FUTURE CONTINGENTS AND THE BATTLE TOMORROW

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Using Aristotle's well-known sea battle as our example, we offer a precise, intelligible analysis of future contingent assertions in the presence of indeterminism. After explaining our view of the problem, we present a picture of indeterminism in the context of a tree of branching histories. There follows a brief description of the semantic bases for our double-time-reference theory of future contingents. We then set out our account. Before concluding, we discuss some ramifications of, and alternatives to, a double-time-reference approach to the problem of future contingents. There are some technical ideas at the foundation of our analysis, ideas of which most philosophers are largely ignorant; on our view, in the absence of mastery of these ideas it is quite impossible to speak responsibly about either indeterminism or free will.

I

The sea battle. When, roughly twenty-five hundred years ago, Aristotle famously wondered about tomorrow's sea battle, he presented us with a splendid problem, a problem neither easily dismissed nor easily solved, one that even now continues to be a valuable source of philosophical insight. In Aristotle's picture, "if one man affirms that an event of a given character will take place and another denies it, it is plain that the statement of one will correspond to reality while the other will not."[1]

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[1] All quotations of Aristotle are from *De Interpretatione*, Part IX, Edgehill, tr. Our concern is not to elucidate Aristotle's ideas; we, instead, are concerned to use this famous example dialectically. For a closer examination of Aristotle and future contingents, see, for example, Arthur Prior, "Three valued logic and future contingents," *Philosophical quarterly*, 3 (1953): 317–326; and Jaako Hintikka, "The

We will not here be concerned with the issues raised by inquiring whether statements correspond to reality.[2] We focus instead on the initial portion of the quotation, interpreting the latter portion to say that two agents have, at a particular time and place, made conflicting assertions about the future, the assertion of each being the denial of the other. Thus understood, the problem arises because, given the truth of the assertion at the time it is asserted, it seems, as Aristotle puts it, that "nothing takes place fortuitously—either in the present or in the future, and there are no real alternatives," because "that of which someone has truly said that it will be cannot fail to take place; and of that which takes place, it was always true to say that it would be." "Yet," Aristotle continues, "this view leads to an impossible conclusion of each being the denial of the other."

On our view, if determinism were everywhere and always true, the difficulty with which we are concerned simply disappears. If it was determined that a certain battle was going to occur on the sea between Aphetae and Artemisium, then the prior claim that it will occur was, and always had been, settled true.[3] If determinism were everywhere and always true, there is no loss in giving up the potentiality of the future. But, as Aristotle has seen, if that which is asserted truly "cannot fail to take place," then "we lose the potentiality in either direction." The potentiality of the future, as we understand it, commits us to a real indeterminism rather than the merely epistemic variety. Real or objective indeterminism tells us of a *future of possibilities*, where each among several incompatible possibilities has the potential to eventuate—though of course only at the expense of canceling the other outcomes that were formerly possible.

In this way, Aristotle put the problem of indeterminism in terms of language directed toward the future. We concur in this strategy. Although often over-

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once and future sea fight: Aristotle's discussion of future contingents in *De Interpretatione* IX", *The philosophical review* 73 (1964): 461–492. Lennart Åqvist plies these same waters with slightly different intent in "Future contingents and determinism in Aristotle's *De Interpretatione* IX: Some logical aspects of the so-called second oldest interpretation", *Logique et Analyse* 181 (2003): 13–48. Where Åqvist is concerned to use the logical machinery offered by branching tree structures to "give analysis-interpretation" of Aristotle's argument, we use Aristotle's argument to show how branching-tree structures can help in the enterprise of understanding of our indeterminist world.

[2] For discussion, and rejection, of the view that true statements correspond to reality see two essays by Wilfrid Sellars: "Time and the world order," in Herbert Feigl and Grover Maxwell, editors, *Minnesota studies in the philosophy of science*, volume III, University of Minnesota Press, Minneapolis (1962): 527–616; and "Truth and correspondence," *The journal of philosophy* 59 (1962): 29–56.

[3] To introduce a theme to which we shall return, we note that "true" often plays its so-called disappearing role, a role that must be distinguished from the role of the phrase, "settled true." The latter non-pretentiously means just "true no matter what the future brings." Our experience is that talk of indeterminism cannot avoid confusion if "settled" is dropped—as, alas, almost always happens.

worrying about language leads philosophers astray, in this case, in order to understand the metaphysics of objective indeterminism, it is essential to be able to answer the following question: What features must a language have to be adequate for use by speakers inhabiting an indeterministic world? It is for this reason that our essay concentrates on the language of indeterminism. Indeed, we consider the question sufficiently tricky to require deploying some of the techniques of formal metaphysics and formal logic that have been developed only in the last half-century or so.

Here is the linguistic situation: Two agents make contradictory assertions about the future. At the time the assertions are made, the future is not settled. In this case we know that Eurybiades, the Spartan, wanted to retreat in the face of the Persians; while Themistocles, to encourage Eurybiades to engage, threatened to withdraw the Athenian fleet to Sicily. Suppose that on the second of the three days, Themistocles says to Eurybiades,

> (*) There will be a sea battle tomorrow,

while Eurybiades says to Themistocles

> There will not be a sea battle tomorrow.

