Framework for Understanding SE Principles and Heuristics

(Tracing the evolution of SE's guiding propositions from patterns in experience to system-scientific insights)

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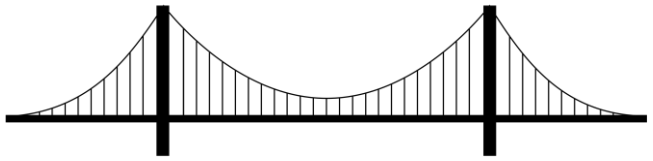
Context

Brook

Rousseau

Pennotti

- The Bridge Team was set up in June 2020 to create a Conceptual Bridge between two substantial INCOSE FuSE Projects, one collating SE Heuristics and another collating SE Principles
- Answering this call required us to first delve deeper into the nature of SE, what distinguishes it from other engineering disciplines, how SE evolves and what it might contribute in the future
- From this base we discovered a wider perspective on the relationship between heuristics and principles, one that also includes other kinds of guiding propositions and exposes common processes by which they mutually evolve
- This new perspective can provide us with means to systematically improve the quality and value of SE's guiding propositions

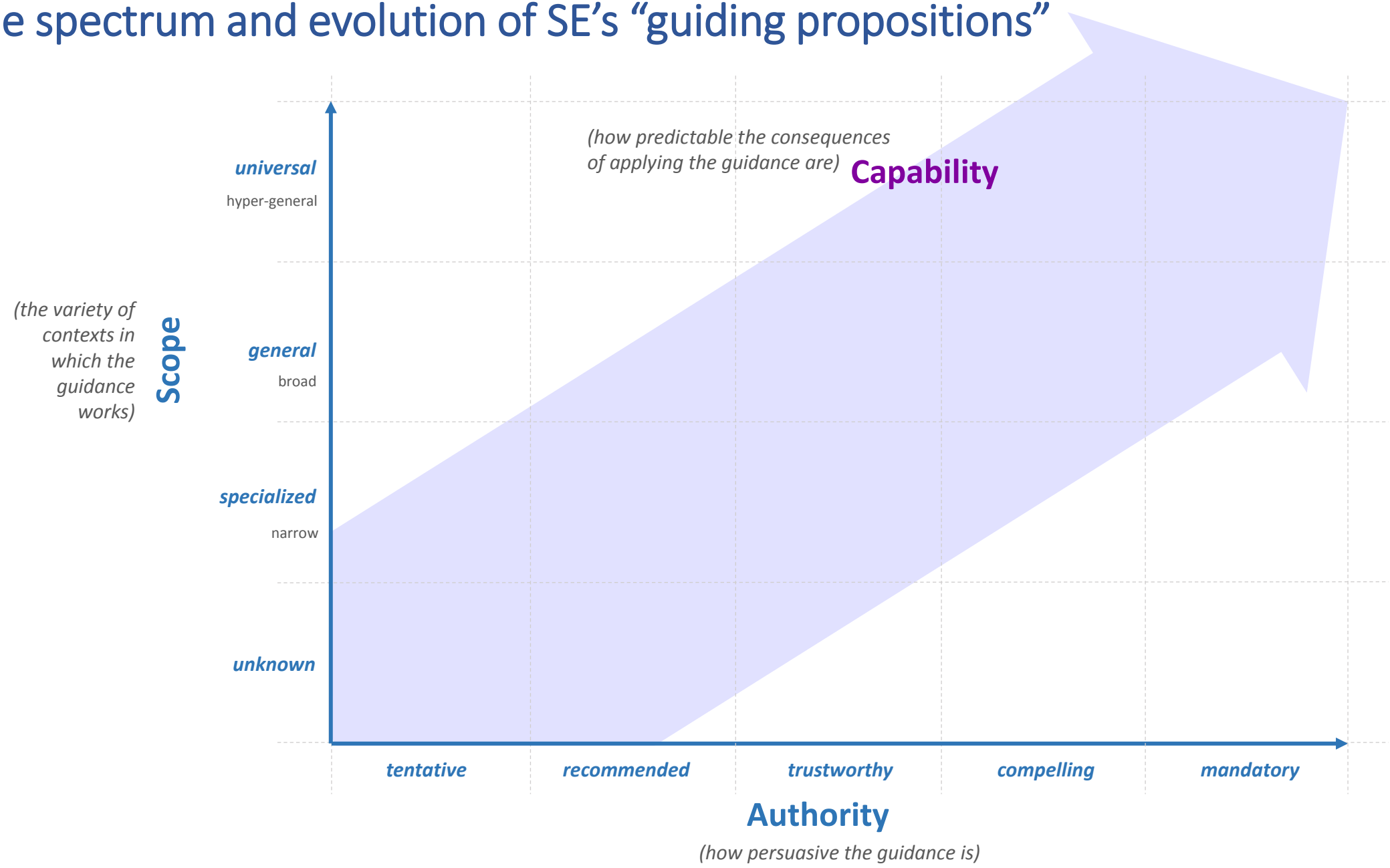


The “guiding propositions” of SE: Background

Names	principles, heuristics, tenets, axioms, guidelines, elementary assumptions, accepted truths, basic rules, basic ideas, generalizations, fundamental truths, hypotheses, etc.
Usage	Inconsistent, and sometimes explicitly coupled, e.g. • principles equated with “tenets” (Sillitto et al, 2018) • principles equated with “heuristics” (Pratt & Cooke, 2017) • principles equated with “accepted truths” (Watson et al, 2018)
Similarities & Differences	• All provide guidance for purposeful judgment or action in a context • All “guiding propositions” start as tentative **patterns** found in reflections on experiences and/or known patterns • Instances can vary from each other in **scope** (the range of SE contexts in which they work), in **authority** (how compelling they are), and **capability** (how predictable the consequences of applying them are) • All can evolve towards increased scope, authority and capability

- The similarities suggest that a unified conceptual framework can be created for relating them
- The differences suggest that important distinctions are at stake that should be preserved in the unified framework

The spectrum and evolution of SE's "guiding propositions"



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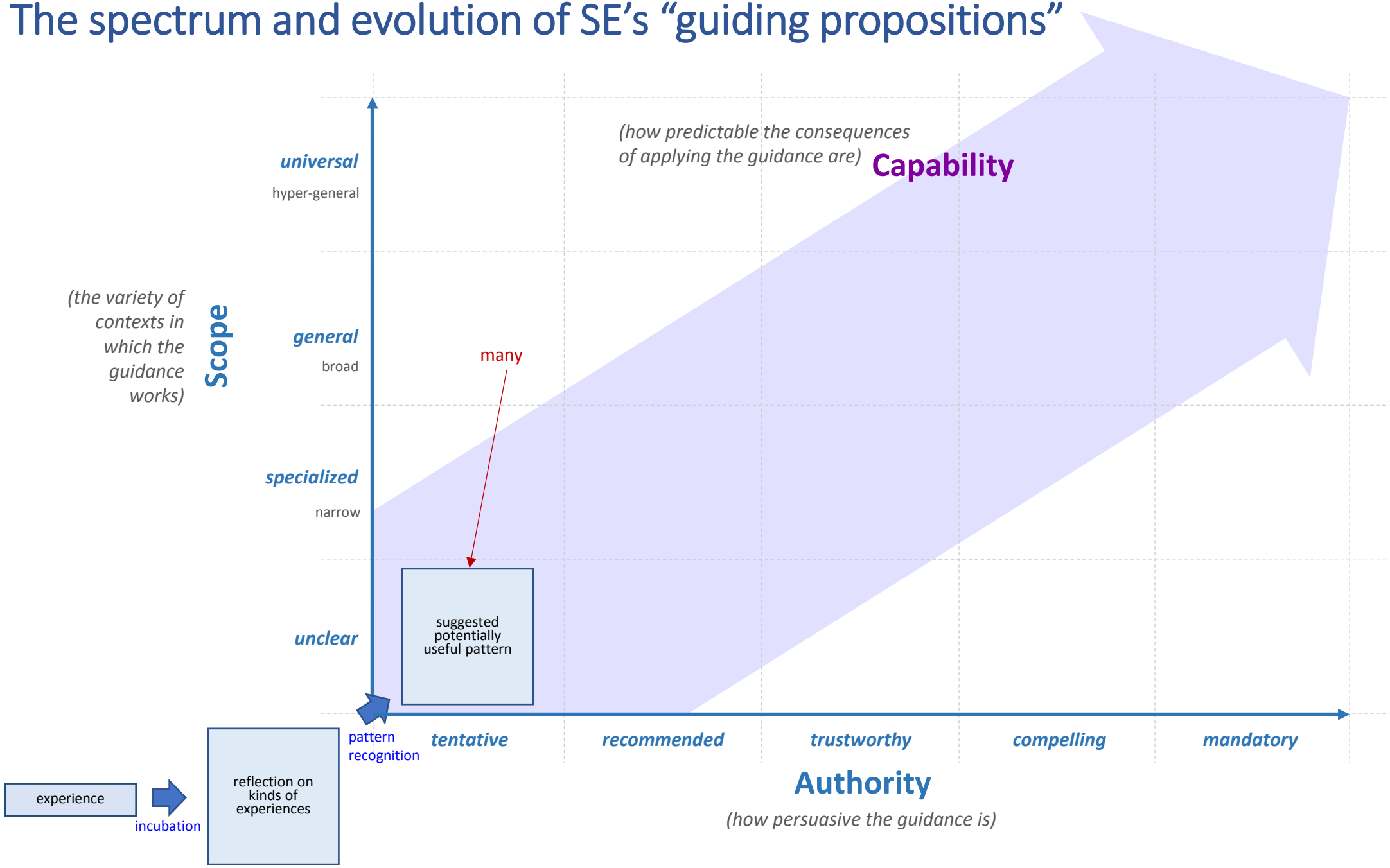

