INDETERMINACY:
The Mapped, the Navigable, and the Uncharted

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Nebula (Latin for small cloud) denotes a cloud of interstellar gas and dust. In astronomy, it is subcategorized into diffuse-, emission-, reflection-, or dark-nebulae; hazy speech and cloudy ideas can be "nebulous" (German *Nebel* for fog; Greek *Nephélé* for cloud).—*Ed*.

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1 Definitions, Distinctions, and Dilemmas

Jose V. Ciprut

From Roads Pre-Paved, to Paths Not Taken

Determinism is the philosophical conception and claim that every physical event and every instance of human cognition, volition, and action is causally determined by a continual, uninterrupted sequence of prior events. It confines chance, jettisons mystery, limits the inexplicable, and restricts doubt of total randomness. Over time and in principle, determinism has served the philosopher-practitioner well in theory and in practice,[1] at times, in passing, serving to assuage a skeptic king or two, as well.

Formal thinking[2] about certainty/uncertainty gained greater focus in scientific domains with the advent of particle physics and quantum mechanics.[3] The problem of figuring out how to specify (precisely and simultaneously) the exact location of a subatomic particle with a

1. From before Origène's (third-century) views of "ordered liberty" (Benjamins 1994), and including Johannes Kepler's (seventeenth-century) ruminations on a six-cornered snowflake (Goetz 1987), to well beyond W. Rostow's *The Stages of Economic Growth* (1960).

2. For an expert overview by insiders see, for instance, Price and Chissick (1977), perhaps also Pagels (1983), and certainly Maxwell (1998), among many others.

3. Prior to its newfound rigor in the context of its born-again implications in quantum physics, indeterminacy used to be the subject of religious sermons, of spiritual rhetoric (Edwards 1780), and of antipositivist idealist philosophy (Fouillée 1896). Even after its entry in the academic realm and consolidation as a scientific concept (Cassirer 1937), it found ways of inching sideways and back: first, via the complicated space where physics and philosophy always intersect (Frank 1941); then, through renewed if enriched focus on such topics as ethics (Broad 1952), free will and moral responsibility (Dworkin 1970), dilemmas of choice in social interaction (Hardin 2003), and, yes, once again, chance and causation (Dowe and Noordhof 2004)—handy terminological borrowings from fields afar, for example, engineering (Maugh 1964) or geology (Geological Society of America 1963; Geophysics Research Board 1982), and economics, too (Cass 1990; Lee 1986; Siconolfi 1987, Siconolfi and Villanacci 1989; Tallon 1991, . . .), notwithstanding.

definitely measured momentum—for which there has to be a fundamental limit—challenged the time-honored routines of 'scientific method'. To questions of how to measure a particle's energy came to be added some pressing queries such as: how long a particle's measured energy would last; and how this reality could be precisely specified.

Post Hoc, Ergo Propter Hoc?

Concern with the exact predictability of events under guidance from scientific determinism[4] led first to the speculation, then to the realization and acknowledgment of quantum *indeterminacy*. But much of the *Unbestimmtheit*[5] talked about seemed to arise from human inability to predict with precision in space-time, arguably owing to limited powers of observation and discernment, to yet-improvable human thought processes, and even to fallible human memory—altogether giving reason to distinguish between what is physically *indeterminate* out there, and what (maybe) is *indeterminable* by human observation or in human action—over here, on the inside, right now.

The insights, latitudes, and hopes unleashed over the decades by reevaluations of indeterminacy and indeterminabilities have yielded myriad reinterpretations and reassessments of their implications for theoretical and practical knowledge[6] and for a variety of professions in the arts and the sciences, in addition to the more direct expert re-interrogations from inside the discipline of quantum physics itself (Price and Chissick 1977). These writings have spanned a wide range of interests and concerns,[7] and have come to include, among others,

4. Cf. W. E. Johnson (1921–1924) "The Determinate and the Determinable."

5. Born to the name *Unbestimmtheit*, Heisenberg's Uncertainty Principle offers a good example for the notion of "vagueness." As any good German-English dictionary will confide in its reader, the word can come to mean different things to different ends depending on who the bidder is (as Humpty Dumpty might say): from "indefiniteness" and "indeterminableness" (*sic*) to "indeterminateness," "indeterminacy," and "indetermination," but strangely enough and most certainly not . . . "uncertainty."

6. Cf. Gamm (1994), especially "Die Positivierung der Unbestimmten" (212–234), and Gamm (2000), particularly "Die Normative Kraft des Unbestimmten" (207–307), as certainly also "Diskurs und Risiko—Über die Vernunft der Kontexte" (308–326).

7. One of the oldest practical concerns with determinacy/indeterminacy was in the domain of structural steel; nowadays, it resides in the fundamental properties of structured 'systems', where internal/external stability and statical indeterminacy continue to be integral to checks of safety and serviceability. An 'unstable' structure is recognizable when it undergoes large deformations under the slightest load, without the creation of

forms of critical (Daujat 1983), analytical (Arendes 1992), or comparative (Brody 1993) retrospectives of the evolution of physics, viewed from the perspective and inside the general framework of philosophy; closer reexaminations of the implications for ontology, causality, and the mind (Bacon, Campbell, and Reinhardt 1993), for connections among agents, causes, and events (O'Connor 1995), and indeed for intelligibility itself (Martine 1992); deeper concerns for the logic of probabilistic inference and attending methodologies (Earman 1992a, 1992b); reconsiderations of the notion of 'development': societal (Fogel, Lyra, and Valsiner 1997; Norgaard 1994), personal (Elman et al. 1998), and psychological (Hacking 1995); newer ecological concerns with 'the Environment' (May 1974); re-ideations and reconceptualizations of complexity from systemic perspectives (Holland 1995; Jervis 1997), and re-appraisals of risk (Bayerische Rückversicherung 1993; Löfstedt and Frewer 1998; O'Malley 2004; Overholt 1982), not only under uncertainty (Chavas 2004; Jodice 1985) but also in the face of indeterminabilities (Lupton 1999); redefinitions of 'precaution' (Godard 1997), too, not to mention the fallout on other branches of thought and practice—whether in "the uncertain sciences" (Mazlish 1998); on ontological or epistemic concerns with "objectivity" (Bedford and Wang 1975;

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restraining forces, and hence proves unfit for its purpose. Sometimes, the addition of a restraint can create an unknown reaction at one point—create an unknown reaction in some direction, and restore stability to the system. "*It is generally not sufficient to count up unknown reactions and compare them to the number of equations of equilibrium*," however: whereas the addition of extra support might increase the number of unknown reactions, it would not thereby necessarily also create a stable system. For while systems with fewer reactions than equations of equilibrium always are unstable, systems with a number of reactions exceeding or equal to the number of equations of equilibrium are not stable necessarily. A structure, for which the number of equations of equilibrium is exactly equal to the number of unknown reactions, is said to be *statically determinate*, since one can determine all unknown forces in the structure from the laws of statics alone. Structures for which the number of unknown reactions exceeds the number of equations of equilibrium are *statically indeterminate structures*. The *degree of statical indeterminacy* is the difference between the number of unknowns and that of equations. Described in simpler vernacular, the degree of statical indeterminacy is *the number of restraints one would need to add to the structure to make it statically determinate*. Put differently, "*the degree of statical indeterminacy of a given structure is equal to the number of unknown support reactions minus the number of restraints removed by internal hinges, minus the number of equations of equilibrium*." It is possible for a given structure to be—*externally—statically determinate* (i.e., all reactions can be calculated from the equations of equilibrium), *yet—internally—statically indeterminate* (i.e., equilibrium conditions are not sufficient for the calculation of internal forces). See Paul Gavreau's Web site at http://www.ecf.utoronto.ca/apsc/courses/civ214/2003. Note that comparable thinking subsequently affected research on *indeterminacy* and '*sunspot equilibria*' issues in Mathematical Economics, to be referred to later in this book.