It is when we concern ourselves with sentences whose truth or falsity depends upon a not yet settled future, a future in which both alternatives are real possibilities based in present fact such that each excludes the other, though neither is yet determined, that the difficulty arises.

II

Ideas of indeterminism. We turn first to a consideration of the very idea of indeterminism.[4] Part of the idea of indeterminism as we conceive it is that at any given moment there are a variety of ways in which the world might proceed. Such possibilities are real, not merely epistemic; they are possibilities in re. The indeterminism of which we speak is not what might be called a second order indeterminism, an indeterminism of our mind or of our language, but indeterminism as a part of the real causal order of our world. Before the event there were various things that might either take place or not take place. These two outcomes, battle or no-battle, are evidently not temporally related, neither in McTaggart's well-known B

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[4] Deeper exploration of the material discussed here is to be found in Nuel Belnap, "Double time references: Speech-act reports as modalities in an indeterminist setting," in Frank Wolter, Heinrich Wansing, Maarten de Rijke, and Michael Zakharyaschev, editors, *Advances in modal logic*, vol. 3 (Singapore: World Scientific Co. Pte. Ltd., 2003): 37–58; and Nuel Belnap, "Branching space-time", *Synthese* 92 (1992): 385–434; and Nuel Belnap and Michael Perloff and Ming Xu, *Facing the future: Agents and choices in our indeterministic world* (Oxford: Oxford University Press, 2001), henceforth FF.

series nor in his A series.[5] The battle, if it occurred, would be subsequent to the Admirals' statements; but as possible outcomes neither one precedes the other, nor are they simultaneous. This is confusing, which is a fine reason for nailing down the concepts needed for an accurate discussion. As affirmed in FF, we require a concept of indeterminism that is local, objective, feature-independent, de re, existential and hard.

A local concept of indeterminism contrasts with a global one. The latter is generally rejected out of hand because the thought that everywhere and everywhen our world is a total mess is not merely at odds with enlightened everyday experience, but may be seriously frightening. Kant apparently thought that one little fracture in what he envisioned as the strictly determined universe would bring in its train a complete and universal psychotic breakdown of Nature, and thereby, transcendentally, of us, depriving us of all rationality.[6] A local indeterminism supplies us with concepts that can be used to describe as indeterministic a certain specified local transition from an earlier locatable event to a later one: The coin is flipped, the coin landed on the table. The putative facts are that the coin landed tails-up, but at the time of the flip, it might well have landed heads-up. To claim that that is a true description is to claim that although many aspects of the transition from flip to landing that may be determined, not all are. It is to claim that the transition is a locatable specimen of indeterminism, a claim not needing reference to world-wide transitions such as sometimes treated by philosophers of science.

Our idea of indeterminism is existential, claiming only that some or other transitions are indeterministic. This claim comes by straightforward existential generalization from examples such as the coin flip-to-landing transition. There is no suspicious hasty generalization in sight. There is no attempt to cast doubt on the importance of deterministic transitions that fall under some law of nature.

In the flipping example, we picked out the initial event of the transition in terms of a coin-flipping, and we pointed to the outcome event by describing it as a coin-landing. These descriptions, however, were irrelevant to indeterminism. For that we only need that given the initial event, however described, there are multiple possible outcome events, however described. In this sense, we are employing a feature-independent or description-independent concept of indeterminism.[7] An

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[5] John McTaggart Ellis McTaggart, "The unreality of time," *Mind* 18 (1908): 457—484.

[6] "The baby [note well], assailed by eyes, ears, nose, skin, and entrails at once, feels it all as one great blooming, buzzing confusion...". William James, *The principles of psychology*, vol. I (Henry Holt, New York, 1890): 488.

[7] The idea that the descriptive content of definite descriptions is sometimes irrelevant to what a speaker says was first made clear, we think, by Russell's colleague, Alfred North Whitehead. In *The concept of nature* (Cambridge: Cambridge University Press, 1920), he offers the following illustration. Two dons are walking through the campus, and one says, "That college building is certainly commodious. The second don replies, "That's not a college building; it's the lion house of the Zoo."

objective concept of indeterminism contrasts with concepts that are explicitly about who thinks about what and whether it is reasonable to do so. An objective concept of indeterminism is not relative to what goes on in anyone's head, nor to laws or theories, nor to the status of a conversation, nor to what anyone cares about. Consider the event that occurred a minute ago two feet to your left, and a second event, that occurred shortly thereafter in the same place. The transition from the former to the latter was indeterministic just in case from the perspective of the first event there were possible outcomes alternative to the second, regardless of the space of reasons, hopes, fears, and other mental or linguistic baggage. In other words, contrary to what empiricists of Hume's stripe seem to believe, the concept is de re. The specified transition, if indeterministic, remains indeterministic no matter how it is described.

Finally, we intend our concept of indeterminism to be hard; that is, a concept for which a rigorous theory is wanted. Wittgenstein's concept of a game is soft; von Neumann's is hard. This last point bears directly on our presentation below. The examples that follow are intended as elucidation of the underlying theoretical structure, not as argumentation in lieu of structure.