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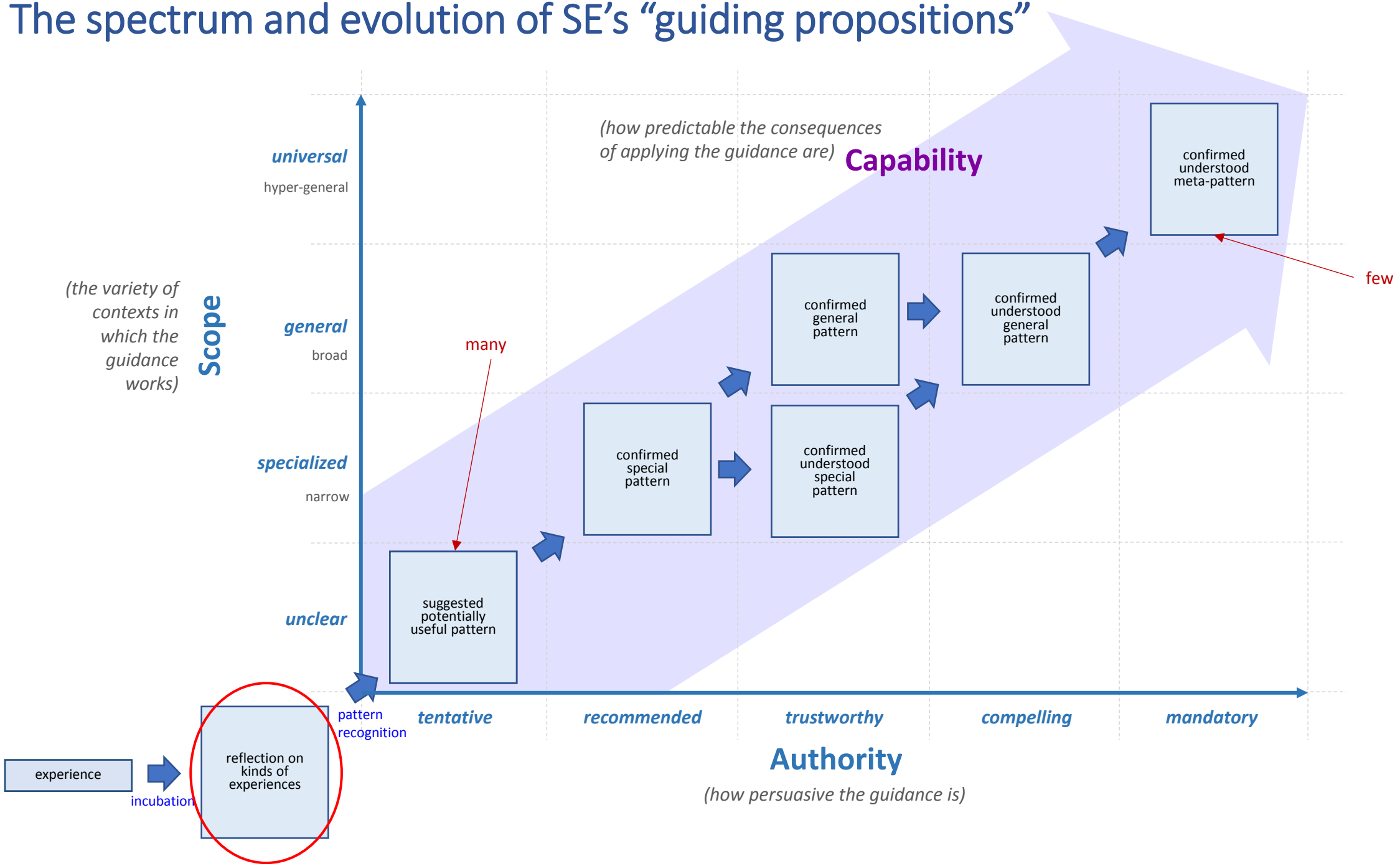

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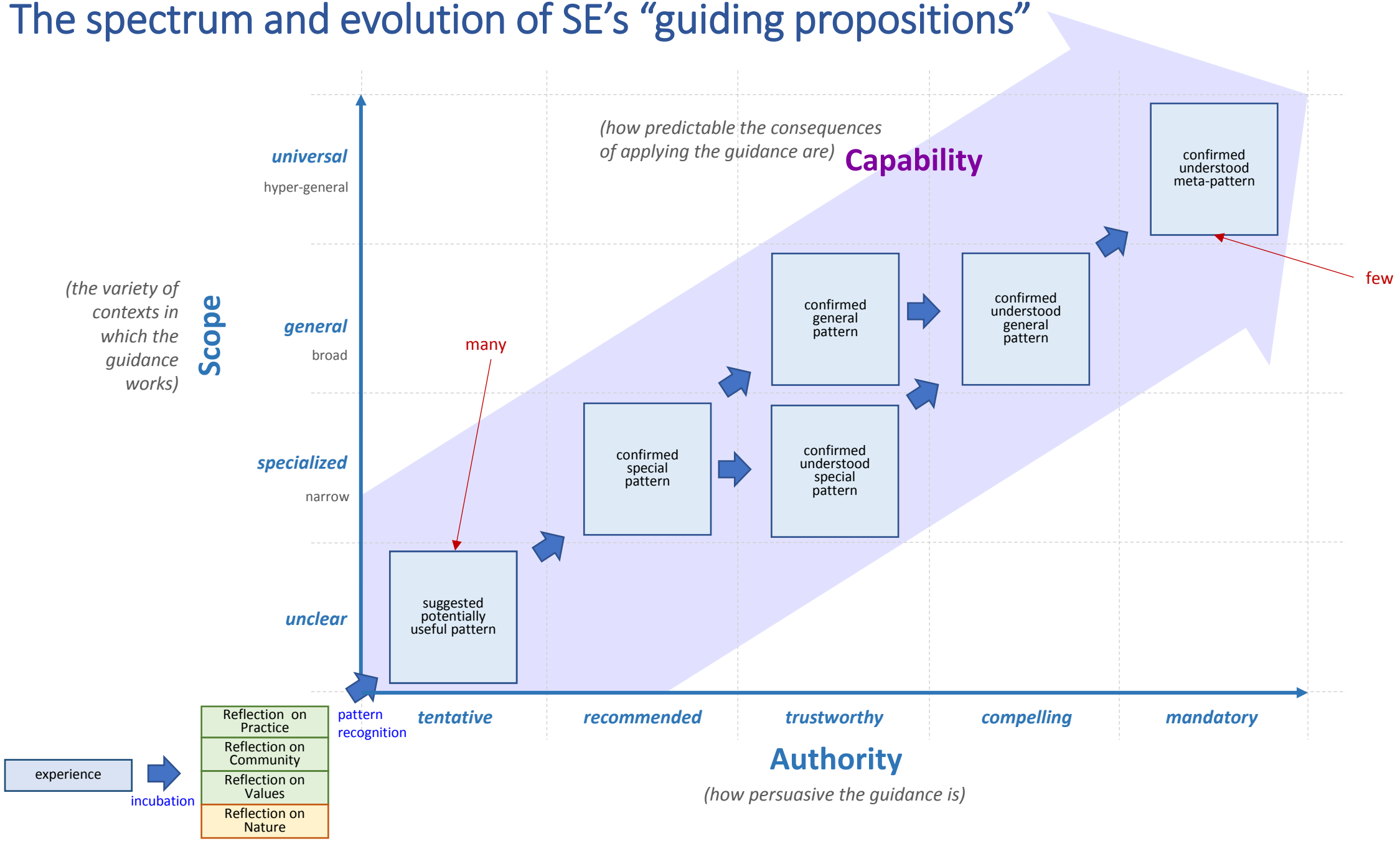

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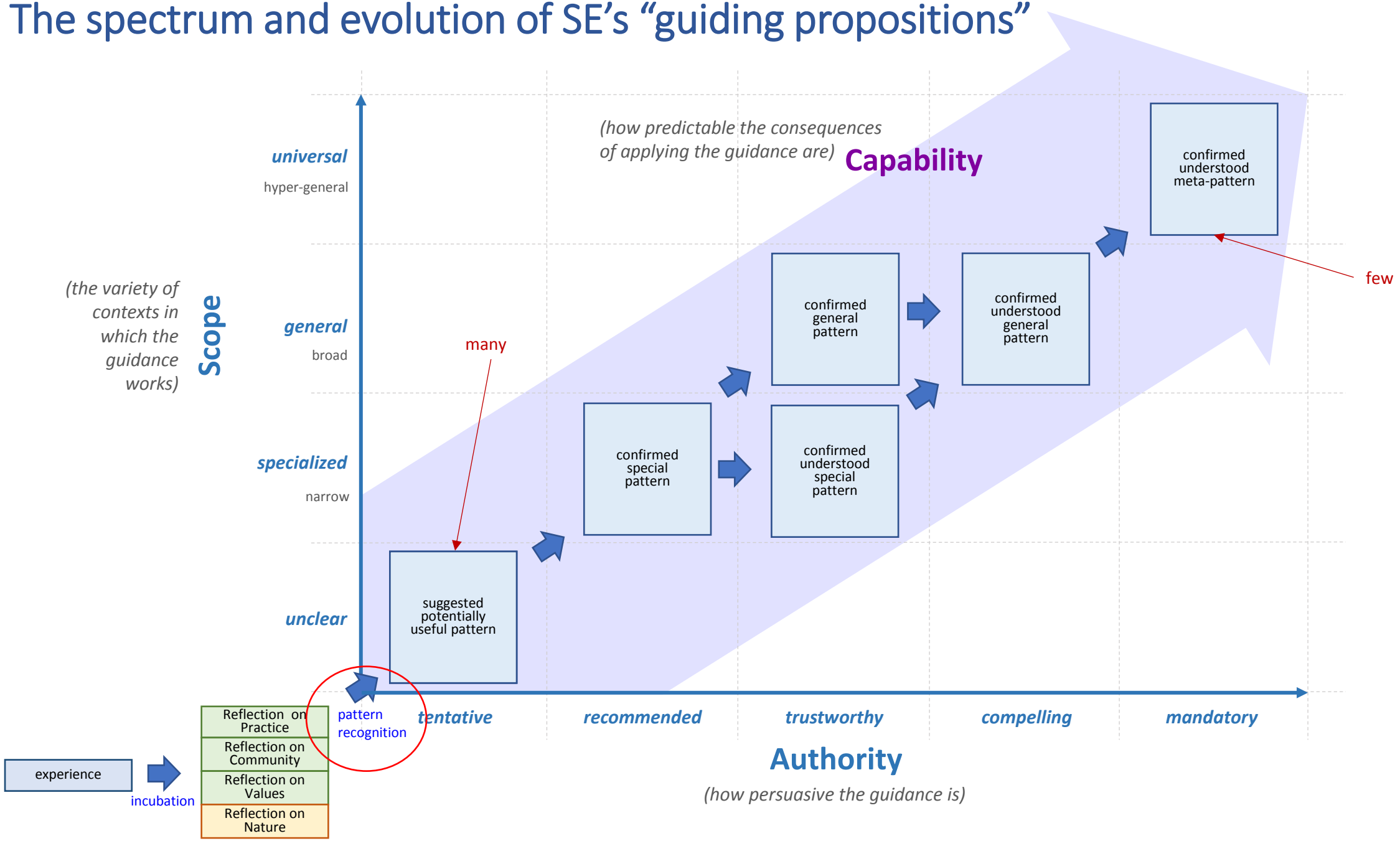

