Theory Choice, Theory Change, and Inductive Truth-Conduciveness

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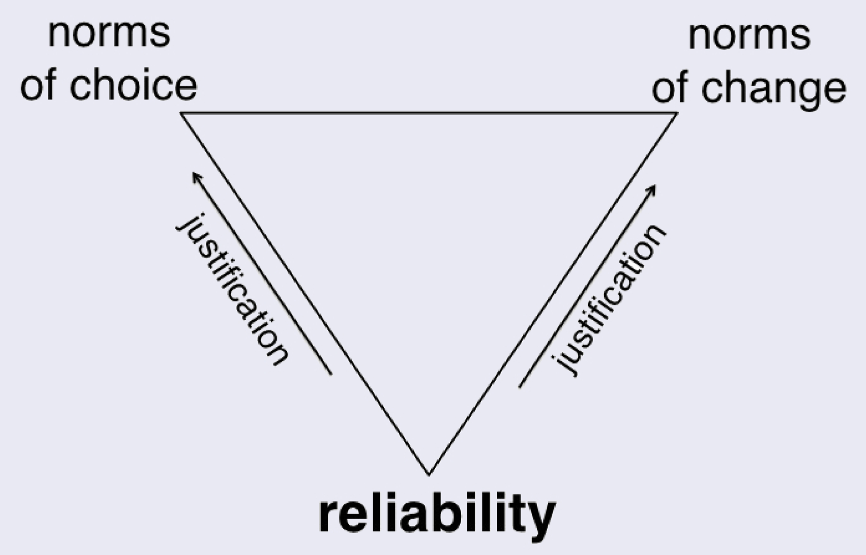
Abstract

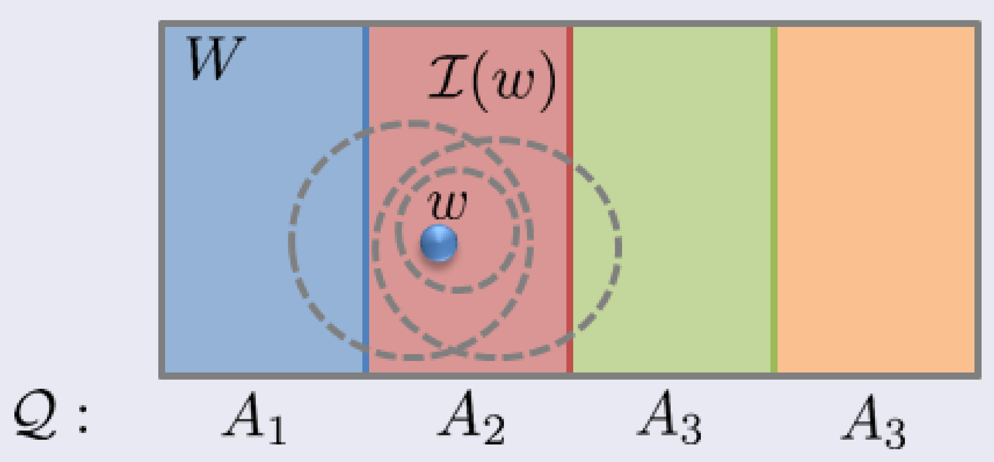


Can the norms of theory **change** articulated in belief revision motivate the norms of theory **choice** prevailing in empirical inquiry? Can these norms be justified by their **reliability**, or truth-conduciveness? We show that a weak norm of theory change from belief revision necessitates a preference for simpler, and more falsifiable, theories. Furthermore, both norms are justified by a principle of **direct** convergence to the truth.

Empirical Problems

An **empirical problem** is a triple $\mathfrak{P} = (W, \mathcal{I}, \mathcal{Q})$.

- W is a set of possible worlds.
- $\mathcal{I}$ is an information basis (a cover of W closed under conjunction).
- $\mathcal{Q}$ is a *question* partitioning W into countably many *answers*.



Topology as Epistemology

Closing $\mathcal{I}$ under arbitrary disjunction generates a topological space. The open sets are **verifiable** propositions, and the closed sets are **refutable** propositions. The closure of A, written $\overline{A}$ is the set of worlds where A is never refuted by information.