III

Branching representation of indeterminism. It is to the presentation of that structure that we now turn. Our representation of indeterminism lies within a framework suggested in passing in an unpublished letter of Saul Kripke to Arthur Prior dated September 3, 1958. The idea was originally published in 1967 by Arthur Prior[8] and further developed in 1970 and 1984 by Richmond Thomason.[9] John MacFarlane, in 2003, explored many of the same issues as our essay,[10] while Robert McArthur in 1974 offered an early attempt to exploit

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The first don makes what he said crystal-clear by responding, "Well, anyhow, it is commodious." Since the work of Keith Donnellan ("Reference and definite descriptions," *The philosophical review* 75 (1966): 281–304) and the entirely different work of David Kaplan ("Demonstratives: an essay on the semantics, logic, metaphysics, and epistemology of demonstratives and other indexicals; and afterthoughts," in Joseph Almog, John Perry, and Howard Wettstein, editors, *Themes from Kaplan* (Oxford: Oxford University Press, 1989): 481–563, 565–614) similar discussions of non-Russellian uses of definite descriptions have blossomed into a large garden, if not an industry.

[8] *Past, present, and future* (Oxford: Oxford University Press, 1967).
[9] "Indeterminist time and truth-value gaps," *Theoria* 36 (1970): 264–281, and "Combinations of tense and modality" in Dov Gabbay, and Franz Guenthner, editors, *Handbook of philosophical logic*, vol. II: *Extensions of classical logic* (Dordrecht: D. Reidel Publishing Company, 1984): 135–165.
[10] "Future contingents and relative truth", *The philosophical quarterly* 53 (2003): 321–336.

Prior's insights.[11] The fundamental idea is to represent the world as momentary events (we call them moments, which are not to be confused with times) ordered in a tree of histories. Forward branching represents the openness of the future. The absence of backward branching represents the settledness of the past. Each history represents a complete temporal evolution of the world. Because the structure is indeterministic, a single moment may well occur in more than one distinct history, as depicted in Figure 1.
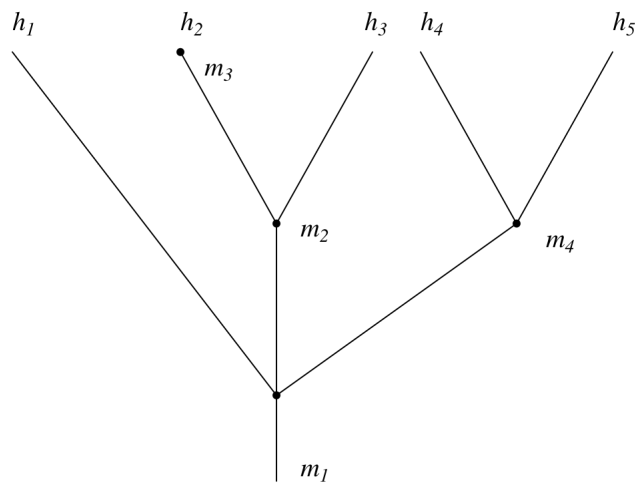

Figure 1: Tree of branching histories

The upward direction in Figure 1 is meant to suggest the forward procession of time. The figure depicts a branching temporal frame with five histories, h_1 through h_5. The moment m_1 occurs in all five histories; m_2 occurs in h_2 and h_3, while m_4 occurs in h_4 and h_5. The moments in this tree of branching histories represent event-stages in alternative possible courses of events. So m_2 is in the future of possibilities of m_1, not simply in its future. A future of possibilities, unlike a future portion of a history, can contain incompatible moments. Moments should be pictured as instantaneous, spatially unlimited, really possible, concrete events. We suppose that each moment stretches across all of space-time. This account is then obviously Newtonian and pre-relativistic.[12] Branching times is, even so, a helpful approximation to the truth. Accordingly, the present account concerns only trees of branching histories.

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[11] "Factuality and modality in the future tense", *Nous* 8 (1974): 283–288.

[12] This representation of indeterminism is usually—and unhappily—called branching times, or even worse, branching time. A more adequate theory, branching space-times, is explored by Belnap in the carelessly named "Branching space-time," and in several later publications by Belnap, Thomas Müller, Tomasz Placek, and others, all of which are listed as references in Tomasz Placek and Nuel Belnap, "Indeterminism is a modal notion: branching spacetimes and Earman's pruning," *Synthese*, forthcoming. That theory takes seriously that physical and human happenings are local events rather than universe-wide events.

The possibilities represented in a tree of branching histories should be thought of as the real possibilities of our (one and only) world. Our world contains real possibilities for what might be and for what might have been. The fundamental idea is that possibility—real possibility, objective possibility—is of this world rather than other-worldly in the Lewis fashion.[13] If there are alternative worlds, they too come with their own real possibilities. Our idea contrasts with views that take possibilities to be what is consistent with the laws of logic, or with the laws of physics, thus giving possibilities a linguistic status. None of this is to object to other ideas of possibility, ones that take possibilities as abstract or as creatures of the mind. We urge only that in fashioning a rigorous theory of indeterminism, it is worthwhile and helpful to construe possible events as both concrete and objective.