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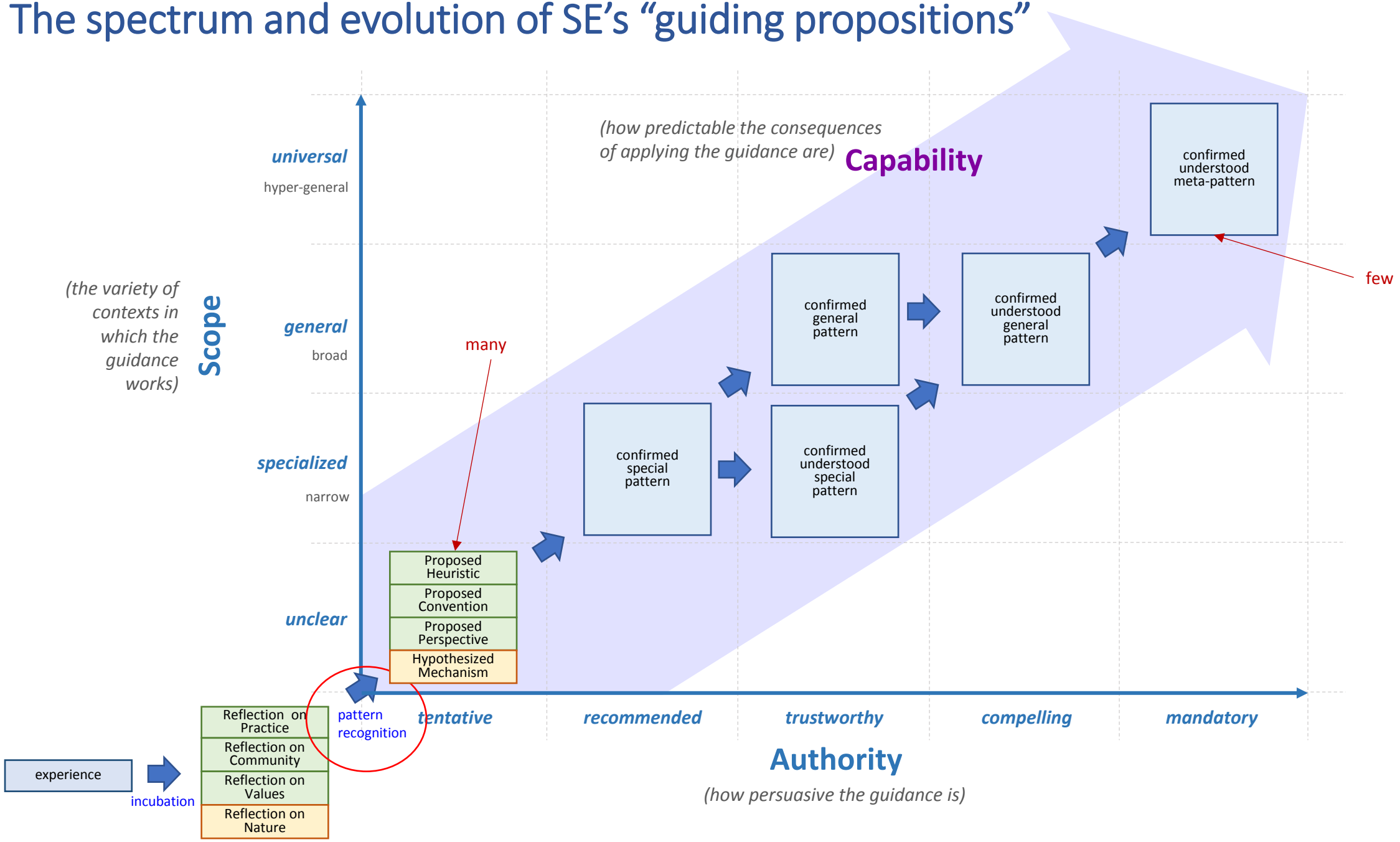

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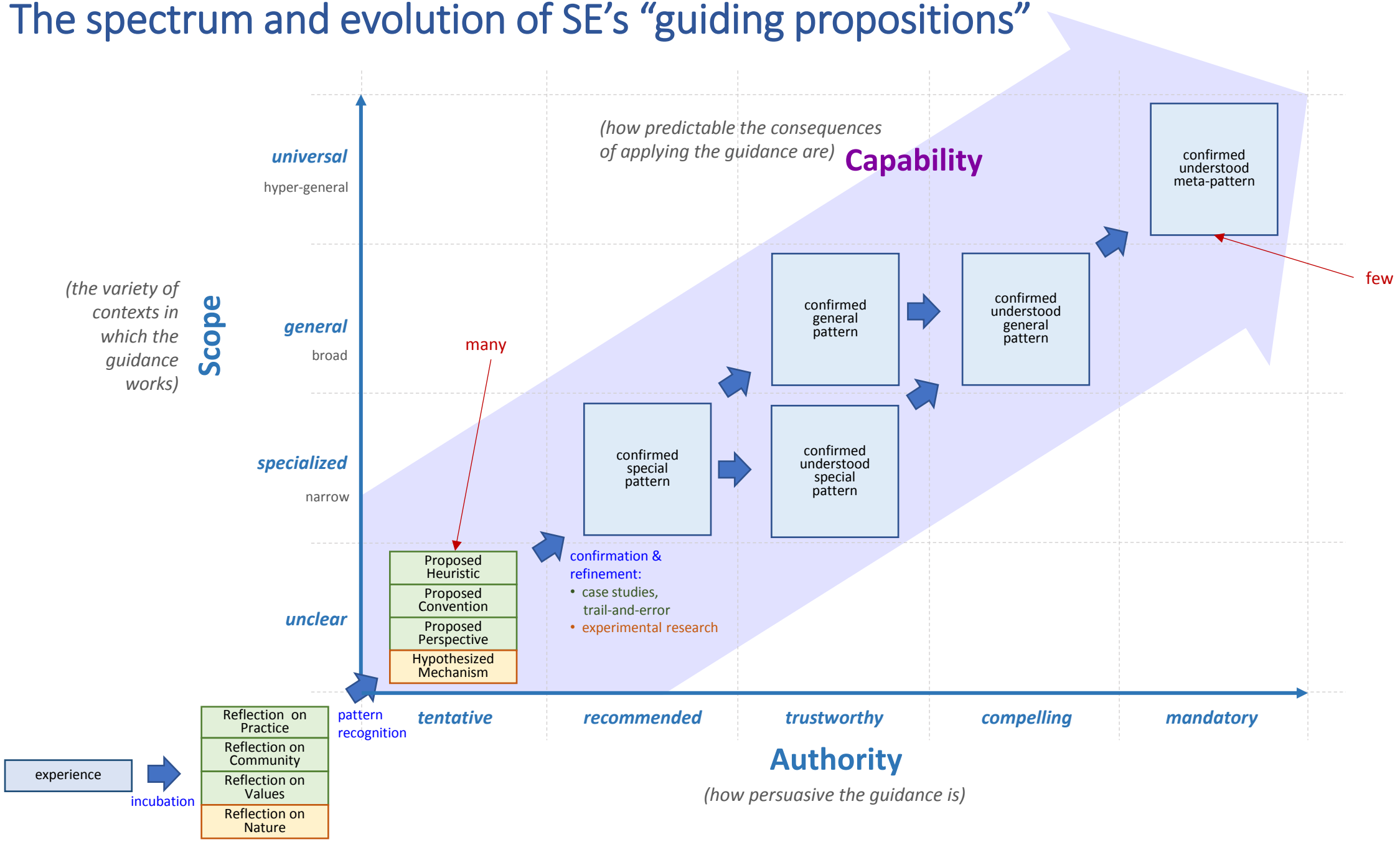

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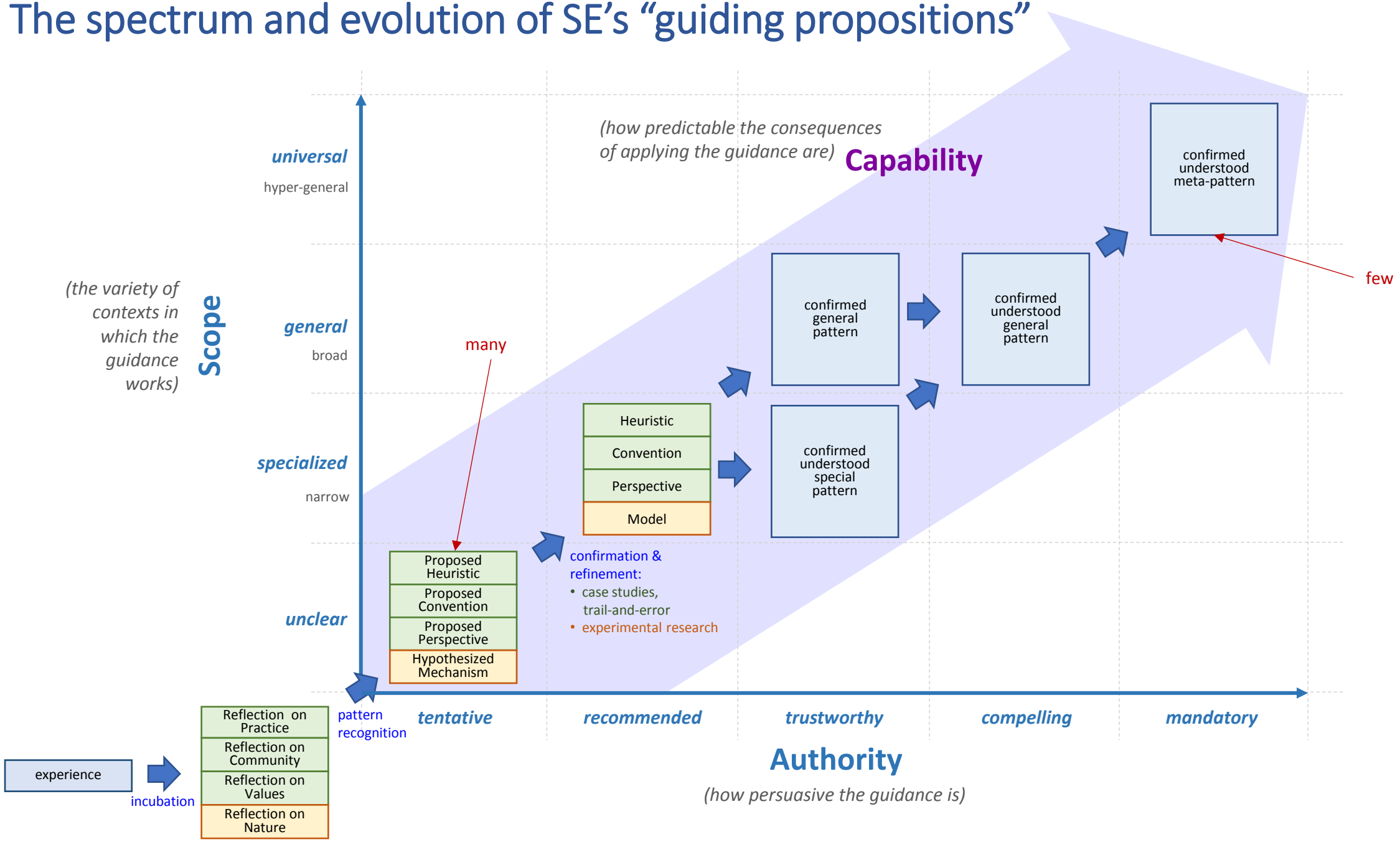

