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Author(s): Nuel Belnap and Mitchell Green

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# INDETERMINISM AND THE THIN RED LINE

Nuel Belnap and Mitchell Green  
University of Pittsburgh

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## 1. Introduction

Central to the idea of indeterminism is this: At a given moment in the history of the world there are a variety of ways in which affairs might carry on. Before the toss of the coin there are two things that could happen, either Heads up or Tails up. This possibility is not merely epistemic, but *in re*.<sup>1</sup> In spite of this it seems clear that the outcomes Heads and Tails could not be temporally related. Although Heads, if it happened, would be subsequent to the coin toss, and Tails, if it happened, would be subsequent to the coin toss, surely neither of Heads or Tails precedes the other, nor are they simultaneous.

One may hold that being present, past or future are intrinsic properties of moments, and thus be a champion of McTaggart's "A-series." We aim to avoid this question altogether. Instead in considering indeterminism we concentrate on a generalization of McTaggart's "B-series," which describes the before/after relations that moments bear to one another, with no reference to whether any of those moments are past, present or future. Both sides of the debate about the A-series admit that the B-series captures some of the truth, and surely much of our thinking about our world derives from the presumption that it has the B-series

shape. That is to say, it is natural to think of the B-order of our world as a *series*, defined by the condition that every distinct pair of moments  $m_1$  and  $m_2$  are such that either  $m_1$  is prior to  $m_2$  or  $m_2$  is prior to  $m_1$ . Yet if the B-order is a series, it follows that the events Heads and Tails cannot both be in our world, even if the coin toss can.<sup>2</sup>

One common way of conjoining the aspect of indeterminism formulated above with an understanding of our world deriving from a construal of the B-order as a series, is to hold that at a given moment in the history of our world from which there are a variety of ways in which affairs might carry on, one of those ways is asymmetrically privileged over against all others as being what is actually going to happen. Not only is it true that the coin could either come up heads or tails, and therefore true that it will be the case that either the coin comes up heads or the coin comes up tails. Not only is it the case that either the coin will come up heads, or the coin will come up tails. What is furthermore true is that there is, at the time of the toss, a directly referential, rigid, absolute specification of "what, at the time of the toss, is actually going to happen." This specification breaks the symmetry, picking out either Heads or Tails. Only our limited minds keep us from knowing which. One might express this by saying that our world does not itself branch, leaving open the ontological status of the alternate possibilities required by indeterminism. The thought is bolstered by the fact that when we see heads we are inclined to say, "Aha! So this is what was going to happen. It was therefore true before the toss that the coin was going to come up heads."<sup>3</sup>

It used to be said of the British Empire that it was maintained by a thin red line of soldiers in service to the Queen.<sup>4</sup> We shall express the view just sketched by saying that from among the lines along which history might go, subsequent to an indeterministic moment, one of those lines is the course along which history will go, and it is both thin and red. You may think of the hue as infrared, to capture the idea that belief in the Thin Red Line does not imply that mortals are capable of seeing the future.

Our tendency to believe that there is a Thin Red Line is powerful. When we presume that there will be a sea battle, in spite of knowing that there might not be, what we seem to presume is the following: There will *in fact* be a sea battle even though there need not be. When we wonder, "What does the future hold? Will there be a sea battle or not?", even when we know that there are two possibilities, we seem to be wondering whether there will *in fact* be a sea battle. Further, belief in an actual future, a Thin Red Line, appears to be consistent with believing that there is indeterminism in the world. There seems nothing untoward in supposing that while there are two things that might become of the coin about to be tossed, it is in fact going to come up Heads. It would seem to be consistent to say, "The coin will not come up Tails, but it could. What is more, the coin will come up Heads, but it needn't do so."

In this essay we shall argue that in spite of its stalwartness the Thin Red

Line cannot be maintained. We shall argue, against an established opposition, that one can make sense of an indeterministic, branching structure for our world without postulating an actual future as distinguished among the possibilities. We shall furthermore argue that the Thin Red Line doctrine turns out, on closer scrutiny, to have unpalatable consequences. We shall call the view that in spite of indeterminism, one neither needs nor can use a Thin Red Line, the doctrine of the *open future*. We intend this terminology to make contact with the intuitions (but not the style) of many decades of thinking about indeterminism, and to make contact with an analogy that we develop in detail between the “openness” of expressions like ‘the coin will come up heads’ and the well-known “openness” of ‘*x* is bridle.’