Popper 1972) and "subjectivity" (Chauvier 2001; Cohen and Marsh 2002; Dumouchel 1999; Fleming 2004; McAfee 2000; Newirth 2003; Press and Tanur 2001; van Reijen and Weststeijn 2000; Wiehl 2000); human preoccupations with the future (Popper 1982; Popper and Lorenz 1993), and especially applications in law (Eisenberg 1992), literature (Comnes 1994; Empson 1953; Perloff 1999), music (Cage 1967, 1963; Porzio 1995; Savage 1989; Schoffman 1990), and far from last, languaging in conversation (Bogen 1999; Empson 1979) and its critical relations with judgment calls (Elgin 1996; Sloop and McDaniel 1998). One dissertation even reconsidered causality and finality *given* "the problem" of indeterminism (Braumandel 1965), whereas another reexamined the protracted psycho-linguistic impact on interpretive judgment of a particular modality of "indeterminacy": the absence from the outset of any predisposing orientational rules to steer by (Meyer 1998).

Metaphoric transfers in a relentless search for dramatic effects achieved through daring poetic transgressions (Beach 1998; McPherson 1993) aside, demagogical trespassings by some physicists themselves have managed to fuel predispositions to connect quantum indeterminacy with free will (Herbert 1993; and English mathematical physicist Roger Penrose 1989, 1994, 1997) in speculative ways that have not been widely accepted, and were ultimately debunked (Dennett 1984). Would that this very modest selection of items, from an otherwise vast and varied literature, may provide the reader with a sense of the great interest upheld in an array of fields for re-assessing each of the concepts as such, and sometimes even in relation with one another. The old debate finds itself rejuvenated. And the interrogations continue within, and now also between, domains.

From Trails Trodden, to Forks Beckoning

The very convincingly argued existence of quantum indeterminacy, on the other hand, so very much upset Albert Einstein (for whom God would never condescend to roll dice) that he attempted to refute what was being presented as objective fact with a theory of his very own—the Hidden Variable Theory: a claim that quantum mechanics, as known to the world of science and philosophy at the time, was an *incomplete* description of reality, and that quantum probabilities were but merely expressions of the observer's ignorance of the exact state of nature. Einstein's Hidden Variable Theory denied that distant events could exert instantaneous effects on local ones (when a butterfly flaps

its wings here, nothing flutters at the antipode). Imaginations fueled by popularized versions of Chaos Theory notwithstanding, wishful beliefs in the existence of a Local[8] Hidden Variable Theory (synonym for Local Realism) linger to this day, however, albeit for differently motivated reasons.[9]

In this book, the concept of indeterminacy and a few varieties of indeterminability are examined with attention as to distinctions between the two phenomena; as to the more appropriate approaches to be considered in examining both; and as to any differences perceived as being deployed by either, vis-à-vis uncertainty, and vagueness, and ambiguity. Our chapters address systemic issues; they scrutinize the more salient among the corresponding caveats; they reexamine the many probabilistic considerations; the equilibria in question; the likely presence or absence of over- or under-determinations; consistency and reflexivity issues; specific constraints; and effects of noise. We discuss in detail the logic and degrees of vagueness; the influence of uncertainty; the meanings and modes of ambiguity; the importance of context-sensitivity; and, of course, the nature of undecidability and unknowability. We look at ontological and epistemic determinisms and predictabilities; the epistemologically indeterminate; complexity as such; infinitary structures; dynamical systems; ontological modes of (in)determinism; also, at function-related ontological and epistemic dilemmas, and "principled uncertainties"; determinable chaos, with sharp focus on indeterminabilities in deterministic systems; context, ambiguity, perceived determinacy, and determinisms of the imagination; language, memory, identity, and complexity; epistemic and ontological dilemmas when planning the indeterminable; and not less than four kinds of indeterminability, which could well be mistaken for as many classes of indeterminacy. But, then, let our chapters themselves

8. See Einstein's 'principle of locality' (1948).

9. What had catapulted *Deutsche Physik* into such a shrill academic reality as an ethnonationalist movement (not only *against* "Jewish Physics" in a fast-Nazifying Germany, but also *for* . . . an unscientific method to explain science) was not so much Einstein's four-page paper on the Hidden Variable Theory (1935), but far more directly his Special Theory (1905) and General Theory (1916, 1922) of Relativity, which had upset the long-established hierarchical order in the profession. In hindsight, this seems a rather ironic situation in and of itself: metaphorically helping to exemplify the very simple reality that "hidden" variables (such as ethnic hate) and "distant" effects in "far away Lands" (like Chamberlain's Czechoslovakia) do not for long remain unrelated, let alone tolerate mutual exclusivity in the ever more complex and increasingly intricate context of an interdependent world. For more on "Deutsche Physik" (German Physics), see Lenard (1936–1937).

now introduce to our readership their synergetic approaches and linkages:

Indeterminacy, Probability, and Freedom of the Will

Much has been debated over the past millennia on the many-angled complexities of the Judeo-Christian spiritual-philosophical obsession with "free will." Cage's tongue-in-cheek pedestrian humanization[10] of the concept aside, Free Will has remained of serious scholarly focus and interest in modern European and contemporary American thought. Meanwhile it seems to have penetrated Muslim reformist political thinking (Khan 2003) as well.[11] The scope and reach of the term have long outgrown erstwhile classical preoccupations with *fate* (Alexander of Aphrodisias[12]), *grace* and *foreknowledge* (Augustine of Hippo[13]), *Nature* (Leibnitz[14]), *religion within the boundaries of mere reason* (Kant[15]), *Natural Law* (Fichte[16]), *the voluntary* and *the involuntary* (Ricoeur 1966), and *nihilism* (Athearn 1994; Emrich 1981). Today, Free Will impinges on contemporary thinking about *agency* and *answerability* (Watson 2004); *freedom/determinism* (Campbell, O'Rourke, and Shier 2004;

10. "An Eskimo lady who couldn't speak or understand a word of English was once offered free transportation across the United States plus $500 providing she would accompany a corpse that was being sent back to America for burial. She accepted. On her arrival she looked about and noticed that people who went into the railroad station left the city and she never saw them again. Apparently they traveled some place else. She also noticed that before leaving they went to the ticket window, said something to the salesman, and got a ticket. She stood in line, listened carefully to what the person in front of her said to the ticket salesman, repeated what that person said, and then traveled wherever he traveled. In this way she moved about the country from one city to another. After some time, her money was running out and she decided to settle down in the next city she came to, to find employment, and to live there the rest of her life. But when she came to this decision she was in a small town in Wisconsin from which no one that day was traveling. However, in the course of moving about she had picked up a bit of English. So finally she went to the ticket window and said to the man there, 'Where would you go if you were going?' He named a small town in Ohio where she lives to this day" (Cage 1967, 137).
11. The main trends distinguishable among Muslim reformists today comprise the revivalist and the modernist movements. This book examines the main trends of Muslim reformist political thought in Bukhara, utilizing original sources preserved in Soviet archives.
12. See Sharples (1983).
13. See Ogliari (2003) and Matthews (2005).
14. See Rutherford and Cover (2005).
15. See Wood and Di Giovanni (1998).
16. See Merle (2001).

Honderich 2004; Lehrer 1966); e*motional reason* in processes of *deliberation, motivation,* and *the nature of value* (Helm 2001); *initiative* (Machan 2000); *action* (Tomberlin 2000); *biology* (Pollack 2000); *genetics and criminality* (Botkin, McMahon, and Francis 1999); *character* (Jacobs 2001); *deontology* (Darwall 2003); and even *the search for an adequate God* (Cobb and Pinnock 2000), among others.[17]

Rather, in chapter 2, historian-philosopher Paul Guyer takes a closer look at the sometimes intelligible yet sometimes not so evident connections between indeterminacy, probabilistic heuristics, and the everlasting question of human free will: for centuries, many in the West have found the idea of determinism—the very notion that every event is necessitated by antecedent conditions and by the unchanging laws of nature—to be a threat to the possibility of human freedom of choice. In the twentieth century, some thinkers have contended that, by establishing the objective existence of indeterminacy in the physical world, quantum mechanics creates a space for free will that would not exist in a thoroughly deterministic world. This explanatory strategy is open to objections that microscopic, quantum-level, indeterminacies do not so very obviously carry over to macroscopic events like human choices, and that in any case, indeterminacy is not a suitable basis for ascribing to human agents responsibility for their choices, which is what freedom of the will is supposed to justify. In fact, many philosophers opposed the latter objection to the idea of the "liberty of indifference" long before the postulation of indeterminism received scientific support from quantum mechanics. The most recent interpretations of the bearing of quantum mechanics still do not overcome these objections. However, beginning even before the advent of quantum mechanics, modern science did emphasize the probabilistic character of human judgments that follows from incomplete knowledge of the determining conditions of human action—even in a deterministic world—thereby also acknowledging a *subjective* or *epistemic* form, rather than solely an *objective* or *ontological* form, of indeterminacy. This recognition merits to be accommodated in our thinking about freedom and responsibility.