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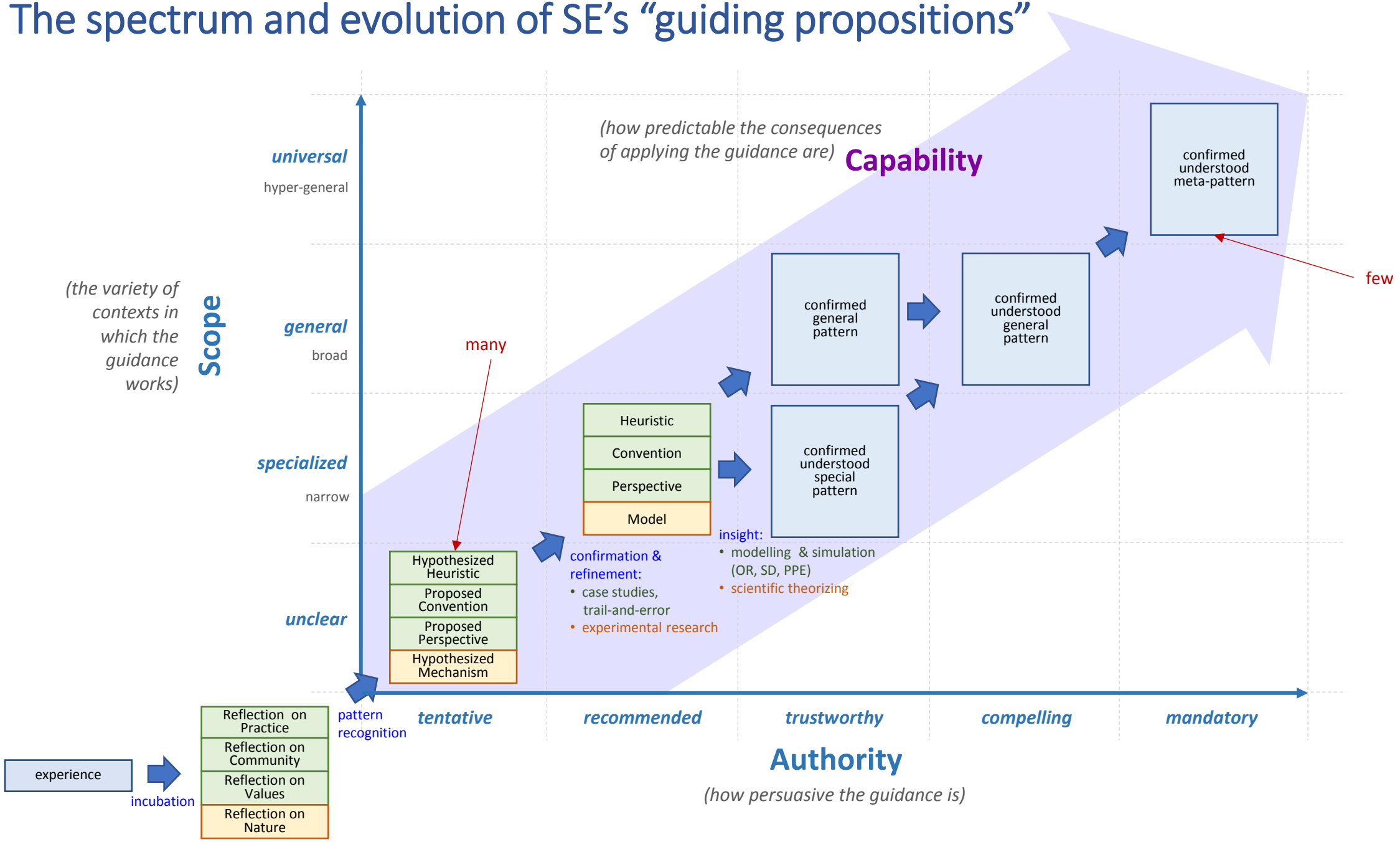

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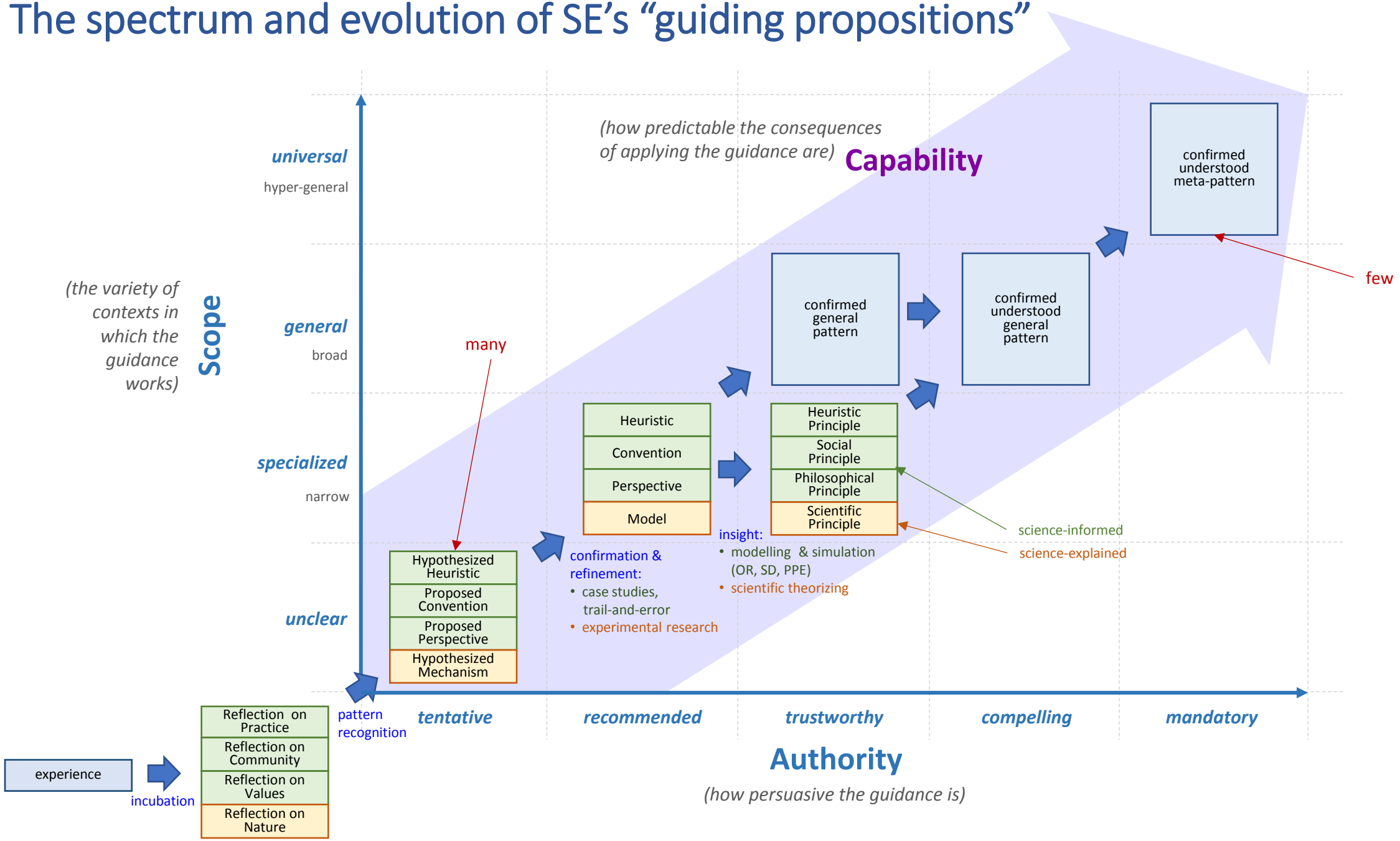

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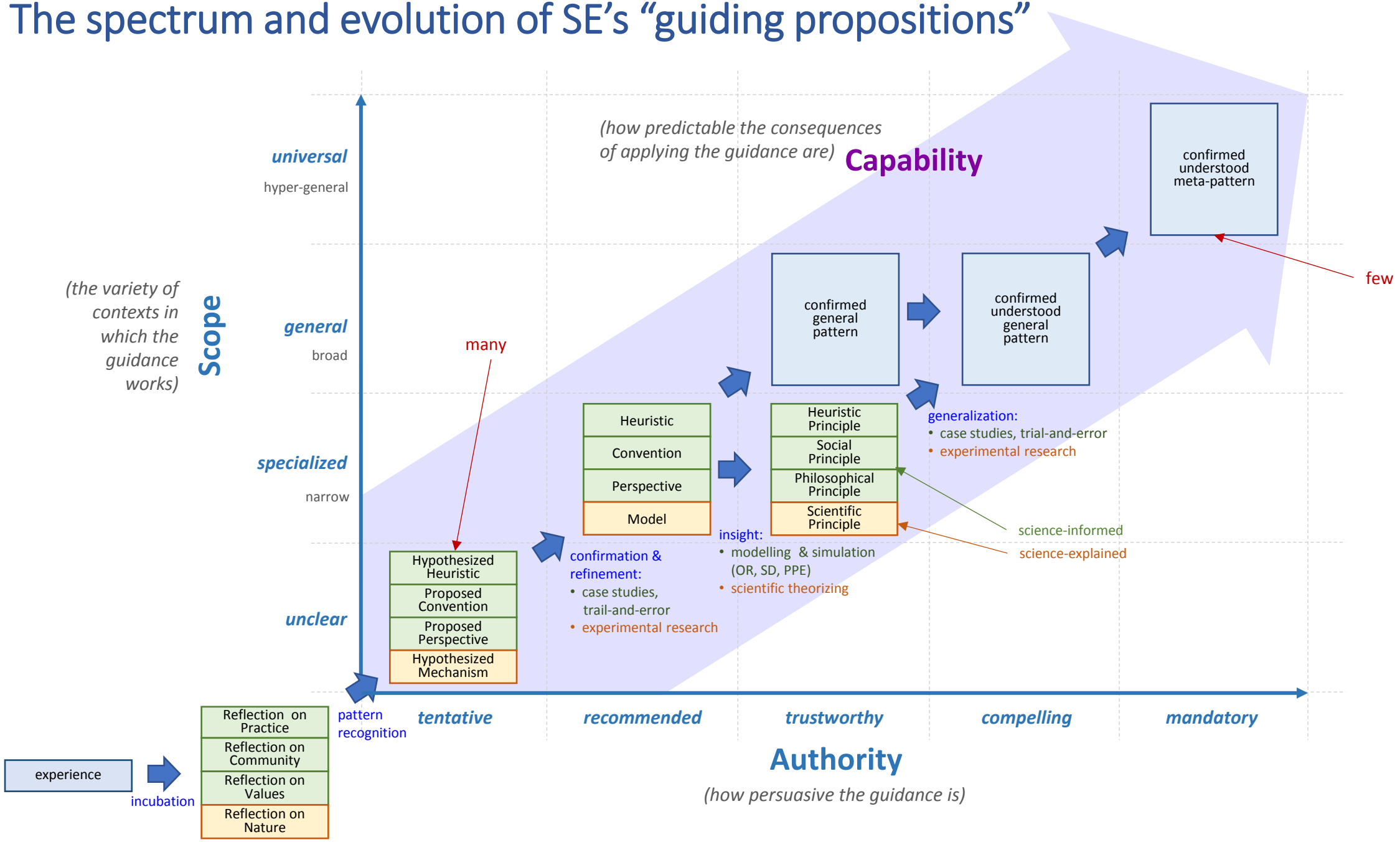