The Topology of Simplicity

P is **simpler than** Q, written $P \prec Q$,

1. iff $P \subseteq \overline{Q} \setminus Q$,
2. P entails that Q is false, but will never be refuted,
3. iff P is more falsifiable than, but incompatible with, Q.

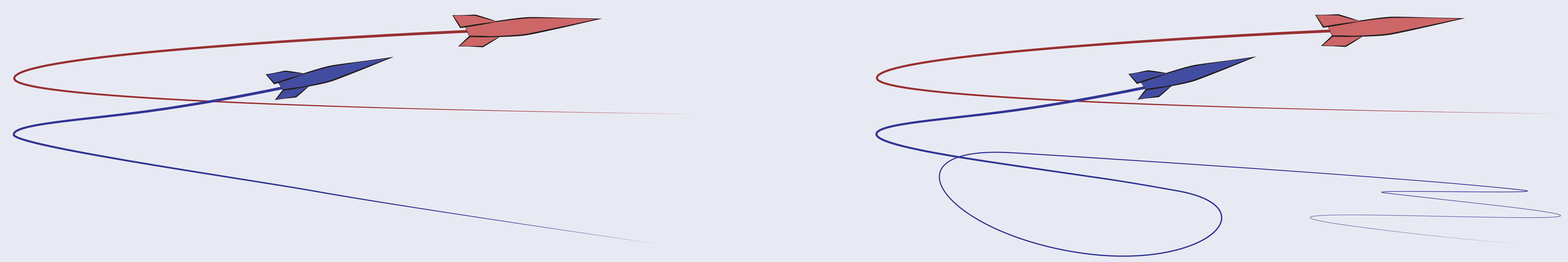
P is **at least as simple as** Q, written $P \preceq Q$ iff $P \prec Q$ or $P = Q$.

Reliability: Convergence in the Limit

A method λ **solves** $\mathfrak{P}$ **in the limit** iff for all $w \in W$, there is **locking information** $E \in \mathcal{I}(w)$, such that for all $F \in \mathcal{I}(w)$, $\lambda(E \cap F) = \mathcal{Q}(w)$. A characterization of solvable problems is given in de Brecht and Yamamoto [2009], Baltag, Gierasimczuk, and Smets [2015] and Genin and Kelly [2015].

Reliability: Optimally Direct Convergence

Limiting convergence is too **weak** a norm too mandate any short-run methodological principles. We refine limiting convergence to optimally **direct** convergence.



(a) Good Pursuit   (b) Bad Pursuit

Reliability: Cycles and Reversals

A **reversal sequence** is a sequence of elements of $\mathcal{Q}^\omega$, $(A_i)_{i=1}^n$ such that $A_{i+1} \subseteq A_i^c$ for $1 \leq i < n$. A **cycle sequence** is a reversal sequence $(A_i)_{i=1}^n$ such that $A_n \subseteq A_1$.

Method λ is **cycle-free** iff there exists no nested sequence of non-empty information states:

$$e = (E_i)_{i=1}^n,$$

such that $\lambda(e) = (\lambda(E_i))_{i=1}^n$ is a cycle sequence.

Change: No induction, without refutation.

A method λ satisfies **conditionalization** iff

$$\lambda(E) \cap \mathcal{Q}(E \cap F) \subseteq \lambda(E \cap F)$$

for all $E, F \in \mathcal{I}$,

Change: No retraction, without refutation.

A method λ is **rationally monotone** iff

$$\lambda(E \cap F) \subseteq \lambda(E) \cap \mathcal{Q}(E \cap F)$$

for all $E, F \in \mathcal{I}$ such that $\lambda(E) \cap \mathcal{Q}(E \cap F) \neq \varnothing$.