After confronting Libertarian and Compatibilist approaches in historical perspective, and surveying Indeterminacy and Incompleteness in twentieth-century thought, Paul Guyer argues that, in the final analysis, indeterminism provides no basis for human responsibility. A fresh

17. A good entry for the novice would be the enjoyably informative introduction to the notion by Dilman (1999) along both historical and philosophical perspectives.

glance at the impact that the notion of indeterminacy has exercised on modern scientific thought is followed by a look at how incomplete knowledge and self-responsibility relate with one another, before discussing the issues with one's holding others responsible for their choices. A critique ensues of the variety of ways in which the incomplete and therefore probabilistic character of our knowledge of the factors that determine our choices and those of our others do in fact—significantly—affect our lives. Paul Guyer concludes with the recognition that even in a deterministic universe, *probability* remains the guide to human life.

Indeterminacy and Rationality

Almost by definition, social settings are situational-relational contexts of logistic, tactical, and strategic interaction, requiring dynamic, preferably active-adaptive, stances as new needs arise, novel interests emerge, and unforeseeable circumstances acquire life, assume shape, gain weight, and add to the complexity of the human condition. Under such labile existential conditions, it would behoove one to be able to predict, to preempt, or to plot, the more powerfully to pounce, depending on what predeterminably can be known, sensed, or expected, preferably without adding confusion to ambiguity in such self-serving processes. This is where rational thought came to occupy its place of pride. The presumption that rational cogitation is the alpha and omega of choice, decision, and action is an audacious Rationalist principle that goes back to the early Greeks. Considering that we are still at it, and have long ways to go before we "understand" our Selves and our Others in situational and transactional ecologies—that is, in our daily, vitally relevant, systemic contexts—we can for the moment only acquiesce that the more we learn about reality, the more we uncover how appearances cannot be much trusted. Distinguishing the unknown from the unknowable, and discerning that which looks indeterminable at this time from that which remains indeterminate in principle, still presents humanity with sizeable dilemmas in giant puzzlements wrapped in mammoth interrogations: indeterminacy has come a long way since its Anaximandrian origins as an ancient Greek *abstraction for indefinite boundlessness*.[18]

18. *Apeiron* [Απειρον]—neuter of the adjective used substantively with the article—occurs in the first three of the five fragments attributed to Anaximender in Diels-Kranz: specifically, the ones from Simplicius on the *Physica*, from Hippolytus, and from Aristotle's *Physica*. (I thank my colleague Dr. J. Mulhern, specialist in Greek Classics, for the precision.)

Today, it has come to be discerned as an ontological concern with epistemological, empirical, axiological implications, and practical methodological consequences. These need to be reckoned with, in the complex fields of modern thought and action. For these fields, though far apart from one another, remain crucial in their actual and potential promises for the human condition. And this, indeed, is the very reason for our decision to study these phenomena and their inputs and impacts, closely, in cross-disciplinary context, one more time.

Consider contemporary human interest in the theory of games[19]: Where T is time, and C stands for pursuing a cooperative strategy, and D for defecting from such cooperation, in the esoteric erudition of two prisoners whose personal payoff (liberation from one's shackles) depends on their respective (yet interdependent) behaviors: what will B do at T_1 (would it opt for C or D?) if A were to do D or C at time T_0? Sheer math: cold calculation? All business: no sentiments at all? Yes. Based, alas, on the shallow presupposition that my scale of utility and yours are one and the same; that we are coveting the very same cherry pie, that more is never less, that—as has been suggested to be the case with "rational" Nation-States—deference-worthy rational humans, too, have no permanent friends, only permanent interests. That adversary "interests" are measurable on the same standard scale of value preferences, and in units of exactly comparable pay-off,[20] is a curious perspective on equality, appearances to the contrary notwithstanding.

In his chapter, political mathematician and philosopher of ethics Russell Hardin seeks to demystify some expedient tenets of convenience that have long lulled humans into electing to seek on public terraces where there is daylight, what is best found in the intimate darkness of private cellars, wishful expectations that sun rays might enhance the searching—and the finding—aside. Hardin's argument is direct:

In subtle ways that link different perspectives and approaches in historical and philosophical contexts, Hardin demonstrates how and why "few technical problems in rational choice have been hashed out

19. "Rational choice theory is an account of action that explains choice within constraints, namely, those imposed by the choice situation (decision theory) and those imposed by the choices of others (game theory)" (Bohman 1991, 67).

20. There is a flood of literature on rational choice and game theory, the more recent of which show greater consideration for the intangible in the calculable: see, among others, George Tsebelis (1990), Robert H. Bates (1998), and Nicola Giocoli (2003).

and fought over as intensely as the analysis of how to play in an *iterated* prisoner's dilemma. And no problem in all the millennial history of political philosophy has been more central and debated than that of how to justify government and its actions. Both these problems are substantially clarified by assuming that they are indeterminate in important ways so that our theories for handling them must be grounded in indeterminacy. The critical success of some theories historically has probably depended substantially on papering over the indeterminacy that undercuts them, as in the case of Locke's contractarianism; in the more recent variants of arguments, from reasonable agreement and deliberative democracy; and in Rawls's theory of distributive justice. Despite its flaccidity, Locke's contractarianism commonly has been taken to provide a better account of the justification of government than has Hobbes's theory." For Hardin, this judgment is badly wrong: "Hobbes achieves the astonishing success of founding government in an account from self interest, or rather, from its collective implication in mutual advantage. Locke's theory leaves us dependent on a normative commitment—our moral obligation to abide by our supposed contract—that is not credible."

Thus, "if rational choice were determinate, then it would tend to produce equilibrium outcomes. But if rationality is indeterminate, equilibrium may also be indeterminate, as it is if properly conceived, in the iterated prisoner's dilemma." So, "if we do reach equilibrium outcomes, we may generally expect to be stuck with them. But in many contexts, there—in general—will be no reason to expect to reach equilibrium because there will be none."

Interpretation and Indeterminacy

Some have interpreted indeterminacy as 'tragic fate' (Sponberg 2004); some have welcomed it as 'the end of certainty' (Prigogine 1996); while yet others have elected to register a few reservations.[21] Political

21. James Bohman (1991), for one, has argued that the very existence of a "variety of types of interpretation, each with its own governing constraints and norms," each upholding "correctness" as "a regulative ideal," has made "the problem of interpretive validity . . . more difficult" (142–143): "Dreyfus's claim that 'all interpretation is a skill'; Gadamer's, that 'it is a fusion of horizons'; Davidson's, that 'all understanding of the speech of another involves radical translation'"; or Habermas's, that "all interpretation is evaluation," ignore—in Bohman's own interpretation—"the multiplicity of contexts and tasks," since "neither 'social science' nor 'literary criticism' [or any of the myriad

theorist-philosopher Aryeh Botwinick has long wrestled with the intricacies of belief, skepticism, democratic theory, and political participation—each of which intimately connected with humankind's everlasting search for meaning. Yet meaning itself is largely dependent on interpretation, oftentimes under conditions far less determinate or determinable than one might have rather preferred.

One may wonder how *underdetermination* may be of interest in talks about indeterminacy. The connection is a fundamental one: the success of heuristic pursuits—which, using inductive reasoning, proceed from available empirical evidence to the discovery of the best explanatory hypothesis along a process known as *abduction*—pivots on whether rival hypotheses *are* consistent with the available evidence (the proviso of *underdetermination*). The sheer possibility that 'scientific theories' (which, almost by definition, *must* be consistent with the evidence) may be always underdetermined (hence, indefinitely nondetermined) raises questions of indeterminacy versus indeterminability. And their implications and consequences are of great pertinence to our topic.