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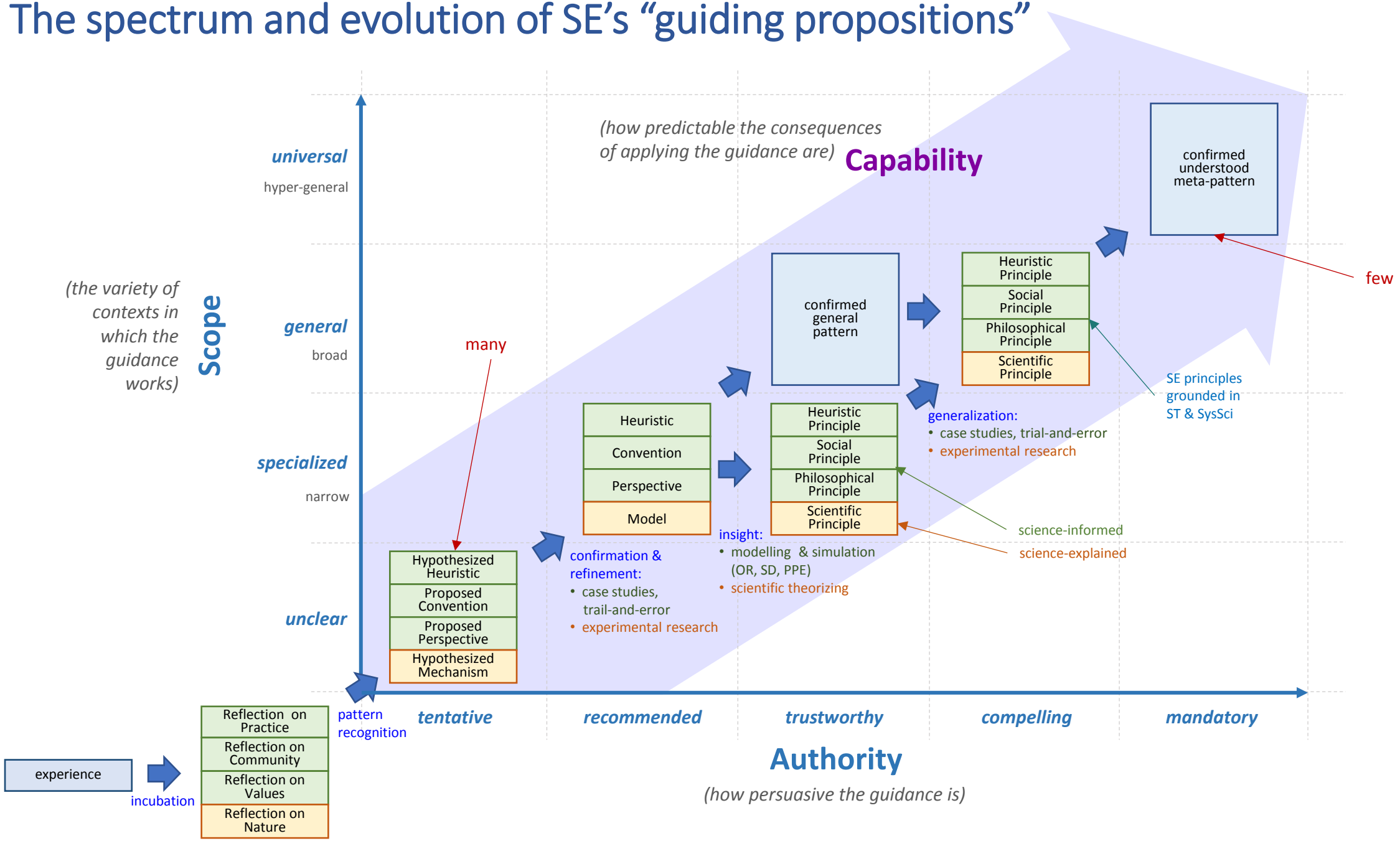

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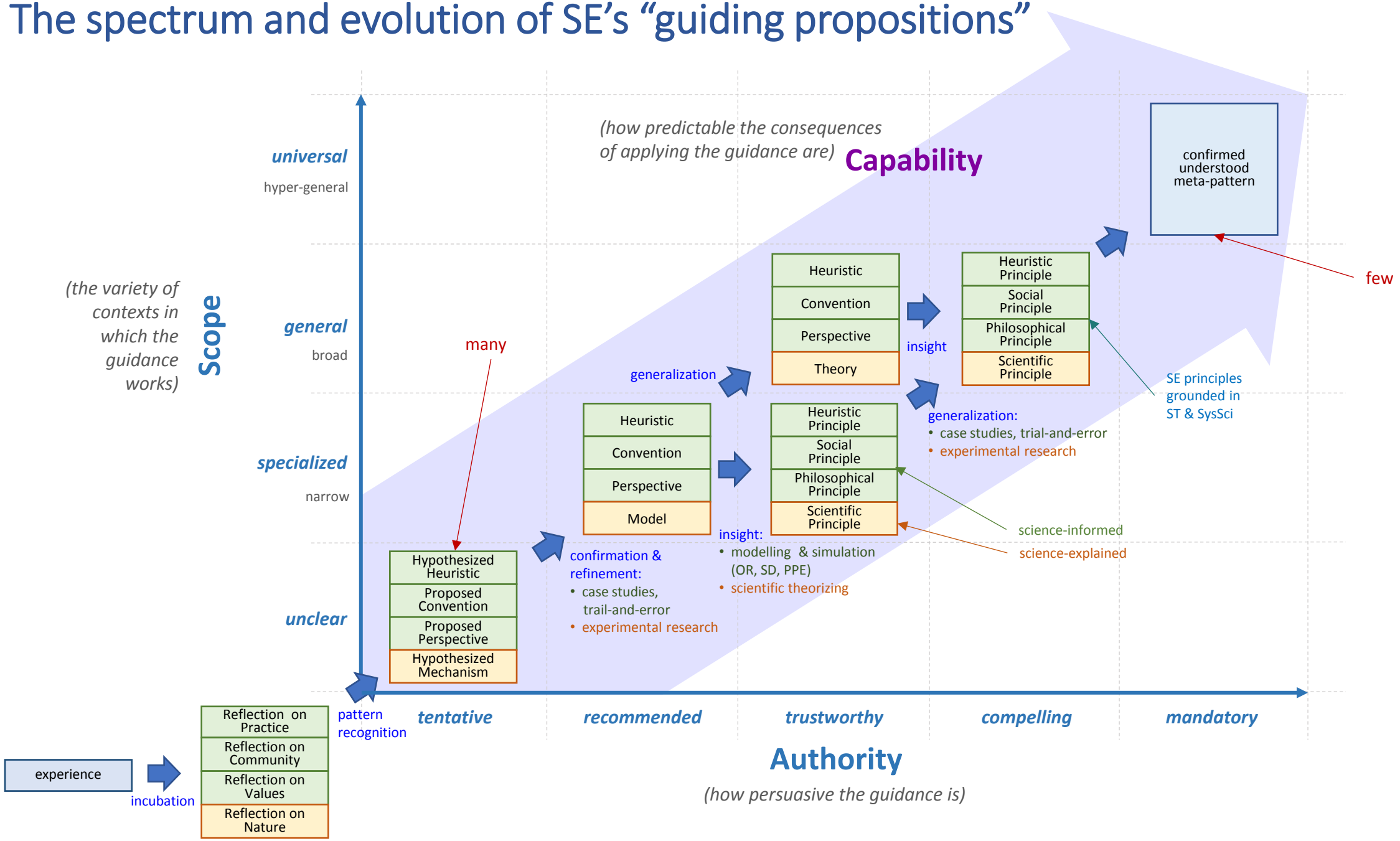

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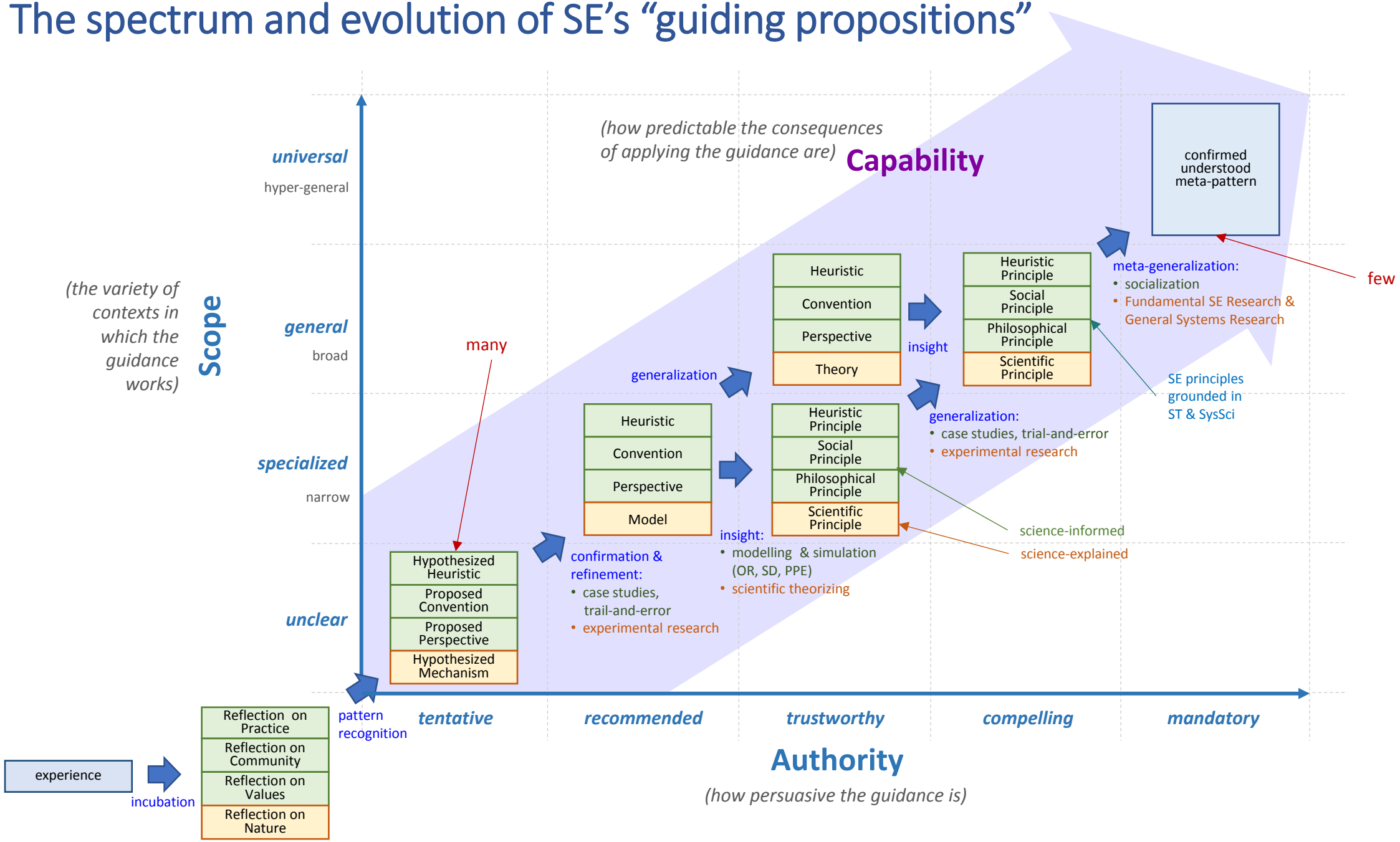