IV

Sea battle at Artemisium. With this account of indeterminism as depicting objective possibilities represented in a tree of branching histories, we return to the original problem, namely, conflicting assertions about an undetermined future. Let us, accordingly, recall the famous sea battle at Artemisium, and Themistocles' and Eurybiades' conflicting assertions. We envisage the situation as follows: The Battle of Artemisium took place over a period of three days. On the first day, the Greeks attacked the Persians. On the second day, after receiving reinforcements, the Greeks attacked again. We suppose that the wind shifted on the third day and that the Persians then held the weather gage.[14] It then became a Persian decision whether or not there would be a third engagement. In Figure 2, let m_1 be Noon on the second day, the moment when the assertions are made. Let m_2 be 2:00 pm on the second day, the moment when the Persians decide whether or not to engage on the third day. Let m_3/h_1 be at dusk on the third day, at which moment in that course of events a battle has already occurred. Let m_4/h_2 be at dusk on the third day, at which moment, in an alternative course of events, it has become settled that there has been no battle on that day. Figure 2 gives a picture.
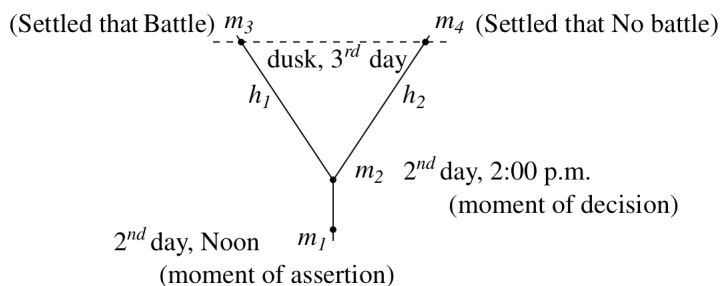
Figure 2: Themistocles and Eurybiades

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[13] David Lewis, *On the plurality of worlds* (New York and Oxford: Basil Blackwell 1986); henceforth, *Plurality*.
[14] For the importance of the weather gage for sailing ships, a constant factor in naval battles from ancient times until the last century, consult Patrick O'Brian, *The reverse of the medal* (New York: W. W. Norton & Co., Inc., 1986), 91–92.

Recall that on the second day of the three-day battle, Themistocles said to Eurybiades

> (*) There will be a sea battle tomorrow,

while Eurybiades said to Themistocles, "There will not be a sea battle tomorrow." We will treat Themistocles' and Eurybiades' assertions as speech acts, considering the way in which speech acts fit into the causal structure of our world. An assertion is a speech act, it is something seen to by an agent and, as such, is a happening.[15] Our intent is to treat assertion as publicly normative. An agent making an assertion, at the least deserves credit when the assertion turns out to be true and discredit when the assertion turns out to be false. So, for example, if it turns out that "There is a sea battle" is true on the third day, Themistocles will be vindicated in his assertion while Eurybiades will be impugned. To deal with assertions such as these in a treelike structure representing possible events as both concrete and objective, we now sketch a portion of the semantics for a language designed to be spoken in an indeterminist world. From Prior, *Time and modality*, credited as being the origination of temporal logic, we adopt the analytically helpful device of treating tenses explicitly as connectives. From Thomason "Indeterminist time," and Thomason "Combinations of tense and modality," and Prior *Past, present, and future* taken jointly, we incorporate the important idea that to make sense of temporal constructions in a branching structure, we must relativize truth to *histories*, that is, to possible courses of events. In the presence of indeterminism, the truth value of a sentence may well depend both on a history of evaluation and on a particular moment of evaluation lying on that history. Since a single event can give rise to alternative historical continuations, histories must overlap, so that a single moment of evaluation will typically belong to many possible histories. This is in stark contrast to Lewis *Pluralities*.

Further, a speech act, just like every other happening, has a definite causal past and a definite future of possibilities. There is nothing abstract or conventional about the moment of the speech act. It is a fact of the matter. Let us, accordingly, place each speech-act event at a moment, the moment of use. We learn from Kaplan "Demonstratives" that the moment of use (of a sentence), an element of the context of use, has the important role of starting the process of semantic evaluation of the assertion by temporarily identifying the moment of evaluation with the moment of use—keeping in mind that the application of tenses is bound to separate the moment of evaluation from the moment of use.[16] For example, to evaluate the prediction (*) "There will be a sea battle tomorrow," the contained sentence, "There

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[15] We idealize by considering the happening as instantaneous so that we can pin it to a moment on a history.

[16] Following Kaplan "Demonstratives," "evaluation" is a technical term that always connotes impersonal and norm-free semantic evaluation. Later we invoke MacFarlane's word, "assessment," as a semi-technical term intended to conjure the picture of an assessor, or at least a possible assessor.

is a sea battle," will have to be evaluated at moments in the future of possibilities of the assertion (*). It is only to begin that process that we must locate the moment of evaluation at the moment of assertion. Similarly, the assertion that there was a sea battle yesterday requires that "There is a sea battle," be evaluated in the past of the assertion, the evaluation again taking its starting point from the moment of assertion. The context of use also has an important role in setting context dependent expressions such as "I," "here," and "now," or demonstratives such as "this." In this essay, however, we are primarily concerned with the role of the context of use in starting the process of evaluation of tenses. For that reason, of aspects of the context, we make explicit only the moment of use, labeled m_c.

