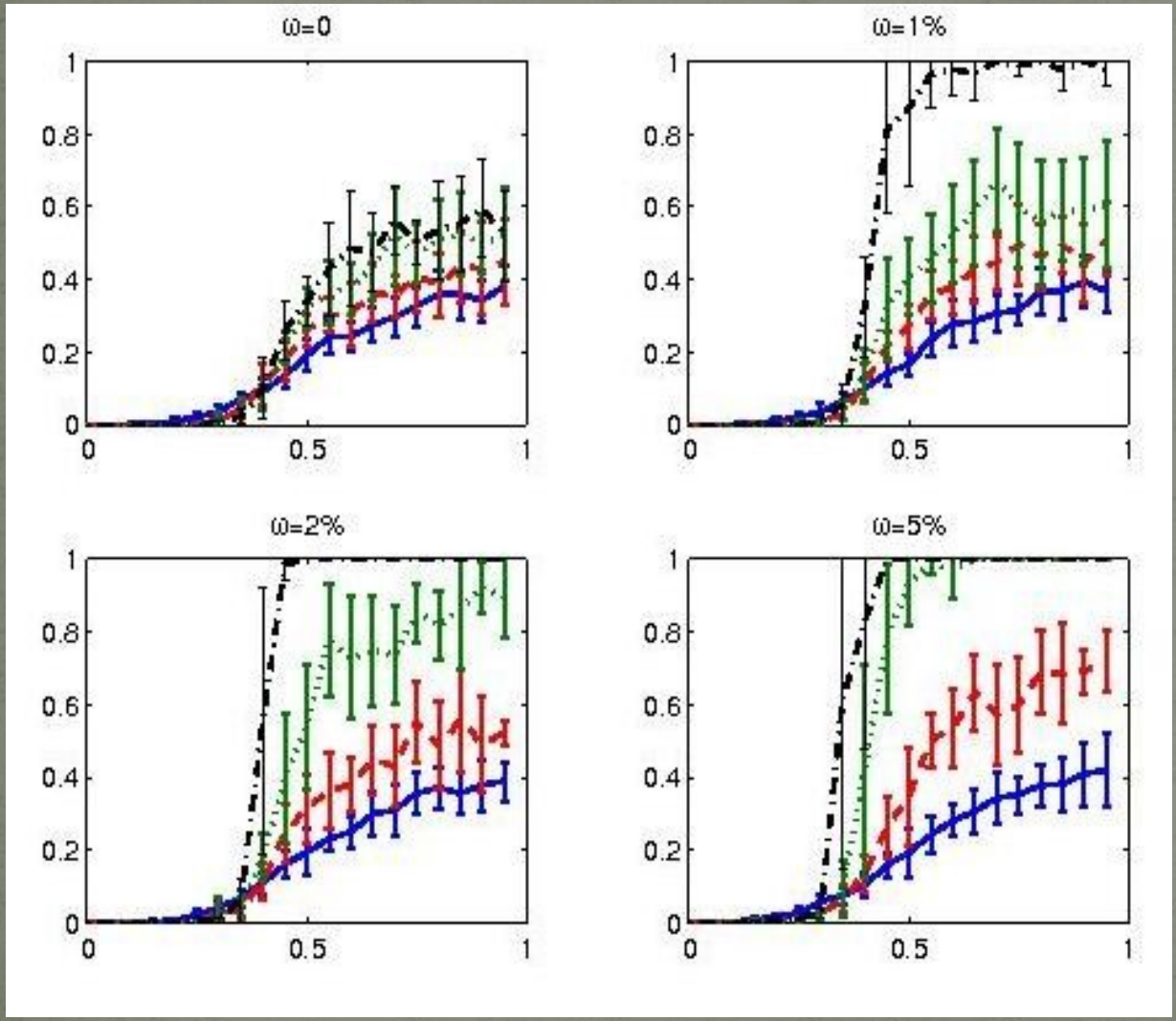
- Framework is suited: choices AND strength of opinion
- Model might not be:
  - Too simplistic reasoning (?)

Simulating the problem

- Let τ be the proportion of experimenters in the artificial world and ρ (x-axis) a measure of the importance of experimental results, relative to social effects.
- The graph shows final proportion of agents that choose best description for different initial configurations.
- Different collors correspond to different initial proportions of people with the right choice (10%, 25% and 50%)



Retirement (and Kuhn)



- Unless there are enough experimenters and social effect is not too large, better theories have difficult at invading a system where people support the previous one.
- By introducing a death (or retirement) rate ω we get better acceptance.
- Here, τ=1 (everyone does experiments), different lines show different number of interactions.

Senescence and evolvability

- In evolutionary biology, aging can be benefitial by allowing faster evolvability