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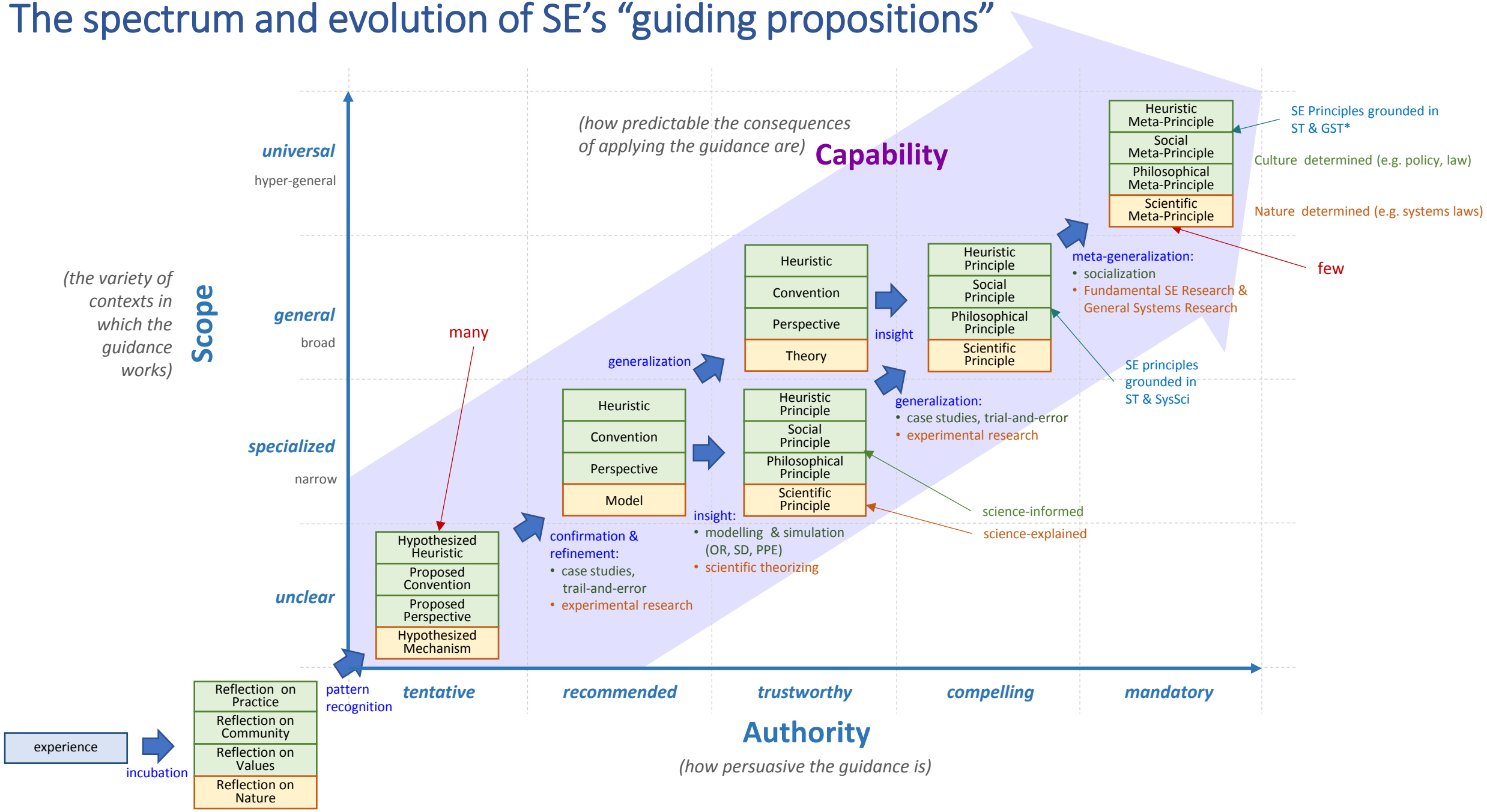

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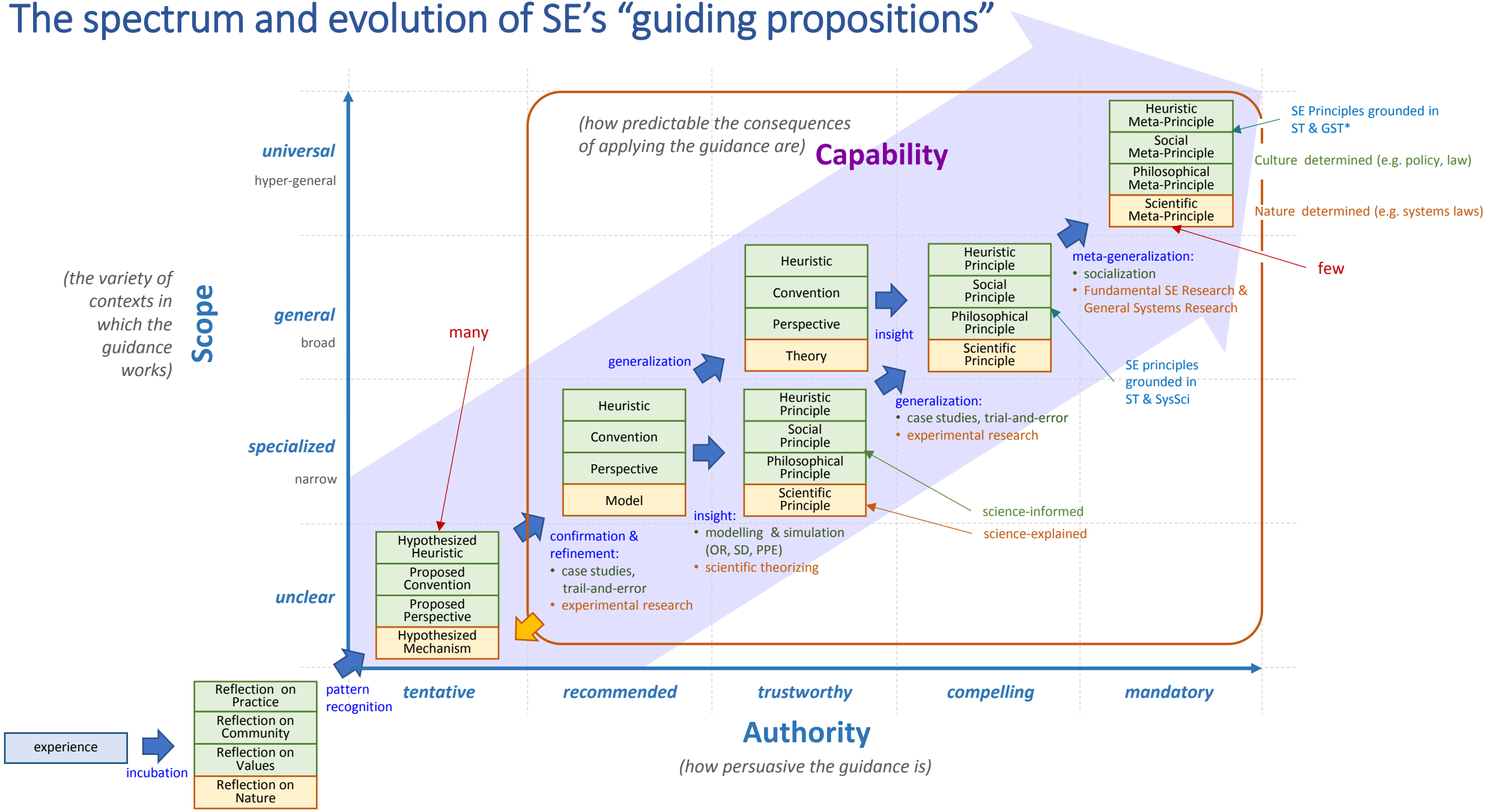

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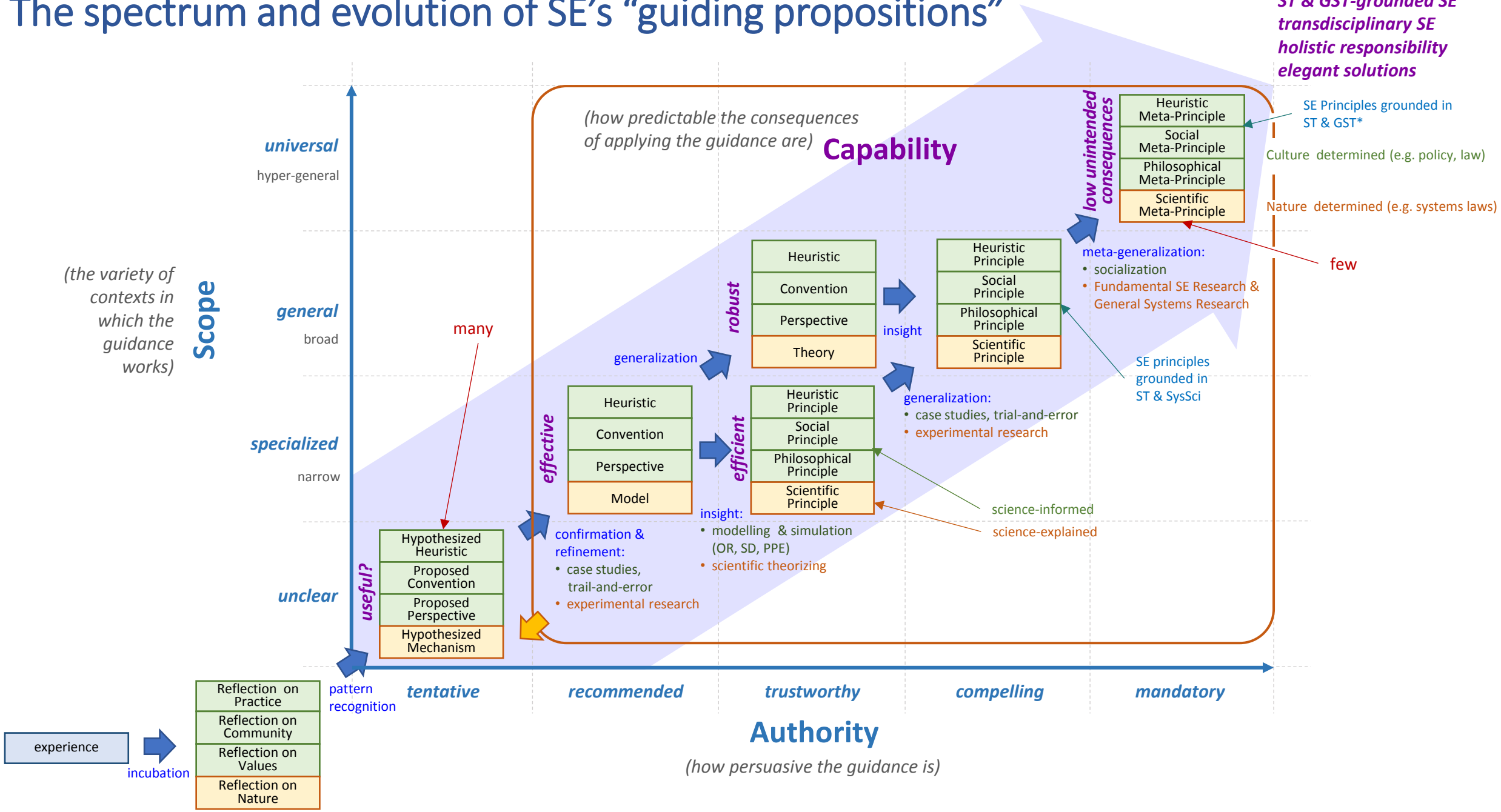