In his chapter, A. Botwinick provides an intellectual historical pedigree and an analytical mapping of the reflexive dimension of the concept of indeterminacy. His question is whether "indeterminacy" itself is determined, or underdetermined? His approach to finding an answer is to place his focus on one section of the very large topic of the indeterminacy of interpretation, thereby the better to examine the underdetermination of theories by facts, or of words by things. And so he begins with a discussion of some of the arguments made by Emmanuel Levinas, seeking to assess the metaphysical weight of the concept of underdetermination: he asks, "Might underdetermination itself be

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other disciplines] provides a unified enough context to justify generalizing about any definite set of purposes for all interpretations" (143). Bohman's "transcendental argument for strong holism" comprises four premises. The first two [that (1) per the 'hermeneutic circle' thesis, "Interpretation is circular, indeterminate, and perspectival"; and that (2) per the 'background' thesis, "Interpretation occurs only against a 'background,' a network of unspecifiable beliefs and practices"] Bohman is willing to uphold as a more defensible 'weak holism', although the remaining two [that (3) per the thesis of transcendental limits, "The background is a condition for the possibility of interpretation which limits its epistemic possibilities of correctness," and that (4) in terms of interpretive skepticism, "All cognitive activities take place against a background and are interpretive and hence circular, indeterminate, and perspectival (thesis of the universality of interpretation)," and that "*Therefore*, the conditions of interpretation are such that no 'true' or 'correct' interpretations are possible"] Bohman does not see as following from the first two, necessarily. Concludes he: "the inference to interpretive skepticism is unwarranted" (116).

underdetermined? And if so, what consequences follow for the fate of the concept?" He notes how Plato, in his early dialogue, *Cratylus*, prefigures the Levinasian argument concerning underdetermination and its limits. He goes on to show how Michel Foucault and Gilles Deleuze in their analysis of the concept of "difference" intersect directly with Levinas, and indirectly with Plato. Dwelling on some key passages from the works of two leading contemporary analytical philosophers, Thomas Nagel and Hilary Putnam, he also demonstrates how they suggest at least some tacit reliance upon a generalized agnosticism, thereby leaving room for—indeed acknowledging—indeterminacy. He explores if and how Karl Popper's analysis of dialectical modes of argument may have provided a new handle on the question of how to grapple with the logical perplexities surrounding "underdetermination" in a way that engages and calls into question Putnam's refusal to countenance any logical categories beyond those enshrined in the traditional logic. The upshot of this chapter's argument is that focusing on issues of *consistency* or *reflexivity* with regard to "indeterminacy" puts a strain on traditional logic; but that the more expansive logical possibilities that indeterminacy conjures up, themselves cohere very well with the theoretical projects subsumed by the term *indeterminacy* for their great pertinence to this chapter.

Decipherment, Learnability, and Indeterminacy

In addition to Sebastian (2005)—to be mentioned again in another context—relevant here for his interest not only in Musil's *Mann ohne Eigenschaften*,[22] but also in indeterminacy and in the construction of hypothetical narratives—references might include also William Reddy's essay "The logic of action: indeterminacy, emotion, and historical narrative" (Reddy 2001), Meredith Williams's essay "The etiology of the obvious: Wittgenstein and the elimination of indeterminacy" (Williams 2001), and perhaps also Paul Friedrich's earlier work (1986) on "the language parallax"—about linguistic relativism and poetic indeterminacy.

Writing on Pierre Boulez, Peyser[23] (1999) remarked that Boulez's *Third Piano Sonata* arose from his interest in literary Modernism,

22. May be translated as Man Without *Qualities* (but also *Attributes, Features, Traits, Properties, Characteristics:* a good example of 'vagueness' *gained* in translation).
23. See chapter 29.

particularly as represented in the works of S. Mallarmé and J. Joyce: "Mallarmé offered the multiple fascinations with form as aesthetic, with his typographical effects drawing attention to the relationships between the printed words and the page containing them; and later his belief that a [good] book should contain a level of *reader-initiated indeterminacy*"[24] [my italics].

Writing on "The Meaning of the Torah in Jewish Mysticism," G. Scholem reminded us that Kabbalah is Hebrew for 'tradition', that the Kabbalists are mystics "thoroughly steeped in *the* religious *tradition* in which *they* have grown up" [my italics] and that "productive minds among [them] found [their engagement in commentaries on the Books of the Bible] a congenial way of expressing their own ideas, while making them seem to flow from the words of the Bible." Says Scholem, it "is not always easy in a given case to determine whether the Biblical text inspired the exegesis or whether the exegesis was a deliberate device, calculated to bridge the gap between the old and the new vision by reading completely new ideas into the text"—a *writer-initiated mode of indeterminability* of sorts. Then, out of the decency that befits the generosity of the gentleman he was, Scholem hastens to remark that "this perhaps is to take too rationalistic a view of what goes on in the mind of a mystic" (Scholem 1996, 33) as s/he *languages* the *thought*.

Modern linguistics—and much recent work in cognitive science—is based on a code model of mental representations. This model asserts that there is *a language of thought*, which has a specific form; that thought consists of the manipulation of expressions in this language; and that verbal communication involves the translation of thought into expressions in a public language, which are transmitted to an audience that subsequently decodes them back into the language of thought. The chapter by mathematical linguist Robin Clark seeks to undermine this model of verbal communication[25]:

For the model to be viable, language learning must be an instance of code breaking. In this case, the plain text would be the language of

24. As paraphrased at http://www.themodernword.com/joyce/music/boulez.html.

25. Wittgenstein's argument *against* the existence of 'private language' ('*language of thought*') may be pertinently evoked here. I thank my colleague and friend Professor K. Krippendorff for kindly reminding me. Indeed, in what often passes for a refutation of solipsism (belief that all objects and persons other than oneself and one's own experience are *unreal*—and nothing but the object of the Self's own consciousness), Wittgenstein (2001) is often cited for his conclusion that it is *impossible* for the common of mortals—*the isolated individual*—to boast a 'private' language, since s/he is unable to afford or to use adequate criteria for following linguistic rules.

thought, and the code would be the public language. Using standard examples from cryptology and linguistic cryptography, Clark shows that the problem of language learnability is massively *underdetermined* on the code model. The standard solution—to say that the learner already knows the language of thought—is plagued with indeterminacy. How does the learner discover which expression of the language of thought might indeed have been intended when any one of an infinite number of such expressions might do?

The response to this level of indeterminacy is to build a model of language learning that is grounded in the public and social aspects of language. In this view, both thought and language have semantic content because they exist in a community of speakers, and this social network constrains the contents of expressions. The precise nature of the mental representations may be underdetermined and, in fact, wholly indeterminate, but this will not matter since these representations are systematically associated with public signs, *constrained* by the community.

Vagueness, Indeterminacy, and Uncertainty

In *The indeterminacy of Beowulf*, Johann Kèoberl (2002) aptly covers the place of indeterminacy, uncertainty, and ambiguity in Old English poetry and prose. And ambiguity in literature gains pride of place in Treharne's recent translation into English of Dario Gamboni's *Potential Images: Ambiguity and Indeterminacy in Modern Art* (2001).

Rather, philosopher of language Steven Gross's chapter focuses on one particular kind of indeterminacy: *indeterminacy of truth-value*, or the failure of a complete thought to possess any truth-value (in the classical case, to be either true or false). Gross focuses on a particular alleged source of this special kind of indeterminacy: the phenomenon of *vagueness* itself—that is, the failure of a term to possess clear (sharp) boundaries of application (as with 'bald' in relation to intermediate cases of baldness).

Providing a *semantics* and *logic* for vague terms—an account of their meaning-related properties and of the reasoning involving them that is valid—is an important task for theorists of language and of reasoning, but one that proves very difficult. This difficulty Gross explores through a consideration of the ancient Sorites Paradox and the various contemporary responses to it. The notion of indeterminacy used here should not be confused with that of a *non-deterministic scientific theory*:

"a theory is indeterminate if the dynamic laws of the theory, conjoined with a complete description of the state of some system to which the laws apply, do not together entail a complete description of the system's succeeding state." And it is not *obvious* what relation the notion of a truth-value gap has to that of a non-deterministic theory: "there can be determinacy of truth-value even if no one knows what the case is; but, though one cannot know to be the case what is indeterminate in truth-value, one can know that it is indeterminate. And since future-tensed statements about contingent events lack a truth-value, at least until the future time of which they speak comes to pass, indeterminacy (in the sense of there being no "fact of the matter" as to some claim) must be sharply contrasted with *uncertainty*."