We first lay down constraints upon the notion of indeterminism relevant to the present discussion (§2). Satisfying those constraints involves two tasks, not unrelated to one another. The first is an ontological task, requiring the elucidation of a notion of indeterminism that applies to our world (§3). This account will embody an understanding of the B-order free from any assumption of linearity, and will explain how this very world, if indeterminism is ever true, is replete with possibility. The second task is a linguistic one, involving the development of a semantic theory for temporal discourse (§4). At this point we will have finished our positive development of the open future doctrine.

A natural basis for doubt about that doctrine is that it appears unable to make sense of one who asserts that, bets that, or wonders whether there *will* be a sea battle even when it is clear that there might not be. A special case of this problem is formulated in §5 as the “assertion problem.” One superficially reasonable response is to postulate a Thin Red Line. In §6, however, we argue that the Thin Red Line doctrine, in either of the versions of that doctrine that we consider, has unacceptable consequences, ranging from a mistreatment of actuality to an inability to talk coherently about what *would* have happened had what is *going* to happen not taken place. In §6 we solve the assertion problem by arguing that our framework does make sense of such acts and attitudes once we see that to assert that *A* is to do something that has a normative significance no matter how history carries on.

## 2. Concepts of indeterminism

Among all the numerous concepts of indeterminism, we are concerned with one that is local, pre-probabilistic, objective, feature-independent, *dé re*, existential, and hard.

We need a *local* concept of indeterminism. The contrast is with *global*. Perhaps our entire world is indeterministic or not, or perhaps a law or even an entire scientific theory is indeterministic or not, but we take it to be essential to be able to describe a certain specified transition as indeterministic or not. Here

and below by a *transition* we mean an ordered pair of events, the first entirely preceding the second in the causal order. The earlier is called the *initial* of the transition, while the later is called the *outcome*.

*Example.* This morning we threw a die. It showed six; but there were five other possible outcomes. Then we loaded the die, and threw it again. Again it showed six; but this time, that was the only possible outcome.

The first throw-to-six transition was indeterministic, the second was not. We need a concept that can be used in this local and particular way to describe individual transitions from one event (the initial of the transition) to another (its outcome). In this study we shall simplify by worrying only about the temporal dimension of locality. We will suppress the relativistic considerations arising from the spatial aspects of indeterministic transitions.<sup>5</sup>

The idea of locality described above should rightly make you think of “single case probabilities.” But we need a *pre-probabilistic* concept of indeterminism. Perhaps when the first throw was made there was a 1/6 chance of six. Before the numbers come into it, however, there is the idea that given the throw that in fact came up six, there were five other possibilities. To say that does not require any numbers, just possibilities. These possibilities are themselves “local.” The actual transition was throw-to-six, the other possibilities were the transitions throw-to-one, throw-to-two, etc. Nothing as global as a “world” or “theory” or even “law” comes in this early, and no numbers representing probabilities are part of this concept. Quite to the contrary, any concept of probability must rest on a concept of possibility (sometimes called “the probability space”).

We need an *objective* concept of indeterminism. We mean that the question of how many possible outcomes there were for a certain throw shall be classed with the question of how many ears on a certain Scottie, and contrasted with questions that are explicitly about who thinks what about what, and whether it is reasonable to do so. Our aim is to theorize about a concept of indeterminism that does not require simultaneous explicit theorizing about people and their thoughts or norms or culture. Thus, we are after a concept of indeterminism that does not put *the number of possible outcomes of a certain throw* in anyone’s head, or make it relative to laws or theories, or have it depend on the status of a conversation, or depend on what people care about. All to exactly the same extent as *the number of ears on a certain Scottie*. The most explicit contrast is with “epistemic indeterminism” a.k.a. “epistemic possibility” as codifying a form of ignorance.

There is a difference between calling a transition indeterministic relative to some feature, and calling it feature-independently indeterministic. By definition a transition is *feature-independently indeterministic* if there is more than one possible outcome for its initial, and otherwise it is *feature-independently deterministic*. In this study we shall be content with these “feature-independent”

ideas because of their foundational role. The feature-relative ideas are, however, of great importance. When every possible outcome of an initial has a certain feature, we may well say that the transition was deterministic with respect to that feature. Given the throw, for example, not only did the die come up six, but it landed on the floor. Since it landed on the floor on every one of the other five outcomes, the transition was deterministic with respect to landing on the floor. This sort of *feature-relative determinism* (for a particular feature), which is doubtless of enormous importance both for science and common sense, is evidently consistent with feature-independent indeterminism.

We want a concept that can apply to a transition *de re*, without requiring some description under which the initial falls. No matter how you describe the throwing of the die, even if you are confused enough to refer to it as the holding of a martini by that man in the corner, still, *it* has just six possible outcomes. Take the ancient example:

She remained at rest. But she wasn't tied up. So she could have moved or remained at rest. On the other hand, given her exact beliefs and desires, there was evidently but one possible outcome, not two.