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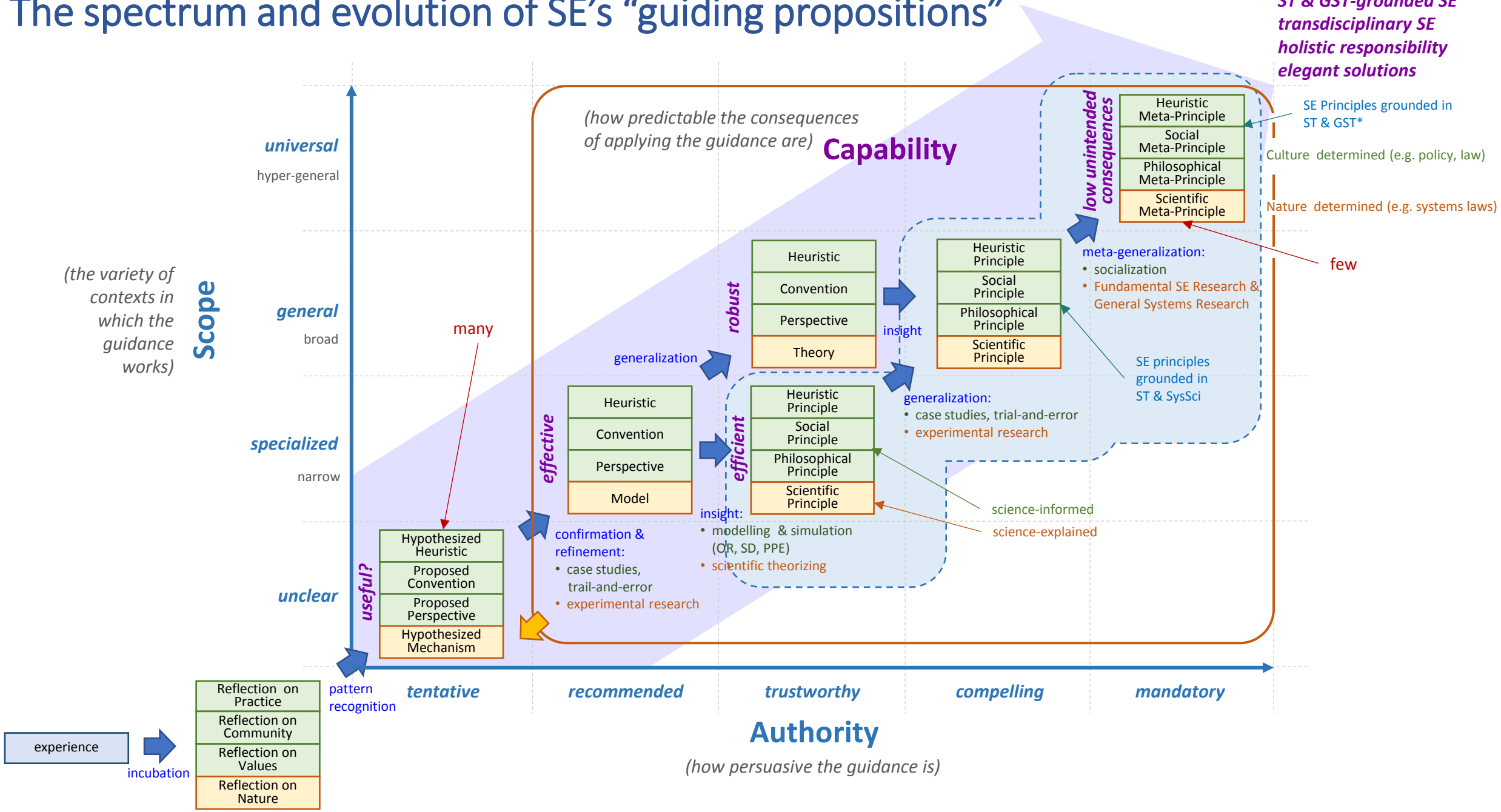
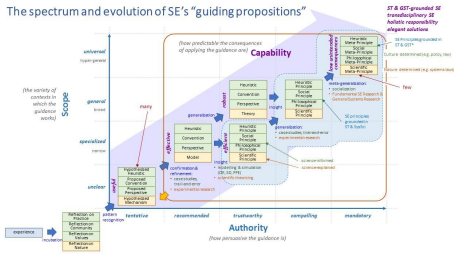
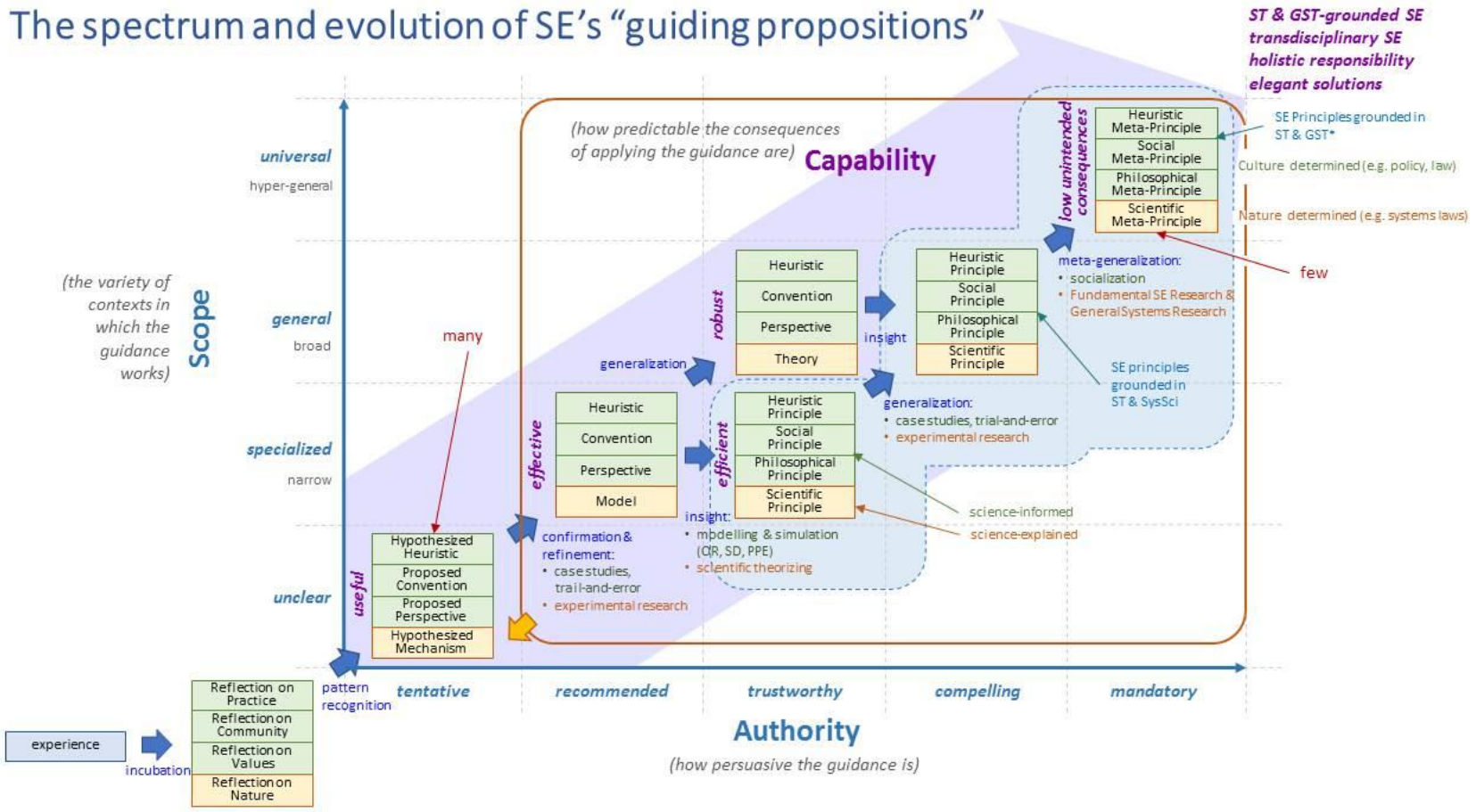


From this, we now can:



- Appreciate that SE's guiding propositions come in different kinds that:
  - have different origins (e.g. experiences, theories, worldviews, conventions etc.),
  - evolve via different mechanisms (trail-and-error, experiment, general systems research etc.), and
  - serve different purposes (guide practice, ethics, approach, purpose) (see also the "Bridge" model)
- Assess the adequacy and maturity of specific guiding propositions, and consequently judge to what extent they require adding to or further development, and what to do to support that evolution
- Understand why it is important to evolve our principles – the future is unknown so has no best practice based on *experience*, but the future scenario will be systemic and require systemic solutions; in that future the hyper-general principles and laws can be relied on for guidance
- Appreciate the significance of Systemology (Systems Thinking , Systems Science and General Systems Theory) in the theoretical foundations of SE
- Understand how SE Principles grounded in Systemology are key to:
  - executing SE's transdisciplinary approach,
  - fulfilling SE's holistic responsibility, and
  - ensuring SE's capability to deliver elegant solutions to complex problems

Thank you!



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Questions?

