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Managing path dependence in innovation and policy – Reflections from a behavioral OR perspective

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Path dependence

Studied widely in economics, organizational decision making, technology

- 'History matters': current state depends on the history
- Economic, technical, organizational, cognitive origins
- Lock-in phenomena, e.g. QWERTY
- Inferior technology can become dominant



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Path dependence in innovation literature

Dosi, G. (1982). **Technological paradigms and technological trajectories: a suggested interpretation of the determinants and directions of technical change.** *Research policy*, 11(3), 147-162.

Arthur WB (1989). **Competing technologies, increasing returns, and lock-in by historical events.** *The economic Journal*, 99(394):116–31.

David, P. A. (1994). **Why are institutions the ‘carriers of history’?: Path dependence and the evolution of conventions, organizations and institutions.** *Structural change and economic dynamics*, 5(2), 205-220.

Thrane, S., Blaabjerg, S., & Møller, R. H. (2010). **Innovative path dependence: Making sense of product and service innovation in path dependent innovation processes.** *Research policy*, 39(7), 932-944.

In OR: discussed implicitly early

Morris 1967. **On the art of modeling**

Management Science, 13(12): B707-B717.

Landry, Malouin, Oral 1983. **Model validation in operations research**

European Journal of Operational Research, 14(3): 207-220.

and explicitly today

Lahtinen, Hämäläinen 2016. **Path dependence and biases in the even swaps decision analysis method**

European Journal of Operational Research, 249(3): 890-898

Hämäläinen, Lahtinen 2016. **Path Dependence in Operational Research - How the Modeling Process Can Influence the Results**

Operations Research Perspectives, 3:14-20.

Lahtinen, Guillaume, Hämäläinen 2017. **Why pay attention to paths in the practice of environmental modelling?**

Environmental Modelling and Software, 92: 74-81.

Path dependence in OR:

Outcome depends on the path followed

Path = sequence of steps taken in the OR problem solving process

Is path dependence a risk in OR based problem solving?

Yes in

- Optimization, efficiency
- Important policy problems, normative decision support

Not necessarily if goal is to increase understanding

- Trying different paths can be beneficial to learning
- Creation of shared understanding of the problem

Drivers of problem solving paths

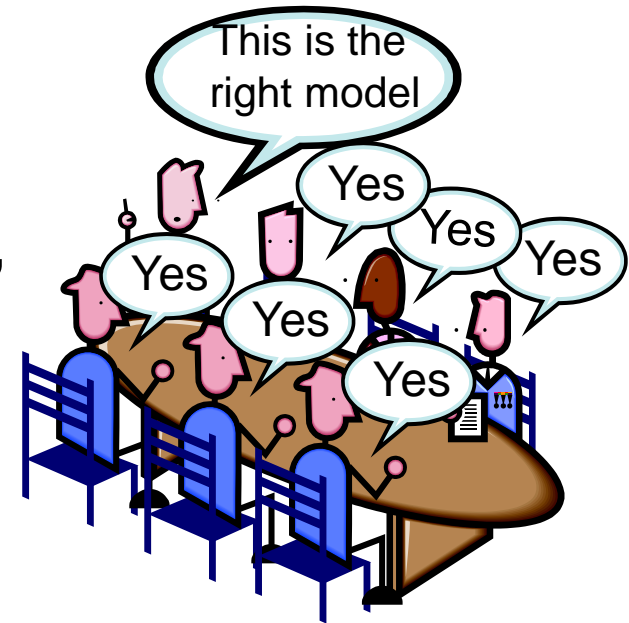
Human interaction with the methods, problem, and the context

- **System**
- **Learning**
- **Procedure**
- **Behavior**
- **Motivation**
- **Uncertainty**
- **External environment**

Social system

Formed by the people involved in the problem solving process

- **Social interaction: Engagement, dialogue, communication**
- Lock-in to one approach. Groupthink, working with "our" models



Also the system under study

- Increasing returns, bifurcations, feedback loops

Learning

Learning about the problem: revise assumptions, redirect the process

- Unlearning preconceived approaches can be difficult
- Importance of early framing and value-focused thinking