In its standard use as a term by philosophers, logicians, and linguists, a predicate is deemed vague if it lacks clear boundaries of application. The phenomenon of *vagueness* is one of the most intriguing supposed sources of indeterminacy: it gives rise to Gross's main focus in this chapter—the Sorites Paradox—which perplexes one as to where and how to set a demarcation line between baldness and non-baldness, between how many grains constitute a heap and how many do not. But vagueness is not limited solely to predicates (verb phrases,[26] such as 'is bald'); it is also a property of linguistic items falling in other syntactic categories [adverbs (how slow is "slowly"), and quantifier phrases (exactly *how many* make "many people")], as it is also a property of particular *non*-linguistic, representational, items (such as concepts). In the view of some, also nonrepresentational items can be vague: for allegedly, vagueness is not (just) a feature of how we *represent* the world in language or in thought—the world itself is vague. Depending on one's views concerning the relation between language and thought, thus, the relation of linguistic and non-linguistic representational vagueness can and will raise distinct issues.

So pervasive is vagueness that it is nigh impossible to provide clear cases of non-vague predicates beyond the realm of mathematics. But vagueness must be distinguished from a variety of other pervasive natural language phenomena with which it is easily confused. S. Gross mentions three: *ambiguity*, *generality*, and *context-sensitivity*. A term is

26. In grammar, as one of the two main constituents of a sentence or clause, an entity named 'predicate' modifies the subject and includes the verb as well as the objects or phrases governed by the verb: for example, '*makes me think*' in "It makes me think." In logic, a predicate is the part of a proposition that is affirmed or denied about the subject: for example, in the proposition "It exists," '*exists*' is the 'predicate'.

ambiguous if it offers latitude for more than one standing meaning; but *general* (relative to some other terms) if there are various more specific ways of possessing the property the term expresses; and *context-sensitive* if its contribution to what a speaker asserts can vary across occasions of use without any change in the term's standing meaning in the language.

Could there be a term that was vague yet not context-sensitive? Is what can be termed unambiguous always-already sharp (not vague) as well? It is natural to want to distinguish vagueness in the relevant sense, not only from ambiguity, generality, and context-sensitivity, but from *undecidability*—from 'in-principle unknowability'—as well.

And what about *degree vagueness* (vagueness in the sense discussed) and *combinatorial vagueness*, a.k.a. *conflict vagueness* (resulting when a predicate possesses multiple criteria of application that can come into conflict in certain cases)?

Asking after *the logic of vagueness*, on the other hand, amounts to addressing one aspect of how one *ought to* reason—hence tantamount to asking a normative question. Normative questions, however, must be distinguished from *descriptive* (non-normative) questions that one may very well raise about vagueness. And for the theorist, the *psychology* of vagueness raises a host of (this far, only suboptimally explored) issues. When one tries to address these, one can be easily blamed for conflating the normative and the non-normative. So, after exploring a number of paths attempted toward resolving the Sorites Paradox (many-valued, supervaluationist, and epistemicist approaches in particular), Gross concludes that all in all, whether vagueness is best understood as a source of indeterminacy still very much remains an open question.

Chaos, Complexity, and Indeterminism

There is a plethora of output on each of these separate topics.[27] But in chapter 7, two philosophers of science, Vadim Batitsky and

27. For Chaos, a fast visit to http://order.ph.utexas.edu/chaos/ will combine physics and philosophy as offered by Dr. M. A. Trump (Version 2, August 14, 1998) of the Ilya Prigogine Center for Studies in Statistical Mechanics and Complex Systems, at the University of Texas at Austin. For Complexity, a good introduction would be Mainzer's *Thinking in Complexity* (1996). And for Indeterminism, see Levi (1904) for an early account of its perceived ideation in French thought; Cassirer (1937) for a classic early view of the concept's role in physics, in terms of causality; and Belbruno, Folta, and Gurfil (2004) for a modern account of chaotic behavior in complex systems, on nonlinear dynamics in relativistic rocket mechanics, and on propulsion and celestial mechanics.

Zoltan Domotor, examine what links determinism with the predictability of *natural* systems. Using their framework of dynamical systems theory as meta-theoretical perspective, they motivate a characterization of determinism essentially as an *ontological* feature of natural systems—specifically, as *ontological* determinism—reflected by some geometric properties of state-space trajectories representing a *system*'s time-dependent behavior. They motivate a characterization of predictability as well, essentially as an *epistemological* feature of natural systems (as epistemic determinism), arising when the equations that specify trajectories in the system's state-space allow for *computing* points on these trajectories, within some meaningful margin of error, in a way that would satisfy certain epistemological (but still significantly idealized) constraints on the amount of computational resources (e.g., memory space) used by such computations.[28]

With precise characterizations of ontological determinism now achieved, and predictability at hand, the authors proceed to discuss certain descriptively simple nonlinear dynamical systems more commonly referred to as *chaotic* systems. Although entirely deterministic, the behaviors of these systems are represented by state-space trajectories of such geometric *complexity* that these trajectories in principle cannot be accurately computed over sufficiently long time intervals

28. Note that the language here is understandably cautious. A constructivist's major reservations here might have been: "These constraints are machine constraints, not epistemological. Epistemology provides accounts of how one comes to know, not of how one comes to know *what*." To which Batitsky and Domotor's réplique would have been that constructivists prefer to address the limits of knowing from a broad empiricist perspective, targeting also the classes of social and cultural systems for which no state-spaces and dynamical laws are presumed to be available. In the tradition of Laplace, Newton, and Poincaré, and from a realist angle, Batitsky and Domotor, in chapter 7, address a special form of indeterminacy, arising within the context of obstructions to predictability, and encountered in chaotic dynamical systems: they focus on a class of deterministic natural systems narrowed down for tractability—that is, specified by equations of motion, with special regard to chaotic behavior. In this specialized context, Batitsky and Domotor's focus here is on the explicit computational obstructions to the predictability of future states, which remain empirically meaningful even in the total absence of traditional philosophical commitments to the nature of knowledge. Because assumptions and starting points are different, one cannot speak of inconsistency or a clash of views even between chapter 14 by Krippendorff and chapter 7 by Batitsky and Domotor: their seeming differences in philosophical perspectives are quite understandable since the classes of systems targeted are quite different. Krippendorff's four perspectives in fact touch upon the one by Batitsky and Domotor, which—in its specific focus on the limits of predictability of chaotic dynamical systems—elects not to dwell on the broader details of the underlying metaphysical and epistemological issues involved.

with less than literally infinite computational resources. And thus, deterministic chaotic systems offer a mathematically precise example of divergence between determinism and predictability. Note that, while known to be ontologically deterministic, they also are 'epistemically' (epistemologically) indeterministic.

The authors conclude by considering the extent to which chaos as a *mathematical phenomenon in a model* can be attributed to the actual natural system being modeled. They suggest that it is always best to treat such attributions at least to some extent as provisional, owing to the highly abstract infinitary *structure* of chaos-theoretic models.

Structure, and Indeterminacy, in Dynamical Systems

For decades, an array of approaches, based on diverse interests and pursuits, have sought to elucidate the relations of structure with indeterminacy. Attempts have included the fields of engineering (Goze 1996; Grinter 1949; Hiroi 1905)—both theory-related (Charlton 1973) and practice-oriented (Mikuriya 1960; Sanks 1961; White, Gergely, and Sexsmith 1972)—as well as the literary (Sebastian 2005), musical (Savage 1989), and philosophical (Poulet 1985) domains, among many others,[29] including the fine art of 'concept, color and collage'[30] and related indeterminabilities.

In this chapter, philosopher of systems science Zoltan Domotor takes up the problem of ontological determinism versus indeterminism within the context of *dynamical systems*. He argues that deterministic reasoning should not be given up easily, even if it means

29. For political systems see Jervis (1997): "The Influence of Structure" (197–204) and "Structure Does Not Determine—Room for Judgments" (204–209). For chaotic behavior in Hamiltonian systems see Zaslavsky (2005), among others.