We now present some brief explanations of semantic concepts needed to deal with the problem of making assertions about an undetermined future. We suppose a model M to be an appropriate combination of a language-independent structure, S, and an interpretation, I, the model thus representing both our world and the constant features of our language. The truth definition for branching temporal models tells us that atomic sentences are true where the interpretation function, I, says they are. We write

$$M, m_c, m/h \models A$$

for A is true, given model M and moment of use m_c, at moment m on history h. (For a stand-alone sentence, for example, a vehicle of assertion, m must be identical to m_c, diverging, however, for sentences in the scope of a tense connective.) We next consider an idea crucially important for indeterminism, settled truth; that is, truth on every history to which some moment belongs. A is *settled true* at a moment with respect to a model and a context of use ($M, m_c, m/h \models Sett:A$), just in case given the model M and moment of use m_c, the sentence A is true for every history through m; that is, just in case $M, m_c, m/h_1 \models A$ for every history h_1 to which m belongs.[17] The idea is that

> A should be counted as settled true at some moment just when A is true at that moment, regardless what happens in the future.

This is an unpretentious idea not well put in English by "A is historically necessary." After all, "Themistocles is Greek" is settled true, since whenever it is true at a moment, its truth does not depend on what course the future takes, whereas it is at least debatable whether it is historically necessary in any usual sense. Of course, for settled falsity we have: A is "settled false" at a moment with respect to a model M and a moment of use m_c, just in case A is false for every history h_1 through m.

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[17] In formulas, we write *Sett:A* in place of *Settled-true:A*, just for brevity. Other tense logicians use the modal logician's $\Box A$ (for "it is historically necessary that A"); but that suggests some heavy notion of necessity that seems to go beyond the simple idea that the truth of A at a moment does not depend on what happens later.

As branching tree structures allow alternative possible futures, how shall we understand the Priorian future tense, *Will:A*? In Figure 2, there is a sea battle at m_3/h_1, while there is no sea battle at m_4/h_2. What shall we say about the truth value of *Will:A* at m_1? Letting *A* = "There is a sea battle," we can see that *Will:A* is true at m_1 on h_1 but false on m_1 on h_2: The truth-value of future-tensed sentences at a moment depends on what course history takes. In the context of a tree of branching histories,

> a moment alone does not, in general, provide enough information to evaluate a statement about the future.

We need both a moment and a history through that moment. *Will:A* is true at a moment and history with respect to a model and a moment of use (*M, m_c, m/h |- Will:A*), just in case there is a moment m_1 on h later than m at which *A* is true (*M, m_c, m_1/h |- A*).

With respect to the past tense, we have *Was:A* is true at a moment and history with respect to a model and a moment of use (*M, m_c, m/h |- Was:A*) just in case there is a moment m_1 prior to m at which *A* is true (*M, m_c, m_1/h |- A*). The idea is to shift along the present history, *h,* to earlier moments to check for *A* (with respect to *h*). Though the route of backward travel is uniquely determined, it is not trivial that we keep to the same (current) history in evaluating *Was:A*. As Prior explained, *Was:A* does not imply *Sett:Was:A*, although *Was:Sett:A* does indeed imply *Sett:Was:A*. If, for example, Eurybiades asserted on the second day that there was a sea battle the previous day, and there was a sea battle on that day, as indeed there was, the assertion is settled true at the moment of assertion. But, in general the implication does not hold. Suppose Eurybiades asserts on the second day that it was true yesterday that there was going to be a battle on the third day. When, at m_3/h_1 there is a battle on the third day, the assertion (*) is true even though it was not, at the moment of assertion, settled true.[18]

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Double time references. With this much in hand, our account of indeterminism, Themistocles' and Eurybiades' assertions, the Prior-Thomason semantics, and Kaplan's indexical semantics, we proceed to the double time references needed to

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[18] Computer scientists such as E. Allen Emerson in "Temporal and modal logic," in Jan van Leeuwen, editor, *Handbook of theoretical computer science,* vol. B: *Formal models and semantics* (Cambridge, MA: MIT Press, 1990): 996—1072, devise so-called CTL-like languages based on a branching-tree representation of an open future in the sense of a computer program that might proceed this way or that way to a so-called next stage. Their purposes and requirements are, however, so different from ours (CTL-like languages are designed for use by computers in model-checking computer programs) that it is hardly surprising that one wants to avoid confusing the two enterprises.

take account of the fact that a context of utterance is part of many possible histories. That is, in the presence of indeterminism a satisfactory account of assertion will, perforce, involve double time references. One of the two references will be to the moment of assertion while the other reference will be to a later moment of assessment when it is proper to raise the question of vindication.[19] This is made necessary by the fact that, in the presence of indeterministic transitions, there is no sense to the notion of a unique so called actual future course of events.[20] Two accounts present themselves. For both we take $M, m_c, m_1/h$ |- *Will:*sea-battle as our target, assuming for convenience that "sea-battle" is short for "There is a sea battle"; and furthermore we may assume that we are at the beginning of an evaluation, at which point the moment of utterance is always taken as identical to the moment of evaluation, so that $m_1 = m_c$. For the first account, placing ourselves at the later moment m_3, the moment of assessment, we consider Themistocles' future-tensed assertion made at m_1. We can consider at m_3, not the future-tensed declarative (*), but rather the sentential complement, "sea-battle," that is the result of stripping off the future tense of (*). In that case, we can see that for vindication at m_3 what needs to be settled true at m_3, is "sea-battle," the sentential ingredient to which the future tense was applied.