Procedure

Procedures and methods in problem solving

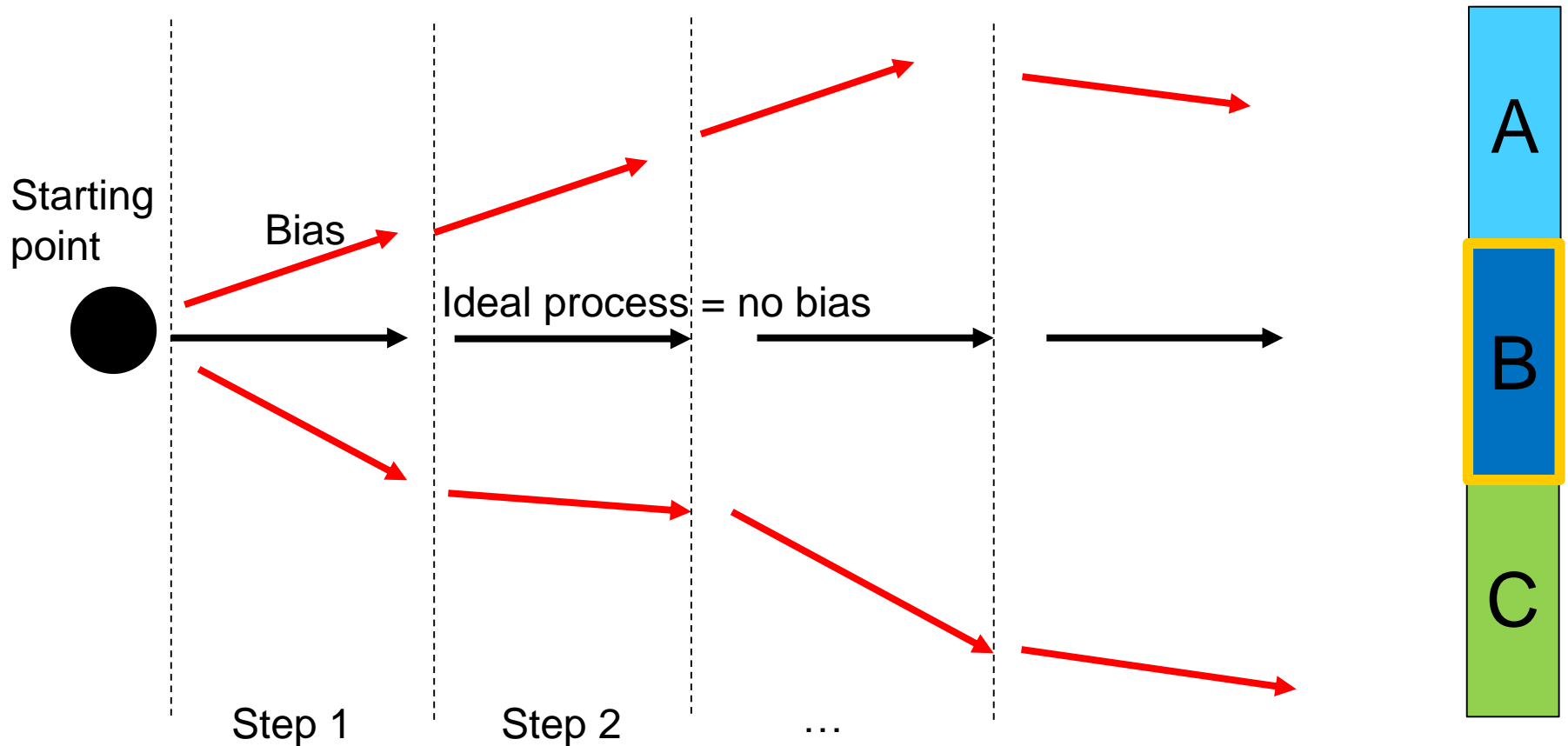
- Order of problem solving steps
- Decomposition into sub-problems

Behavior

Behavioral phenomena related to individuals

- Problem solvers are subject to **cognitive biases**
- 'Getting stuck' with previously adopted models and software
 - Status quo bias, sunk cost effect, anchoring, confirmation bias

Accumulation of bias along the process



Motivation

People's goals affect the problem solving process

- Expert delivering desired result
- Strategic behavior in group processes
- Self-deception

Uncertainty and changes in the external environment

Uncertainty in assumptions

- No one 'right' path

Changes in external environment:

- Same path can lead to different results at different times

Coping with path dependence

- Importance of early steps
- Awareness and reflection of paths
- More than one problem solving process
 - Adaptive problem solving

Reflecting on paths

- What are the critical forks on the path?
- What drives the path?
- Where does the path lead us?