30. The obituary (in the University of Pennsylvania *Almanac* of May 24, 2005) of my admired friend and dear late colleague, Robert Slutzky, Professor of Fine Arts, and former Chair of his department at Penn (who had committed to writing a chapter for this book, under the title I had entrusted him: "Blank Canvas, Empty Site," two weeks before being diagnosed with a debilitating terminal disease), cites from John Hejduk's entry in the catalogue published for a major retrospective exposition in San Francisco of Robert Slutzky's works: "Through [then] 33 years of painting [and teaching 'color and collage'–JVC], Slutzky has been obsessed with structure: geometric structure . . . color structure . . . space structure . . . number structure . . . measurement structure . . . music structure . . . thought structure . . . and the structure of spirit." He had coauthored, with Colin Rowe, an architectural theorist, a pair of influential essays linking architecture and modern art in a pamphlet pertinent to 'structure & indeterminability', titled "Transparency: Literal and Phenomenal."

switching to more complex levels of description. Specifically, he suggests that in many instances, ground-level indeterminacy in dynamical systems can be circumvented by passing to higher-level deterministic models that may involve sets of states, probability distributions thereon, and so on. Indeed, quite typically, many types of indeterminacy are tractable by passing to suitable deterministic models at a 'higher' level. For example, in the case of a nondeterministic automaton, although the next state is not rigidly determined by its current state and input, there is a unique crisp set of possible next states. Thus, by passing from a lower level of indeterminate states to a higher (mathematical) level of sets of states, the nondeterministic automaton can be now perceived as behaving deterministically from that newly gained higher-level perspective. Likewise, a dynamical system operating in a chaotic regime may lead to apparent randomness, hence to indeterminacy that is tractable deterministically—by considering state transitions of probability distributions. Of course, this kind of conceptualization of indeterminism calls for a state-space enlargement of the original underlying state-space and for a corresponding lifting of the given transition map to the enlarged space of probability distributions.

To make these points formally sound, Domotor invokes and indeed elaborates a pertinent mathematical framework for associating higher-level—for example, probabilistic and multivalued—dynamical models with lower-level models that exhibit indeterminacy. These models are treated with special regard to their dynamical and systems-theoretic structure. The essay concludes with various illustratively supportive examples of indeterminacy and of its higher-level modeling.

Function and Indeterminacy: Brain and Behavior

In this chapter, a team of three specialists—a psychologist, a brain expert, and a physician/clinical psychiatrist: R. C. Gur, D. Contreras, and R. E. Gur—closely examines indeterminateness in (functional imaging) methods for establishing neural substrates of behavior. The structure and action of single neurons have been known for several decades now, and the transition from a passive to an active state—the generation of action potentials—has been detectable as a discrete event. However, neural regulation of behavior is achieved through structure and function of neuronal aggregates, and here is where current research

efforts[31] are being invested, with the hope of possibly understanding the mechanisms through which brain processes give rise to perceptions, cognition, emotion, and action in humans. Until the advent of neuroimaging, progress in the understanding of neural substrates of human behavior was painstakingly slow, relying mostly on extrapolations from animal and human lesion studies. However, the last nineteen years have witnessed a revolution in the technology for in vivo studies of the human brain, by adopting methods for structural and functional imaging to that end. And, with continuously improving spatial and temporal resolution, increasingly sophisticated behavioral procedures have been applied in an attempt to achieve the 'brain-mapping of behavior' in animals and humans. Now, neural systems are being identified that become active *during* specific aspects of information processing and behavioral regulation. The promise of such methods seems unlimited, and perhaps it is too early to search for limits to knowledge or principled indeterminacy in this new and vibrant field. Although some limitations seem quite insurmountable for the moment, solutions could be forthcoming. For example, increased neuronal activity linked to excitation is difficult to distinguish from one related to inhibition; and spatial resolution of the methods is much too low to allow examination of local neuronal processing. Also, errors are inherent in warping individual brain anatomy into group-averaged activity, particularly in the cortex; and time resolution for three-dimensional methods is still well below what is necessary for tracing rapidly occurring events or the early stages of information processing. In their chapter, the team submits that one principled element of puzzlement-cum-indeterminability relates to the lack of a "baseline" brain-state: for, in contrast to individual neurons—each featuring clear anatomic definitions and discrete activation and refractory states—brain aggregates may show ambiguously defined boundaries, and no determinable resting state. Functional imaging methods rely on 'subtraction' of activated states from the so-called 'control' states. However, there are no 'natural' control states of the brain: states evaluated in research paradigms are necessarily artificial and inherently variable. Some efforts to deal with this practical issue have led to conflicting understandings,

31. Though much of the research in the field seems penned by—literally—platoons of coauthors, via single articles in specialized professional journals, useful single volumes have also burgeoned: Bernstein, King, and Zhou (2004), Lawrie, Weinberger, and Johnstone (2004), and Schulman and Rothman (2004), among a few recent others.

interpretations, and arguments. Two aspects to the *dilemmas* being faced are examined here: one, ontological; the other, epistemic. Ontological, in the sense that the structure of the brain dictates indeterministic states: independently of any observation, the lack of resolution is endemic and points to *principled uncertainties*. Epistemic, in that indeterminabilities seem to result from sheer inability to secure exact knowledge about the baseline brain-states. Whereas not much can be done about the first source, it is time for the field to reconceptualize the extant means of addressing the second (epistemic) source for puzzlements, using a range of by now standardized conditions. Although baseline state-space models equipped with suitable similarity metrics—in the tradition of numerical taxonomy in phenetics[32]—are not intended to yield a unique resting state, such a method, in the opinion of the team, might well provide a categorization (albeit with overlaps) of such states. And that should prove very useful.

Indeterminacy and Process Unpredictability in Deterministic Systems

In the field of engineering, concern with process predictability stems from two major concerns, among lesser others: the engineer's need for control[33] and the management's demand[34] for productivity. In finance, it is also about operators' risk-taking impulse to profit.[35]

In a synergistic collaborative mode, Haim Bau, an engineer, and Yochanan Shachmurove, an economist, treat issues of indeterminability in otherwise determinably chaotic systems processes. Many phenomena and processes occurring in nature, engineering, and economics—be they pendulum oscillations, chemical and biological reactions, air currents and weather changes, or ocean streams, spreads of infectious diseases, physiological rhythms, population dynamics, stock and financial market movements—exhibit complex, randomlike fluctuations. With the advent of powerful computers, efforts have been made to model such systems.[36] An intriguing and fundamental

32. The phenetic system of taxonomic classification involves categorizations of organisms based on overall or observable similarities rather than on phylogenetic or evolutionary relationships.
33. See Chen (2000), for instance.
34. See Blandy et al. (1985), among others.
35. Consult Groenewold (2004), for example. Cf. political economist Adam Smith's choice of title for his world-famous œuvre, *The Theory of Moral Sentiments* (1817).
36. So-called 'Neural Network Simulations', (NNSs), among them.

question is whether these systems are stochastic or deterministic, and—if they are deterministic—whether one can use this fact to one's advantage. This very question and its potential implications are transparently addressed in this chapter.

A stochastic process yields different outcomes when repeated. In contrast, a deterministic process, when repeated in exactly the same way, yields exactly the same outcome. When a deterministic model is available, one might be tempted to presume that it is indeed possible to forecast that system's future behavior. However, many deterministic systems exhibit irregular, randomlike behavior. These systems are referred to as *chaotic*, and they are highly sensitive to both small changes in initial conditions and subsequent perturbations called "noise": two seemingly identical systems starting with only slightly different initial conditions may follow vastly different trajectories. Since in the real world, frequently, a system's initial conditions are not known precisely, it is difficult if not impossible to make longer-term predictions about that system's behavior. This impossibility of long-term predictions is a fundamental property of chaotic systems. However, short-term predictions with error estimates still can be made for chaotic systems. And, what is more, many deterministic systems can be controlled in ways sufficient to suppress their chaotic behavior—even to cause them to follow desired trajectories. Similar techniques can be used to induce chaos—even to mix in nonchaotic, deterministic systems. Bau and Shachmurove take a synergistic joint look at process determinability and related modes and issues of indeterminacy in this chapter, which connects with, and complements, Domotor and Batitsky's.

Context, Indeterminacy, and Choice: Perceived Determinism in Music

I enjoyed spending hours with composer Jay Reise, debating, refining, and critically discussing the tenets and variables in the earlier drafts of his theory-in-the-making, until both of us were satisfied to have attained conceptual consistency in the ensuing original tenor of this chapter.