Here the initial has been described in two different ways. The first patch of rhetoric suggests free will, the second suggests instead iron-clad determinism. To insist on a concept of indeterminism that is fundamentally *de re* is to disbar pretending to plausibility of contradictory phenomena via colorful redescriptions. You can't have it both ways. Either her concrete situation, no matter how described and no matter what was "similar" to it, admitted two outcomes or it admitted only one. Thinking *de re* prevents you from evading the problems of indeterminism (or determinism) by switching descriptions—as if you could change the number of ears on a particular Scottie by describing it as very like a whale.

For our continuation to have interest we need to consider only the weakest possible indeterminist claim, namely, the *existential* claim that *some* transitions are indeterministic. The existential claim is obviously consistent with the common sense view that numerous transitions are more or less feature-relative deterministic in interesting ways: The stars in their courses bravely run, fire burns here and in Persia, and although the ways of men are various, the same motives are followed by the same actions.

A concept is *hard* if you have a rigorous theory for it, or at least if you wish you had such a theory and are miserable to the extent that you don't. If in contrast you are happy with some interesting stories, some "paradigm cases," or with a sketch of an outline of a skeleton of a never-to-be-supplied theory, the concept is *soft*. Wittgenstein's concept of game is soft; von Neumann's is hard. We are interested in indeterminism as a hard concept. We want a rigorous theory.

We will not further discuss these seven characteristics. In the remainder of this essay, however, we wish always to be understood with this characterization

in mind.

### 3. *Our World* and its causal order

Branching time is a rigorous theory about indeterminism. It is also an account of how to talk sanely in an indeterministic world. Branching time is not itself an indeterministic theory; instead, it says what indeterminism is, and it says what determinism is, but branching time does not choose between them. Because there is not much point in all the fuss if universal determinism be true, this is almost a quibble, but not quite. It implies a recommendation that one become clear on the difference between indeterminism and determinism before taking a stand.

The theory is due initially to Prior 1967 in the course of his work on the semantics of tenses. It was first carefully formulated by Thomason 1970; see Thomason 1984. We need sharply to distinguish the portion of the theory—the “ontology”—that precedes and underlies the semantic development. The theory of this section is therefore quite independent of linguistic concerns.

There are three fundamental ideas: moments, the causal ordering relation, and *Our World*. A *moment* is a spatially complete but instantaneous event. This very moment is what Whitehead called “all Nature now,” idealized to a zero temporal thickness. The concept of a moment (we borrow jargon from Thomason) is of course a Newtonian idea. It is distant from our everyday conceptions, and it is nonrelativistic. It inherits from Laplace’s demon the implausible presupposition that the fundamental terms of the causal order shall be entire instantaneous world-slices, instead of smallish local events or point events. It is, however, a marvelously helpful approximation to the truth. Accordingly we shall pretend that expressions such as “this actual moment” have definite worldwide meanings.

The second idea is the *causal ordering relation*, also called the *earlier/later-than relation*,  $m_1 \leq m_2$ . This is a B-order relation, which we postulate to be branching rather than linear because of indeterminism. We use “<” for the companion proper relation, so that  $m_1 < m_2$  iff ( $m_1 \leq m_2$  &  $m_1 \neq m_2$ ). The whole idea of branching time as a theory of indeterminism is that there can be incompatible moments each of which might follow upon a given moment, though there are never incompatible moments in the past. Thus, given  $m_1 < m_2$ , it is right to think perspectivally of  $m_1$  as in the past of  $m_2$ . On the other hand, one should say that  $m_2$  is in the “future of possibilities” of  $m_1$ —not simply in its “future.” The reason is that it is intuitive that a future of possibilities, unlike a future history, can contain incompatible moments.

The final idea is *Our World*. Start with this very moment (yours or ours; at this level of idealization it doesn’t matter). Now form the set of all moments that are connected to this very moment by means of any zigzag combination of

the causal ordering or its converse. That is, include all moments that you can reach by means of a "causal path," no matter how complicated. That is what we mean by "*Our World*" construed as a set of moments.<sup>6</sup>

The theory of branching time is, as we give it, a theory only about *Our World* and not about any other. Thus by "moment" in what follows we always mean "moment of *Our World*." Moments are thereby not to be confused with creatures of the mind. Moments are mundane.

The theory technically has only two primitives, *Our World* and the causal order. The theory uses these primitives in four postulates: Nontriviality, Partial Order, Historical Connection, and No Backward Branching.