There is, however, a more general and more satisfactory account of vindication, one which makes even better use of double time references within the doctrine of branching histories and its accompanying semantics. This account no longer requires syntactic unpacking of the assertion. We use, instead, the rich semantic content of the assertion (*) at the moment of utterance m_1 (= m_c). Since we are committed to the relativization of future-tensed assertions to moment/history pairs, the question becomes, for which moments and for which histories should we be evaluating Themistocles' assertion?

The answer is that we take the moment as the earlier moment m_1 (= m_c), the moment of assertion, and the histories from among those to which the later moment of assessment, here m_3, belongs. You can concentrate on neither the earlier nor the later moment. You need them both. The assertion uses the pattern of truth values of the assertion at moment-history pairs that feature the single moment, here m_1, which is identified with the moment of use. The asserted sentence contributes its pattern of truth values at points featuring the various pairs consisting of the earlier moment m_1 (fixed as identical to the moment of use, m_c), and each history through m_3. In short, an assertion of (*) at m_1 is vindicated at m_3 if and only if $M, m_c, m_1/h_3$ |- (*) for every history h_3 that passes through m_3.

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[19] The phrase "moment of assessment" comes from MacFarlane, op. cit.
[20] Given indeterminism, the only sound account of "actually" is perspectival, given by whatever is settled true at the moment of speech. If you metaphorically stand outside the tree by abstaining from the use of indexicals, there is no distinction to be had between the actual and the possible. See FF, chapter 8.

Fortunately, this account does not say that Themistocles' assertion (*), "There will be a sea battle," is settled true at a moment later than m_3. (Since m_3 is at dusk on the third day and since the future-tensed (*) points to a moment later than m_3, that would be making a claim about a subsequent day of battle.) Nor does it say that the assertion is settled true at m_1, the moment of utterance; we know that is false. What we want is this:

> At the later moment, m_3, Themistocles' assertion made to Eurybiades at m_1, is vindicated just in case it is settled at m_3 that his assertion, (*) "There will be a sea battle tomorrow," was true—but by no means was it settled true—at m_1.[21]

Since, in the presence of indeterminism, there fails to be a single so-called actual future, we gave ourselves the task of explicating speech acts such as asserting, precisely and intelligibly, within the context of trees of branching histories. In such an account, the truth value of Themistocles' assertion depends both on a moment and a range of histories. We take the moment as the earlier moment, the moment of assertion. We take the histories from those to which the later moment belongs. The speech act thus uses the pattern of truth values at pairs that feature (1) the moment m_1 of use, and (2) histories h_3 taken from the subset of histories of the earlier moment m_1 that also pass through a moment m_3 of assessment. We can forget the grammatical complexities of the assertion and consider only the pattern of truth values on those moment/history pairs. This pattern supplies exactly the right semantic content on which to base our understanding of future contingents in a tree of branching histories.

Given a theoretical commitment to possible worlds in the style of Kripke or Lewis, where there is no overlap between so-called worlds, it would be sensible to use the phrase, "the world of a speech act"; and, as histories resemble worlds, it is easy for one who has made such a commitment to forget that histories are not like possible worlds: In contrast to worlds, histories overlap, so that a single speech act will typically belong to many possible histories. For this reason the context of use determines a range of histories, locating a unique moment but not a unique history. To preserve Aristotle's "real alternatives" and the potentiality in either direction, indeterminism compels the view that an assertion does not determine the future course of history. Themistocles' assertion has choices and chances ahead of it, and so belongs to many histories. If histories can branch in the way we suggest, then a single assertion belongs to many histories, no one of which is specially determined by the moment of use. Accordingly, we have taken the moment as the earlier moment, the moment of assertion and the histories as those to which the later moment, the moment of assessment, belongs.

As we have seen, we follow the Prior-Thomason account in relativizing Themistocles' assertion (*) to a moment and a history, noting that though the moment is supplied by the context of use, the history is not. The appropriate range

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[21] That is, (*) was true at m_1 with respect to all histories passing through m_3, but by no means was (*) true at m_1 with respect to all histories passing through m_1.

of histories is not supplied until the later moment of assessment. We think that is exactly right. In the presence of indeterminism, concerning a future-oriented sentence like Themistocles' assertion, one should not raise the question of its settled truth value until a later moment of assessment, a moment to which we are directed either implicitly or, as in this case, explicitly, at which moment the matter is settled. It is not until that later moment, when it is settled that there is a sea battle, that Themistocles is vindicated and Eurybiades impugned.