It would seem[37] that "indeterminacy" has discipline-specific impacts, meanings, and implications, therefore also commanding remarkably

37. I have already cited, and even quoted from, major sources of relevance—Cage, Boulez, Schoffman, and Savage—and offer full references in the bibliographic list at the end of this chapter, to encourage further reading. Needless to say, numerous other excellent works exist—H.-C. Müller's (1994) among them.

different perspectives and approaches in the arts than it does in physics. This seems to be the case, especially in the evanescent sounds of music. For composer Jay Reise, Keats's suggestion that "beauty is in the eye of the beholder" may serve as a motto for the poet's inability to fix beauty; yet it also could describe the frustrating sense of being unable to draw "scientific" conclusions about art. Bringing his thought a step further, J. Reise would not be surprised if Keats, implicitly, might have been suggesting that indeterminacy is, indeed, "fundamental to the success" of the arts.[38]

The Japanese film *Rashomon* encapsulated the fact that while we all may think we sensed the *same* physical situation—we end up describing our very own (usually unique) different experiences. What Reise now raises to the artist's mind's eye is the question: "*Did* we all in fact 'hear' the *same* things?" And in this chapter he examines also other questions related to that asking-about: this time from the exigent, if bemused, and intensely self-interrogating *ear* of the audience member—the attentive, presumably discerning, and therefore "educated" listener.

What is important in music—especially tonal music—is that as humans listen, they seem to operate under the illusion that the world in the music is determined. Reise views this to be a '*determinism of the imagination*': our unconscious perception of "bottom-up" causality makes us think that the world of the composition is determined. Yet when our immediate expectations are not fulfilled, and rather, new and different courses are proposed, our bottom-up senses adjust to a "newer" perceived determinism. Thus we, the audience, are continually deluded into imagining that determinism—within the music—actually exists.

Reise uses the term 'perceived determinacy' to describe the experience of the seemingly inevitable moment-by-moment progress sensed as a piece of music unfolds. Humans have been aware for at least 2,500 years that they live in a sea of constant change and unpredictability. J. Reise's chapter offers a brief description of what, as a composer—but also as a performer and a listener—he views to be some of the central issues that lead to human perceptions of determinacy and indeterminacy in music. These issues involve, among others, the play and interplay of musical ambiguity, seeming predictability, partial

38. Cf. the appreciation by Cage (1963, 98) of a suggestion made by R. H. Blyth in his book, *Haiku* (1949–1952), to the effect that "[t]he highest re-sponsibility of the artist is to hide beauty."

foreseeability, shifting expectations, and at least some of the time even misguided anticipations.

Reise shows how the composer, as maker of choices in the composition of a work, is the first listener. More surprising perhaps is the role of the listeners who, as made explicit in Reise's chapter, compose their own version of the piece even as they are listening to the performer, who is loyally communicating the composer's work. And as to the performer . . . well, the reader will find out that things are not always crystalline for the performer either: competing with two other kinds of listeners for the exact sound at a precise moment in less than evident ways is never an easy performance, to say the least. In Reise's realm of indeterminacy, it takes more than two to tango.

Making Sense of Pasts Imperfect

As a nonhistorian with an ongoing genuine interest in history—a taste acquired early in life—I recall being once or twice chastised in my high school years for asking questions deemed provocative enough to warrant retribution in lieu of a reply that, if truthfully worded, might have raised doubts in impressionable minds as to the veracity of what we were being fed from officially sanctioned textbooks for fully compliant ingestion as-is: If Ottoman-Russian, or Ottoman-European, or even Ottoman-West Asian relations had been irreproachable on any side, why did Treaties penned by victors have "You shall no more" clauses?

Almost 60 years later, the year 2005 promised to be at least as incisive: books newly in circulation in the West now seemed to question the *historic truths* in tradition-building works (Clark 2005), under declaratory narratives (Wolff 2005), behind interpretations (Sewell 2005), or below historical criticism of ideology and culture, from novel comparative perspectives (Schmidt-Glintzer et al. 2005), as also from self-interrogations and reexaminations of current crises and future directions (Wilson 2005), or out of concern for the death of the past (Plumb 2004), the ethics of history (Carr, Flynn, and Makkreel 2004) when not out of a need to rethink history (Munslow and Rosenstone 2004): as I once remarked to one of my authors, who so took to the thought as to reproduce it with my blessing,[39] apparently "the future of history is not past." And in that future, many more indeterminables

39. See F. Hilary Conroy (2000).

promise to be feverishly at play,[40] whether determinist-reductionist 'realists' like it or not.

History and Indeterminacy

History is indeterminate, yet the legitimating gesture of history as a discipline has rested on the claim that historians can *objectify knowledge* about the past. That claim in turn has entailed assumptions that historical development is governed by some sort of law or, at a minimum, by causal relations that are both discoverable and knowable. For reasons that stem from the professional institutionalization of history, as well as from deeply rooted Western assumptions about meaning and knowledge, historians and philosophers of history have been loath to acknowledge historical indeterminacy. In the twentieth century, the dominant paradigm of professional historical study has been challenged by a number of attacks on determinist and objectivist epistemology, climaxing in postmodernist critique.

Postmodernism radicalized early twentieth-century skepticism about historical knowledge—by extending indeterminacy from the object of history to the subject of historical knowledge, that is to say, to the inquirer herself.[41] Historian Warren Breckman's chapter explores the various ways in which postmodernism's by now heightened awareness of the complexities of *language* and textuality, the vagaries of *memory*, and the contingency of *identity* may lead us to a deeper appreciation of the indeterminacy of the past vis-à-vis our present descriptions of the past. Breckman looks at the wide-ranging reassessment of practices of historical writing compelled by the postmodern 'linguistic turn' and particularly by the exploration of the literariness of historical narrative. He assesses the extent to which narrative form affords a contingent relationship to the 'events' of history. The chapter also underscores its close positive assessment of the effects of the utter collapse of determinist models by concluding with a discussion of the philosopher Cornelius Castoriadis's relevant thoughts on these issues, a thinker whose exploration of the social-historical world shows that indeterminacy is crucial to our potential, both as autonomous mortals and creative human beings.

40. On the semantics of historical time see Koselleck (2004).

41. See also Hacking's "An Indeterminacy in the Past" (1995, 234–257), especially regarding the effects of memory on "one action, under several descriptions" (235).

Giving Sense to Futures Conditional

For long, planning consisted in (re-)orderings to pre-*scribed* ends. It became inputs to predictable outcomes, before successively turning from an expert single-tracked pursuit to a multitask mission, from a static bureaucratic multitiered enterprise into a very dynamic multi-dimensional array of horizontal sub-networks of hubs and spokes continually self-transforming as they concomitantly transform their environments which they readopt and to which they constantly readapt.

The sheer scope and heterogeneity of the modern planning enterprise—whether rural, urban, regional, national, inter-/trans-national, or indeed, global—is likely to remain a haven for myriad ambiguities, uncertainties, and indeterminabilities, due to the increasing number of actors, inputs, and interactions conducive to both decentralized and staggered outputs. Also, the determinability of ultimate results will continue to depend on whether the venue is an authoritarian city-state like Singapore (Dale 1999; Wong and Adriel 2004); a late-modernizing, asymmetric, and heterogeneous aggregate like Mainland China (Ma and Wu 2005); the born-again Baltic rural areas in Estonia, Latvia, and Lithuania vying for quick urbanization, rapid industrialization, and swift Europeanization (Alanen 2004); or a new-old "open" city like Philadelphia undergoing conversions of all kinds (Atkin 1997). Furthermore, in each particular situation, the manner and extent to which *stakeholders* will be willing and able to exercise, in concerted purposeful cooperation, "the power of planning" (Oren et al. 2001) over spaces needing redesign and redirection will significantly help to reduce vagueness, alleviate uncertainty, and abate indeterminability, the more manageably to be able to circumvent and circumscribe instances of indeterminacy, while possibly also optimally banalizing its effects.

Adaptive Planning in Dynamic Societies

Over the last 200 years, the practice of planning in general, and that of urban planning in particular, has evolved. Both used to be the art and science of future-building based on presents taken for granted and pasts seldom understood. Having become a complex cross-disciplinary horizon-scanning profession, the field nonetheless all too often still breeds on types of expertise reliant on quasi-deterministic mindsets fond of linear approaches dedicated to dissolving the indeterminable,

eschewing the ambivalent, and bypassing the uncertain. Endeavors to foretell the shape of things to come do not now preponderantly rely on discrete component-level predictions: they have come to depend on the predisposition of human societies systemically to foster the birth of desirable novelties, and to block the materialization of undesired results—negative externalities of infelicitous outputs, for example—often by recurring to *modeling*. In sum, planning is now tantamount to a *transformation* of the human condition by human design—an audacious enterprise that would resent being caught whistling in the dark, lest its inner doubts and muted apprehensions become publicly too evident, thereby threatening to weaken its traditionally self-assured posture.