Backup

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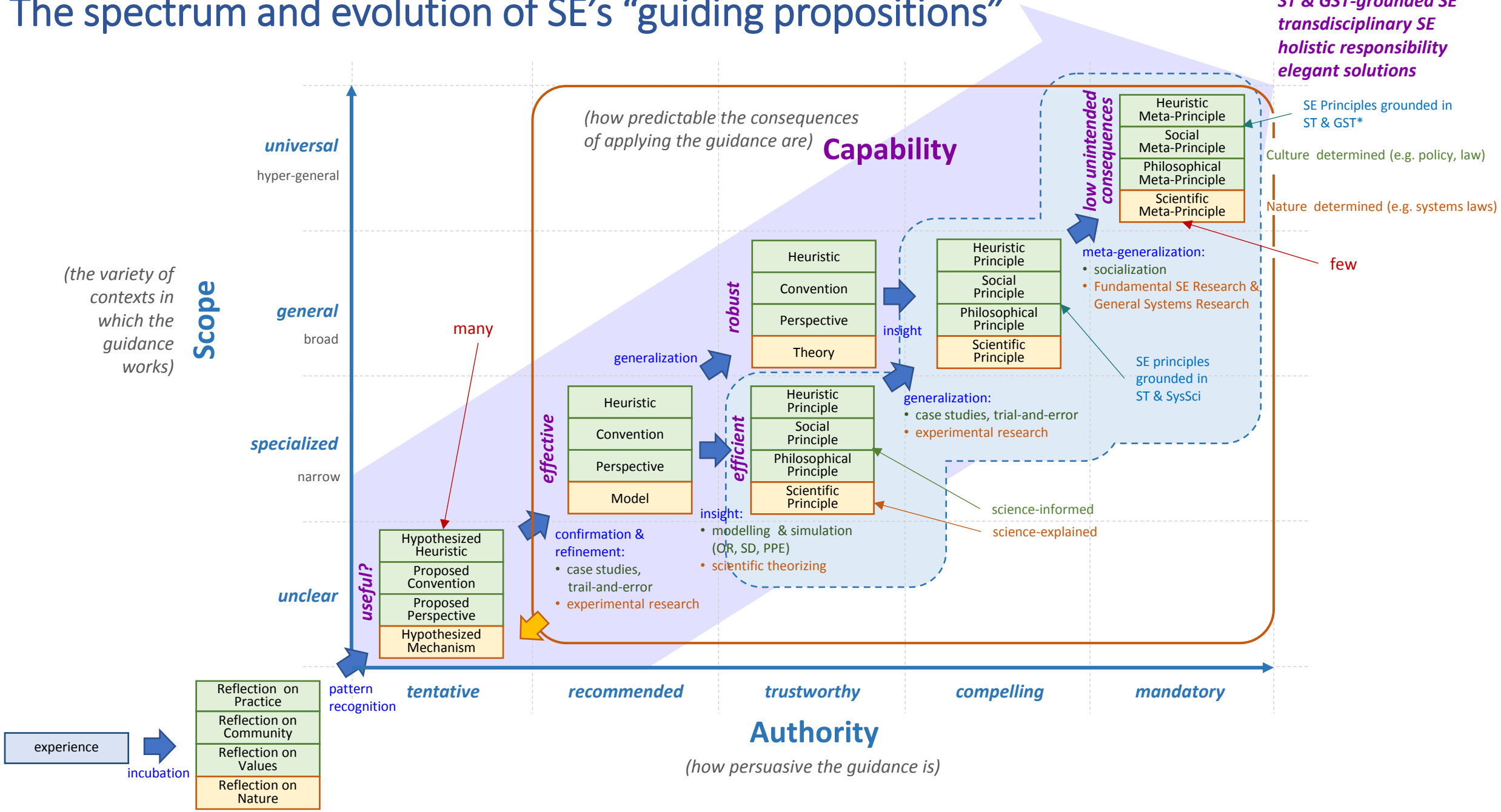


Examples of each type of principles

SE's Technique Principles	SE's Systems Principles	SE's Motivation Principles

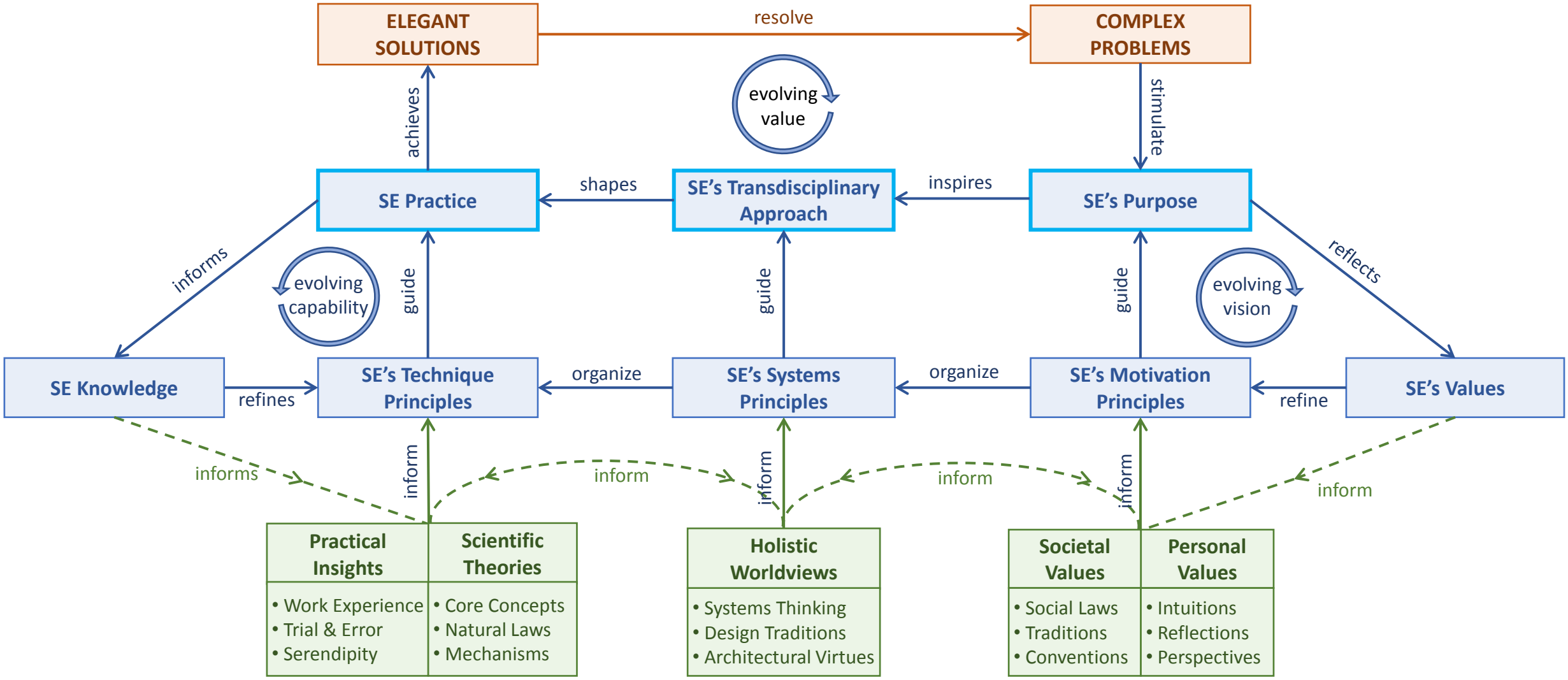
• State the problem in solution-independent terms
• Identify the impact of requirement variations and solution options on performance, cost, schedule and risk
• Identify and manage all the interactions across all the external and internal interfaces
• Design from the top down, test and integrate from the bottom up
	• Recognize that every complex thing is both a system and part of one
	• Recognize that systems principles apply to physical, social and conceptual systems
	• Recognize that our systems and designs evolve
	• Recognize that system patterns are at the root of handling complexity, sustainability and elegance
	• Employ the principles of system thinking, including:
	  • Think why before how
	  • Think outside before inside
	  • Think relationships not just elements
	  • Think loops not lines
	  • Think long term not just initial capability
		• Help build a better world because the present situation is unsustainable
		• Ensure SE rapidly evolves because rising complexity is imperilling the success of our society and our projects
		• Master a systems approach because complexity and sustainability are systems phenomena
		• Create elegant solutions to our complex problems because elegance reduces complexity and supports sustainability

How *we do it*
- *Execute systematically*
- *Leverage methods, tools, processes*

What *we do*
- *Think systemically*
- *Apply systems thinking to engineering*

Why *we do it*
- *Build a better world (sustainable, equitable, …)*
- *Achieve elegant solutions to complex problems*

Our Architectural Framework for the Evolving SE Discipline



***How** we do it*
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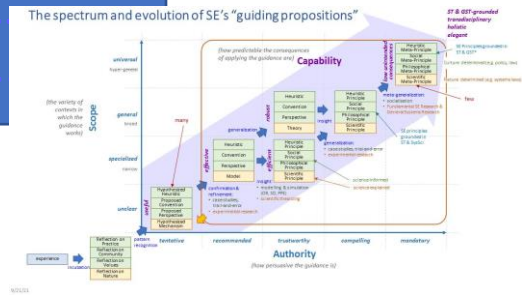
- *Apply systems thinking to engineering*

***Why** we do it*
- *Build a better world (sustainable, equitable, …)*
- *Achieve elegant solutions to complex problems*

The Continuing Evolution of *Transdisciplinary SE*

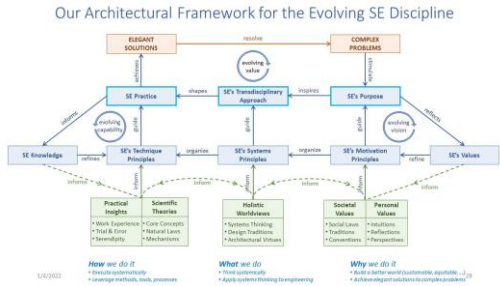
Our grounding DNA

The evolution of SE's guidelines
from Tentative Patterns
to Validated Principles
to Meta-Principles



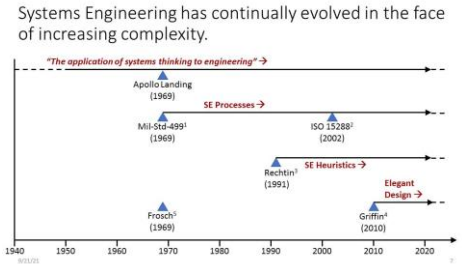
Our sustaining architecture

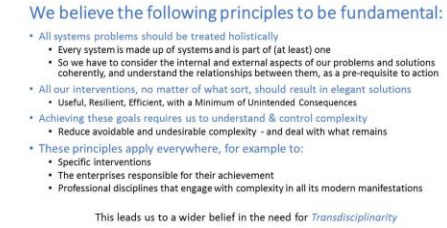
The evolution of SE's focus
from Practice
to
Purpose



Our evolving trajectory

The evolution of SE's role
from Informal Approach
to Process Execution
to Elegant Design



Towards a better world

The evolution of SE's status
from Engineering 'Add-On'
to
Transdisciplinary Necessity