Among the advantages to be gained in employing a semantics that treats assertion as publicly normative, calling for vindicating or impugning, we count our ability to understand assertion as one of a variety of speech acts, including asserting, betting, promising, all of which, in the presence of indeterminism, are illuminated by similar considerations. Just as an assertion about an undetermined future is vindicated or impugned at a later moment, when the assertion is settled true or false, a promise to see to something is either kept or not kept only at a later moment, when the matter is settled. In like manner, a wager made about an undetermined future cannot come due for settlement until a later moment. Suppose that on the second day of our story Themistocles and Eurybiades made a bet about the sea battle planned for the day following. Such a wager is not at all the same as betting on already settled matters of fact. If, on the second of the three days, Themistocles offered to bet Eurybiades that there were exactly thirty-four ships involved in the preceding day's battle, such a bet would be, in spite of a superficial similarity, very different from wagering whether there will be a sea battle the following day, when the matter is not yet settled. In the former case, both the outcome of the wager and the item wagered upon are already settled at the moment the bet is made: The number of ships engaged in the previous day's battle is already settled when the bet is made. At the moment that the wager is agreed to, it is already settled who won and who lost the wager.[22]

Things are importantly different when the outcome depends on a not yet settled future course of events. In the case of future contingencies, assessment must be deferred. Neither assessment nor normative consequence is wholly proper until the matter is settled. It is on the day following the making of the bet that Themistocles and Eurybiades will find themselves at a moment lying on a subset of the histories passing through the moment on which the bet was made. At that later moment the matter is settled, something that was not settled at the earlier moment, when the bet was made. In the presence of indeterminism, it cannot be otherwise.

We suggest that a semantic account invoking double time references is applicable, with suitable adjustments, for dealing with the whole range of speech acts whose assessment must wait, in the presence of indeterminism, for an appropriate moment. Betting, promising, and even the speech-act-like case of wondering, which might be thought of as wanting to know about a not yet settled future, all require for satisfactory assessment the earlier moment of the original speech act as well as the

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[22] Of course beliefs and knowledge-states are relevant to the human practice of betting; but we are here discussing only objective metaphysics.

later moment of assessment. On this account, every history through the moment of assertion receives equal treatment. Assertions are vindicated or impugned, promises fulfilled or not, bets resolved one way or the other, and wonderings laid to rest at the later moment, a moment when the matter is settled one way or the other.

Another delicate feature of the double time reference account arises from the fact that the range of histories required to evaluate the settled truth or settled falsity of an assertion is not supplied until the moment of assessment, at which the question of vindication arises. At the moment of assertion, however, the assertion is neither settled true nor settled false. This might appear a problem apparently resting on an easy analogy between sentences that lack a truth value due to a failure to supply an anaphoric or other individual referent, on the one hand, and sentences that are history-open at the moment of utterance, on the other. Open sentences such as "x is green" without a value assigned to x, or "It is green" without an appropriate anaphoric reference for "it," do lack a truth value and, as such, are not appropriate as assertions. It might seem, by analogy, that future pointing sentences that, at the time of assertion, also lack a settled truth value are similarly inappropriate as assertions. The appearance, in this case, is misleading. The crucial difference is that history-open sentences will, in the course of events, have the range of histories supplied. Assignment-open sentences will remain forever truth valueless. It is this feature that makes assignment-open sentences unassertable. Consider the difference between questions that have no answer no matter how things turn out, and questions that have no answer at the moment they are asked. The former are illegitimate, unanswerable, in a way that the latter are not. Were Themistocles to ask Eurybiades whether the King of France is bald, there being at the time neither France nor King, the question is illegitimate, unanswerable. The question whether there will be a sea battle on the following day is, by contrast, not only reasonable but also certain to have an answer.

Or consider a bequest that says, "I leave all my money to x." If no value is assigned to x, the bequest is empty. On the other hand, if the bequest includes a provision that x is to be the first child born the following year, then, though the referent is not settled at the earlier time, it most certainly will be so. Such a bequest, with the value of x to be settled later, is certainly makeable.

In none of these cases is there a defect in the speech act simply because assessment depends upon a settled value being supplied at a later moment. Similarly there is, we claim, no defect in asserting a typical future-tensed statement such as "There will be a sea battle tomorrow," in the context of radical indeterminism, even though the statement will not have a settled truth value until later. Nothing is needed except the patience to wait until a later moment of assessment when the truth or falsity is settled. Nor is there a defect that has to be remedied by saying that history-open sentences have some third truth value, or some other special status. It is, we believe, a mistake to think of history-open sentences as introducing truth-value gaps that sometimes need to be filled by so-called supervaluations. Assignment-open sentences in quantification theory have no truth value, but we do not therefore feel the need to introduce truth-value gaps, supervaluational accounts of truth, or a third

truth value to play a role in our calculations.[23] In the presence of indeterminism we must wait patiently to see what eventuates. In the meantime we can console ourselves with the knowledge that a typical future-tensed assertion has a settled truth value, once a suitable range of histories is supplied. Nor does this approach give up the principle of excluded middle. Having distinguished between truth and settled truth, we can see that at m_1 (and indeed at every moment)

> Either there will be a sea battle tomorrow or there won't be a sea battle tomorrow

is settled true.