More than one problem solving process

Multiple independent teams solving the same problem

- Alternative problem formulations and approaches

Devil's advocate team?

- Challenge crucial assumptions
- Worst case analysis

Adaptive problem solving

The desired path can change when we learn more

Decide checkpoints where the process can be revised

- Take into account learning, intermediate results, new data

In policy problems there often is

- Accumulation of information and decrease of uncertainty over time
- Changes in the problem environment

Conclusions

Path dependence is a real phenomenon in OR problem solving and in innovation

- Important to consider in prescriptive problem solving and decision support

Can path perspective help understand and manage innovation projects?

Do cognitive biases have a role in innovation?

Checklist for reflecting on the path

1. What is the main goal of the modeling process – learning or prescriptive modelling?
2. How the system created by the problem solving process can influence the path?
3. How procedural, behavioral and motivational biases can influence the path?
4. How technical properties, such as irreversibilities, in the problem under study can influence the path?
5. Is it possible to use multiple models?
6. Consider the possibility of an adaptive modelling approach

Reducing the accumulation of biases

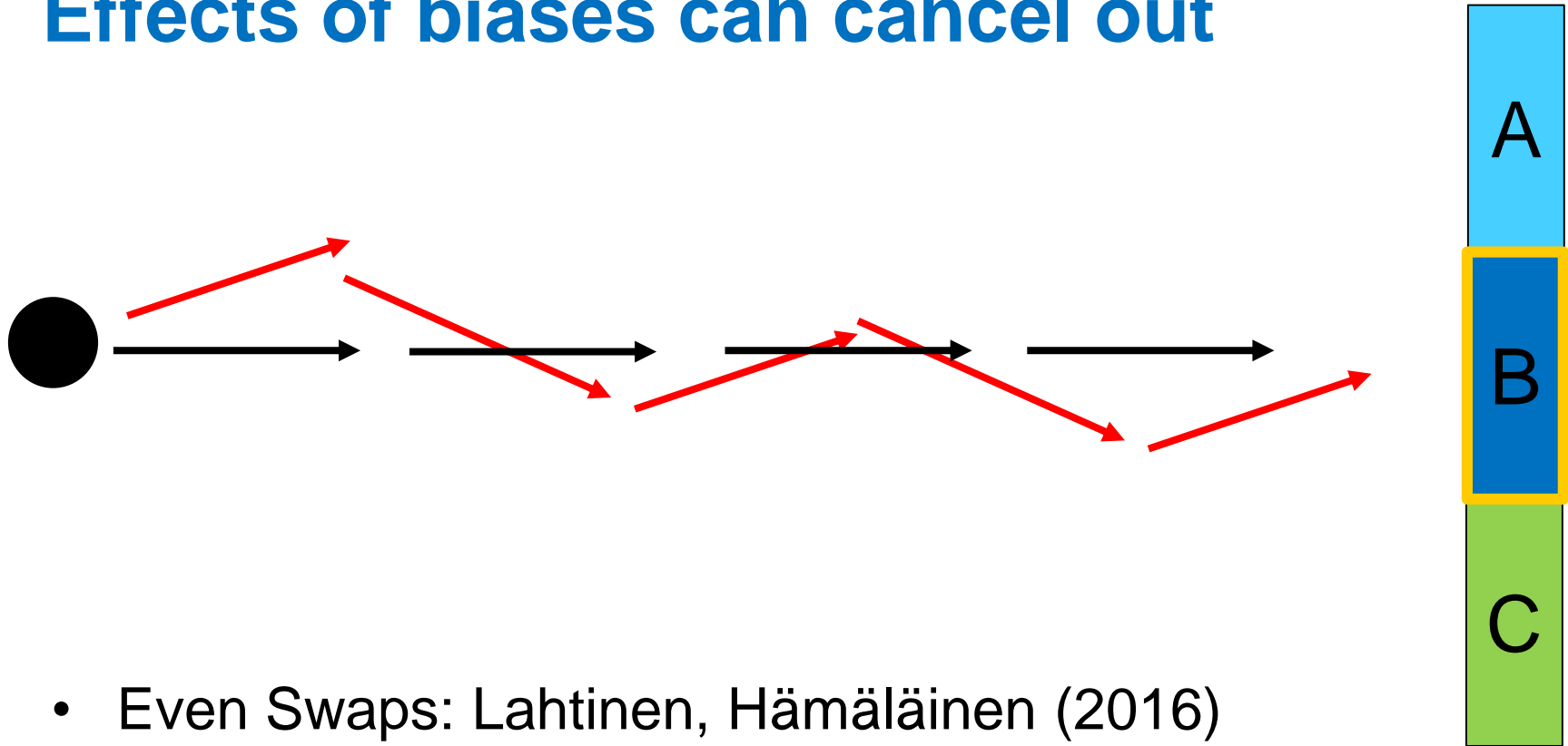
Approaches suggested in the literature:

- Reframe questions, train decision makers, calibrate judgments

Lahtinen, Hämäläinen (2016):

- Design elicitation process so that effects of biases cancel out
- **Possible only if the mechanism of bias is well understood**

Effects of biases can cancel out



- Even Swaps: Lahtinen, Hämäläinen (2016)

Not always necessary to debias individual judgments

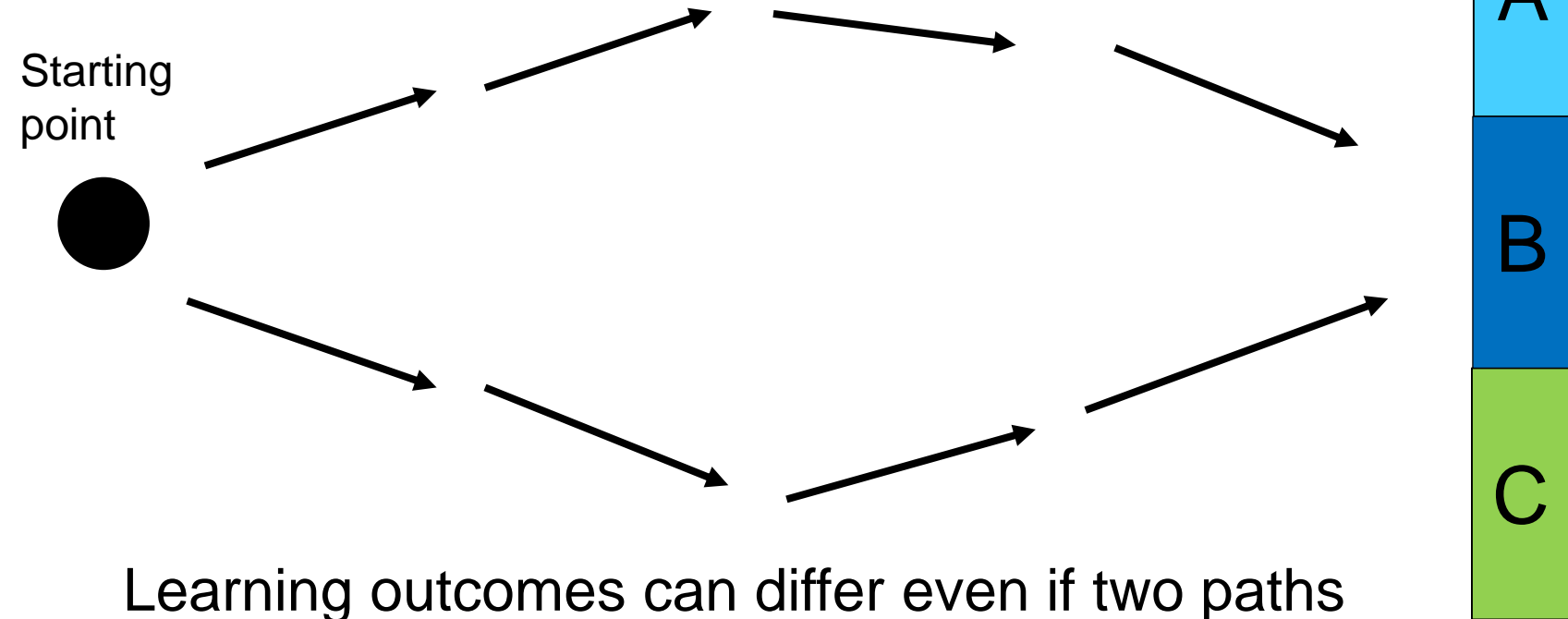
The path can be intentionally directed to support learning

What happens if we change the approach / model / modeler?

Backcasting (Robinson 1982)

Working backwards from an envisioned outcome to figure how that outcome can be reached

Learning outcomes can depend on the path followed



Learning outcomes can differ even if two paths have the same starting point and the same result