By enlarging the circle of their decision makers, and thus also the number of their agents of change ("stakeholders") incessantly at interplay, planners have been successful in unloading some of their basic responsibilities onto the shoulders of partners-in-coalition and of momentary shareholder associations. They thus have concomitantly if unwittingly also multiplied the likelihood for indeterminabilities to become manifest in the planning processes. This might be one reason planners have learned so well to wield ambiguity and to dose vagueness to budgetary, managerial, socio-ethnic, or political-economic advantage wherever deemed logistically, tactically, or strategically rewarding.

In sum, planning remains a realm in which unknowabilities inside indeterminabilities are packaged in prudently stochastic determinisms. And planners' newer tools, techniques, and methods, designed to outwit inherited linearities, and to downplay, circumvent, or deny introduced nonlinearities, continue to service theories that seek to eliminate doubts encountered in the need to determine the net present value of the unknowable and to grasp the sense of the only partly understood. This verity makes of urban planning an eminently dynamic enterprise on the playground of complexities in which the imaginable collides with the anticipated at the intersection of belief and knowledge, sometimes at embarrassing moments when the absence of perfect knowledge and the unavailability of complete information may exacerbate confusion, if for starters they do not precipitate onerous ideological clashes.

In his chapter, after offering a rationale for planning along an international historical perspective, city and regional planner and transportation expert Anthony Tomazinis goes on to detect the possible hiding

places for indeterminabilities in the many stages and at the various levels of 'ordinary' versus 'good' planning. He next extends his scrutiny to the tools of urban planning, to the greater and faster incorporation of knowledge from other fields of expertise, and to the almost exponential increase in the number of processes, participants, and stakeholders at play. Not least, he shows the impacts on planning of the accumulating varieties of disparate inputs, uncertainties, and indeterminabilities confronted along pseudo-determining processes in quasi-indeterminate contexts.

Comparing the usage of extrapolations, the merits of scenario-building approaches, the virtues of goal-oriented approaches, and the importance of including shareholder preferences as elements integral to interactive planning, Anthony Tomazinis argues that *good* planning is a participatory multitask enterprise. As such, argues he, it is also an exercise in shared learning that gradually can develop the means to address ontological (nature-related), epistemic (knowledge-based), and axiological (value-relevant) categories of indeterminism, uncertainty, and indeterminability, arising—among others—also from system susceptibility to never entirely knowable initial conditions.

Insofar as planning is a political process involving negotiations over narrow self-interests in the name of the broader public good, it risks remaining vulnerable—at least in some determining measure—to processual and contextual indeterminability, uncertainty, or ambiguity.

Four [In]determinabilities—Not One . . .

I reserved communications expert Klaus Krippendorff's trenchant contribution for the last, in the provocative intention of concluding our submission by preempting our ephemeral conclusions with a somewhat prodding question: "So . . . if/where does it all converge?" A kind of closure for the thought circle I began to draw, using a sample of John Cage's insight-arousing classroom experience narrated in his own words on the opening page, in the epigraph to this book: What [if any] is the principle underlying *all* of the 'solutions'?

Krippendorff's discerning—if for some, controversial—chapter is placed in closing, not so much in an intent to jerk the general reader into a climactic surprise, as to incite an inquisitive mind's natural propensity to continue to explore the topic in intellectually even more challenging stances and directions after having thought over our

foundational (will-, reasoning-, language-, thought-based), *systems-pertinent* (structure-, function-, process-, context-, action-specific), and *longitudinal* (past-, present-, future-oriented) examinations of the many-faceted, inexhaustibly rich topic of this cross-disciplinary seminar, summarized in the closely interlinked chapters that follow.

In his chapter, Klaus Krippendorff exposes his thinking from the very start: he takes "determinability"—the ability to decide and to conclude, or to specify with finality—to be a human aptitude distinct from "determinacy," a notion that discounts human involvement, to begin with. The four (in)determinabilities his chapter explores are four different ways in which we humans bodily engage *our worlds*. Hence, they are also correlates of as many different epistemologies, each of which addresses an unalike form of human engagement with *the world*: as *detached observers*, we seek to describe and predict, for example, the behavior of a system external to us, without intervening in what the observed system does. As *designers* (engineers, builders, legislators), we program, build, or reconfigure artifacts, the better to serve myriad specific functions, these often relating to yet other technological artifacts. As *users* of cultural artifacts, we utilize objects of nature or artifacts designed by others, thereby aspiring to expand the horizon of our actions, and to understand our engagement with them, mostly through coordination and communication with fellow human beings toward exploring what it is that these make available to us. And as *constituents* of social systems, we endeavor to preserve the identity of the systems in which we participate, in the expectation that the other constituents will follow suit: we sense that our acts constitute the very phenomena in which we take part, and thus create a reality that is predicated on our bodily participation. These distinct forms of engagement lead to four (in)determinabilities, and not just one type that suits all:

- *Observational (in)determinability*, or the (in)ability to determine the behavior of a system from records of past observations—without intervening in the observed;
- *Synthetic (in)determinability*, or the (in)ability to build, program, or refurbish particular artifacts to specifications—which involves intentional participation;
- *Hermeneutic (in)determinability*, or the (in)ability to interpret, understand, and use cultural artifacts in support of desirable practices of living—in coordination with other members of the community; and,

• *(Dialogically) Constitutive (in)determinability*, or the (in)ability of social actors to (re)constitute, bring forth, and cooperatively maintain their social artifacts and to safeguard from challenges the identity of the social system in which they participate.

Krippendorff critically examines two kinds of systemic structures (one above and one below the limits of observational determinability) and demonstrably argues that observational determinability is limited to observing trivial machines. He calls into question the ability of 'detached observers' to understand much of our artificial world, which is structurally nontrivial.

While nontrivial machines, say, computers, are observationally indeterminable, they nevertheless can be built or programmed; they are hence synthetically determinable by their members. All machines are causal mechanisms, context-insensitive, and specifiable in advance of their realization. By contrast, systems that are history-dependent, context-sensitive, closed and/or self-organizing—humans, for example—cannot be built to script or to specifications; they are synthetically indeterminable. This limits the prospect of using machines, trivial or nontrivial (computers and mathematical systems), as "models" of/for human behavior, or of human involvement in cultural artifacts that are themselves history-dependent and therefore grow/develop on their own terms as they continue interacting with each other. Cultural artifacts—texts, works of art, and personal computers—are produced *inside* a culture; their hermeneutic determinability tends to be restricted to the members of *that* culture. Readers, connoisseurs of art, and computer users attribute meanings to these artifacts and interface with them in accordance with the tenets of their respective community memberships. Hermeneutic indeterminability arises when we humans are confronted with artifacts of alien cultures and fail to find access to the history that defines such artifacts from inside the community that produces them.

Social systems (say, families, economies, money, and languaging) are social artifacts as well—their reality is constituted by what their *participants* do in and with them. They hence are dialogically determinable if their participants can (re)constitute them, for having found out what is expected of them, and for performing the roles vital to their sustenance. Where this is no longer the case, these social artifacts become dialogically indeterminable; they break down, wither, and disappear: institutions can fade away, paradigms can

shift, and marriages out of synch can (or, in Murphyese,[42] *will*) end in divorce.

These four types of *(in)determinability* endorse as many different epistemologies: each, with its own limits, none superior to the other. From Krippendorff's perspective, trying to make sense of the world as a detached observer *creates* the very limits that Domotor and Domotor-Batitsky write about. He contends that these limits are not natural; nor are they physical, but the result of the observer's stance. For Krippendorff, it seems all too evident that one can design machines that are indeterminate in Domotor and Batitsky's sense, just as one can *use* parts of nature without needing to have a clue as to how such could be designed. One can also constitutively participate in social phenomena without being able to use them in the manner one may use a computer. In sum, argues he, the indeterminacy of physical systems is not inherent in the systems themselves, but rather owes itself to the sheer inability of detached observers to establish what the case is. This is a rather specialized and otherwise typically scientific inability. It is of little if any practical significance at all, when one can create, utilize, or actually *live* the phenomenon in question.

And this concludes our introduction. Happy readings; and re-readings!

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42. Murphyese is the falsely fatalist language of a probabilistic 'Law' servicing resigned realists and know-it-all cynics: "if it could happen, it will." In the long run, possibly so; but by then, we all may be dead already—from other causes.

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