VI

Evading double time references. The account so far presented attempts to throw light on Aristotle's problem by utilizing double time references, the relativization of truth to histories, and a distinction between truth and settled truth. Before concluding, we turn to a brief examination of some alternative approaches, approaches that appear both to accept indeterminism while avoiding double time references and the assertion problem.[24] One way of avoiding history-open sentences in the presence of indeterminism, derived from Peirce, asserts that future contingents say what is bound to be the case. Put in our terms, it is the claim that *Will:A* really means *Sett:Will:A*. The trouble with this account is that it makes no sense of an assertion that claims (or promises or bets) that there will be a sea battle even though there might not have been one. Another way to avoid history-open speech acts is actually a variation on what we have called the thin red line. Thin Red Line theories take the view that at any moment one among the possible futures is distinguished as the future that will actually occur. Such a view appears to be consistent with indeterminism claiming, as it does, that although two things might happen, there is one that will. Øhrstrøm and Hasle describe this account as "the Ockham-model [in which] only one possible future is the true one, although we human beings do not know which one of them it is."[25] This approach promotes the idea that from among the possible histories subsequent to a choice point, one history is the actual one, the history that is going to happen, the actual history being supplied at the moment of assertion, though we humans cannot know it until, if we are lucky, a later moment. The thin red line proclaims a distinguished history in a tree-like world. This first version of the thin red line is helpless with predictive speech acts that lie off the thin red line. There is no difficulty with predictions that

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[23] Supervaluationists such as Thomason in "Indeterminist time" and "Combinations" uniformly intend to give an account of plain "true." Our account of "settled true" is not like that. Rather, it treats "settled true" as a modality, formally (but not metaphysically!) analogous to "necessarily true." See also note 3.

[24] For more extensive consideration of this topic, see FF, chapter 6.

[25] Per Øhrstrøm and Peter Hasle, *Temporal logic from ancient ideas to artificial intelligence* (Dordrecht: Kluwer Academic Publishers, 1995), 194.

have been made or that will be made. We are left, however, without an understanding of predictions that might have been made. Suppose that Themistocles, at m_3/h_1 in Figure 2, finds Eurybiades hesitant at paying off the lost wager. "Look," Themistocles says, "if things had gone otherwise, if there had been no sea battle, I would have paid you." The predictive core of that assertion (at m_4/h_2 Themistocles will pay) must either be judged permanently truth-valueless and hence unassertable, or simply false, since it lies off the thin red line. One should find both of those alternatives unacceptable.

Another variation of the thin red line, which also postulates that one history is absolutely actual, postulates that each possible context of use has its own thin red line. This version solves the technical problem of predictions because each moment of assessment, required for the double-time-reference account of prediction, either belongs to the appropriate history or, if not, is a moment at which the prediction is false in a peculiar fashion. When future-pointing sentences, are, however, considered as embedded, there is no longer a guarantee that the moment of evaluation lies on the stipulated history. Still another version makes the thin red line a function of the moment of evaluation. Given reasonable assumptions about moments and future possibilities, in order to speak truly, Eurybiades, speaking at m_4/h_2, would, be forced to say,

> No sea battle has occurred. But this is not what was going to happen. Yesterday, there was going to be a sea battle. It just that the sea battle didn't happen. □

That is distinctly odd. We do not, however, wish to rest our case against these positions chiefly on linguistic or logical oddity. We submit that, given the presence of radical indeterminism, no objectively real future is determined by a moment. Moments represent what is settled, what is determined (by consulting every history through the moment). The future course of history—which may, after all, extend past the dissipation of the solar system—is unsettled, is not yet a matter of fact, if indeterminism holds. Observe that the content of a future oriented sentence differs in principle from sentences such as "x is F" that are neither true nor false, as one says, because missing a quantifier. The content of *Will:A* is going be borne out or not, depending on what comes to pass. Time will tell, indeed (normally) must tell, whether we arrive at a moment at which the truth value of the sentence (at the moment of assertion) becomes settled.[26] When the truth value of the assertion is settled, it is then determined whether or not the assertion and the agent who made it is to be vindicated or impugned. And, as there was a battle on the third day, Themistocles' assertion was vindicated while Eurybiades' was impugned.

VII

Final. Our goal in this essay has been to exploit Aristotle's example of the sea battle in order to shed light on agents' assertions about an undetermined future; and to do

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[26] It is of course possible to manufacture a sentence that will never be settled one way or the other.

it as carefully, intelligibly, and exactly as theoretical resources allow. To that end we presented a branching tree account of indeterminism, limiting technicalities to the bare minimum that must be mastered by anyone who professes to advance an account of indeterminism, including objectively characterized free will, that will stand up to a searching examination by reason. We went on to utilize the Prior-Thomason tense-modal semantics in order to examine the ways in which the semantic value of many sentences depends on what the future holds. Ideas from Kaplan added to our understanding of the roles played by the context and moment of use in semantic evaluation. We found that understanding speech acts in terms of their normative consequences requires double time references, which combine the moment of the speech act and a future moment, a later moment at which a normative consequence is considered. Waiting until a later moment of assessment requires patience; but, as Aristotle himself counseled, "Patience may be bitter but its fruits are sweet."

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