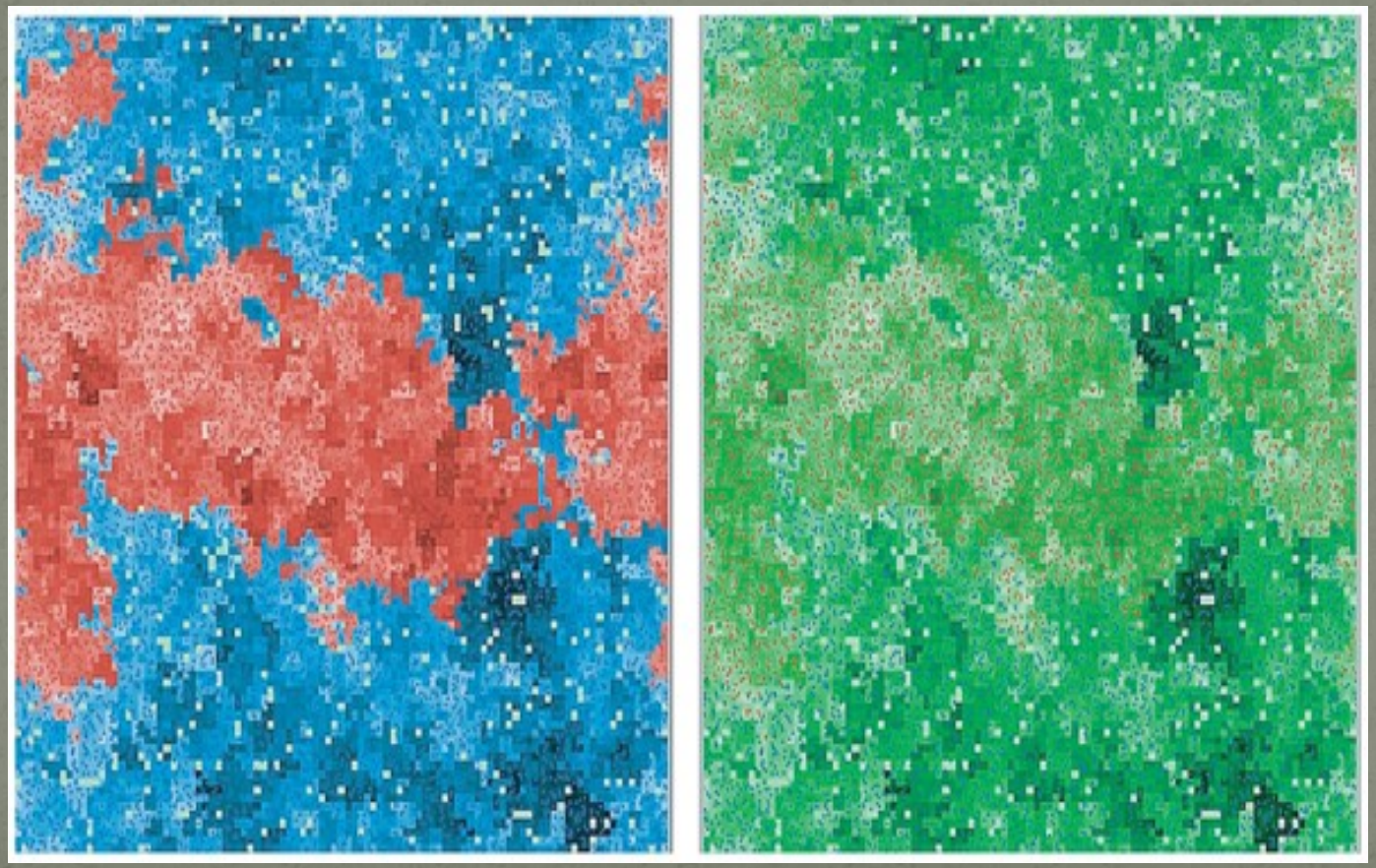


Figure 4. Landscape of fitness values in the middle of a typical one run.

Questions

- In the simulation, experiments always pointed to the best choice. Real world is not so easy.
- Still, a clear division is seeing regarding the importance of social influence.
- For small social influence, agents find the truth.
- For large social influence, the truth has little influence on their opinions.

Relative effects

- The importance of social effect was relative to the force of experiments.
- Where experiments are hard, impossible, or have not very clear results (Humanities? String Theory?), should one expect that knowledge would be a social construct?
- Where experiments are clear, it seems real knowledge about the world can exist!

Questions

- For policy makers, public opinion is very important. But listening to *public opinion* means giving more importance to *social effects*!
- In problems where people always decide based on information of their peers, problems are expected to happen.

Questions

- Should we start a campaign to make researchers pay less attention to their colleagues opinions?
- Should literature in Humanities stop using opinions of other authors and only refer to their data and very well grounded, demonstrated conclusions, mostly?

Landscape?

- Natural Sciences: fixed landscape
- Humanities: Ideas change the landscape: presence of scientists curves geometry? Something like GR is needed?

To remember

- This was a very simplified model. Will its features survive if we make it more realistic?
- Better networks and interactions, more detailed description of the inference process and how Science works can change the results

Checking models for epistemic problems

- Basic data might be useless
  - End of debate could mean failure. Or success.
- We need meaning?

One more question

- Should you be subject to social influence and believe what I am saying?

References

- Martins, André C. R. "Continuous Opinions and Discrete Actions in Opinion Dynamics Problems", *International Journal of Modern Physics C*, v. 19, p. 617-624, 2008.
- Martins, André C. R. "Modelling Scientific Agents for a Better Science", *Advances in Complex Systems* , v.13, p.519 - 533, 2010.
- Martins, André C. R. "Change and aging: Senescence as an adaptation", PloS ONE 6 (9), e24328, 2011.
- Martins, André C. R. "Bayesian updating as basis for opinion dynamics models", *AIP Conf. Proc.* 1490, p.212 - 221, 2012.
- Martins, André C.R. "Modelling Epistemic Systems" in Vahid Dabbaghian; Vijay Kumar Mago (Org.), *Theories and Simulations of Complex Social Systems,* Springer, 2014, v. 52, p. 19-30.

Thank you!