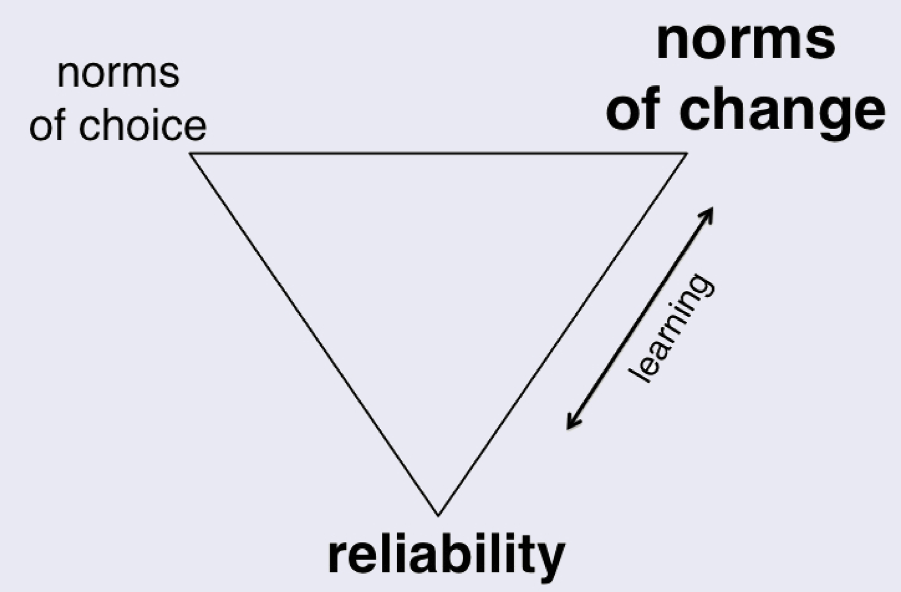
Change: No reversal, without refutation.

Gärdenfors [1988], Schurz [2011], Lin and Kelly [2012] argue that the previous two principles of theory change are too strong for inductive inference. The following weakens them: a method λ is **reversal monotone** iff

$$\lambda(E \cap F) \cap \lambda(E) \neq \varnothing \text{ whenever } \lambda(E) \cap \mathcal{Q}(E \cap F) \neq \varnothing.$$

Theorem 1

If λ is a consistent solution to $\mathfrak{P}$, then λ is cycle-free iff λ is reversal monotone.

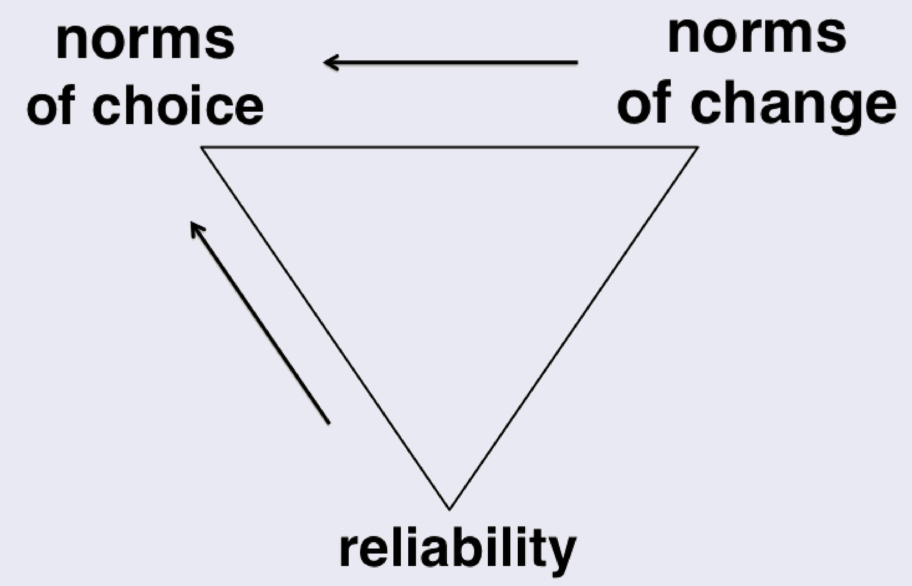


Choice: Ockham's Razor

A method λ is **Ockham** iff $\lambda(E)$ is minimal in $\preceq$ for all $E \in \mathcal{I}$. Equivalently, $\lambda(E)$ is Ockham iff $\lambda(E)$ is refutable in E for all $E \in \mathcal{I}$.

Theorem 2

If λ is a cycle-free solution, then λ is Ockham.



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