Table 1: Dimensions of Causal Complexity in Models

Mechanism From a same-level generalization to an inferred underlying mechanism	**Interaction Pattern** From A causes B to complex reciprocal relations and constraint systems	**Probability** From deterministic causality to chaotic and quantum systems	**Agency** From a central and direct agent to highly distributed and emergent causality
Surface generalization: Simply describes the regularity under consideration in a generalized way, may refer to enabling conditions (*"When it is hot and it rains, there is lightning"*) Often incorrect or confuses correlation with causation. (*"Heat and rain cause lightning"*) ***Token explanation:*** Some entity or phenomenon, intentional or not, made things come out that way. Entity/phenomenon's behavior parallels outcome, no real differentiation. (*"Static electricity makes it happen."*) ***Function centered explanation:*** Explains in terms of form-fits-function but without any elaborated intentional or blind adaptive mechanism. Often teleological, (Plants grow upwards because they need sun.) May be insightful as far as it goes. (*e.g. archeologists explanations of function of prehistoric tools.*) ***Commonplace elements:*** Constructs explanations with familiar elements of the system in question rather than those underlying it. (C*an be illuminating. Darwin's theory of natural selection explains not at the genetic level but in terms of observable adaptive traits, the everyday notion of inheritance, etc.*) ***Analogical model:*** System explains target phenomenon by analogy and analogical mapping (*e.g. electricity as fluid flow*). ***Underlying mechanism:*** Properties, entities and rules introduced that are not part of the surface situation but account for it *(e.g. Ohm's law; and underneath that electrons and their rules of conduct.*) Note: There are often two or three levels of underlying mechanism, each underlying the previous). Form fits function explanations that include an elaborated causal mechanistic for the adaptive process, intentional or mechanical and thus are not solely function-centered.	***Simple linear causality:*** A impinges on, pushes, influences B. A is seen as not affected. (e.g. A pushes, pulls, initiates, resists, supports, stops B. A s typically seen as active as in pushing but can be passive as in resisting. ***Multiple linear causality:*** Multiple uni-directional causes and/or effects: Multiple immediate causes and/or multiple immediate effects; Domino causalities where effects in turn become causes as in simple causal chains like A causes B causes C or branching patterns; Necessary and sufficient causes, etc. Often includes previously neglected causes of lower saliency in the causal story. ***Mediating cause:*** At least three causes in play, M mediates the effect of A on B but not simply in the sense of A causes M causes B (e.g. M is a barrier to A affecting B, or a catalyst, or an enabling condition). ***Interactive causality:*** Two-Way Causality: Interactive causation with a mutual effect (*as in particle attraction*); Mutual cause with two outcomes (*as in symbiosis*); Relational causality where the outcome is due to the relationship between two variables, (*as in pressure or density differentials*). ***Re-entrant causality:*** Simple causal loops as in escalation and homeostasis. ***Constraint-based causality:*** Behavior of system reflects a set of constraints that the system "obeys"—constancy, conservation, and covariation rules *(e.g. conservation of energy, Ohm's law, law of gravitation).*	***Deterministic systems:*** Certain consequences, in-evitable, and predictable outcomes *(e.g. as in Ohm's law, law of gravitation).* ***Noisy systems:*** Basically deterministic systems perturbed by random or unanalyzed factors *(air friction, turbulence on thrown objects)* ***Chancy systems:*** At certain junctures, things might go one way or another with a certain probability. ***Chaotic systems:*** Fundamental unpredictability in long term due to "butterfly effects" *(e.g. the weather)* ***Order from chaos:*** Averaging effects smooth out chaotic systems into highly orderly large-scale patterns *(e.g. gas laws)*. ***Fundamentally uncertain systems:*** As in quantum theory, uncertainty built into the nature of objects and events, even for very small systems in the very short term.	***Salient central agents:*** One or a very small number of key factors fairly directly and conspicuously yield the result. May be interwoven with intentional causality (see mentions of intention in the mechanism category). ***Non-obvious central agents:*** with a passive role or delayed or spatially remote influence *(e.g. spatially remote as in gravity or electrostatic forces).* ***Additive causes:*** Causes with cumulative effects over time *(e.g. erosion).* ***Long causal chains, branching structures, cycles:*** *(as in ripple effects of an ecological disaster*). ***Causal webs:*** Complex webs of causes and effects, often involving reasoning at the population level *(as in ecologies)*. ***Trigger effects.*** A modest influence "topples" a complex system into a new state or pattern of activity. *(e.g. tipping points in epidemiology).* ***Self-organizing systems.*** Seemingly messy systems evolve into clear patterns over time without an external agent or an internal blueprint. ***Emergent entities and processes:*** Agency is distributed. The actions of many individual agents at a lower level converge to give rise to new, complex patterns that are not easily anticipated based on the lower order actions. (*As with the emergence of new species, chemical compounds, etc.)*

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