*Nontriviality*, a technical postulate, says that *Our World* is nonempty.

*Partial Order* says that  $\leq$  is reflexive, transitive, and anti-symmetrical. The postulation of anti-symmetry is more critical than it might appear. It indicates that the moments of *Our World* are nonrepeatables rather than abstract situations or "states" of either "systems" or "times" such as persons with some training in physics are likely to think of. To ask which abstract "states" can follow which is not at all the same as asking which nonrepeatable *events* can follow which, and does not give rise to the same theoretical constraints.

*Historical Connection* says that every two moments of *Our World* have some common historical ancestor in *Our World*, i.e., for every  $m_1$  and  $m_2$  there is in *Our World* a  $m_3$  such that  $m_3 \leq m_1$  and  $m_3 \leq m_2$ . That is, every two moments are connected by a path shaped (at worst) like a V, where each arm of the V is an ordinary causal path. This postulate considerably simplifies the zigzag picture deriving from our initial account of the way that moments in *Our World* are related to this very moment.

Finally, *No Backward Branching* says that all branching is forward, never backward: Incomparable moments in *Our World* never have a common upper bound; or, contrapositively, if two moments are upper-bounded, then they are comparable. That is, if there is a  $m_3$  such that  $m_1 \leq m_3$  and  $m_2 \leq m_3$ , then either  $m_1 \leq m_2$  or  $m_2 \leq m_1$ . This is the postulate that reflects the uniqueness of the past. Starting from any moment there is exactly one chain of moments in the downward direction, its past history. The conviction is that although *Our World* contains alternate incompatible possibilities in the future of possibilities of a given moment, there are no incompatible moments in the past of any moment. A moment may have more than one possible outcome, but not more than one possible "income."

A *history* (we use " $h$ ") is defined as a maximal chain of moments. We think a history in our defined sense is tantamount to a history in the intuitive sense, except that ordinarily "history" connotes only "past," whereas histories as defined extend into the future.

Branching time offers various concepts of possibility. Each history is in some sense possible. Particularly powerful is the quite different idea of an "elementary immediate possibility" at a moment  $m$ . Let  $m$  belong to histories



$h_1$  and  $h_2$ . Say that  $h_1$  and  $h_2$  are *undivided at  $m$*  if they share a moment properly later than  $m$  (the concept is due to P. Kremer). Thus  $h_1$  and  $h_2$  do not split until later than  $m$ . The relation of “undivided at  $m$ ” is an equivalence relation on the set of histories to which  $m$  belongs, and accordingly partitions this set into a family of exhaustive and pairwise disjoint subsets each of which keeps undivided histories together. Each member of the partition (a set of histories) is an *elementary immediate possibility at  $m$* . If there is only one member of the partition, then  $m$  is *deterministic*, while if the partition has more than one member,  $m$  is *indeterministic*. For example, let  $m$  represent the moment at which an ideal die is ideally thrown, and pretend that nothing else is “going on” at  $m$ . Then there will be exactly six elementary immediate possibilities at  $m$ . This will be so even if there are an astounding number of histories to which  $m$  belongs. The partition into six will derive from the very structure of *Our World*. The concept of an elementary immediate possibility, and the derivative concept of indeterminism, is local, pre-probabilistic, objective, feature-independent, *de re*, and hard.

One may consider a new “same-time” primitive that renders all histories isomorphic, so that it makes sense to have a doctrine of linearly ordered instants of time to complement the theory of branching moments. (An “instant” of linear time can be defined as a set of isomorphically mated moments.) Given this added primitive, it makes sense to ask what might have happened “at this very instant.” The primitive seems convenient both for scientific approximations and for fashioning persuasive illustrations, and one of us has previously relied upon it in conceptualizing agency. But (a) one may question whether it is *finally* respectable either scientifically or from the point of view of common sense, (b) it is not needed for an elementary account of indeterminism, and (c) it may confuse us into thinking that we understand things that we do not understand, such as what it means to identify stretches of time across histories. We shall therefore do without it.

#### 4. Semantics of tenses, settledness, and actuality in branching time

An account of how to use tenses against a background of branching time waited for Prior 1957. The explanation is clarified and fine-tuned in Thomason 1970 and Thomason 1984. We shall review the key points, making such modifications as we believe help. We also outline the rudiments needed for a treatment of an indexical concept of actuality, adapting some of the ideas of Kaplan 1989 to branching time.<sup>7</sup> Here are the leading ideas, with indications of our chief departures from Kaplan.

Semantic values need to be relativized both to a “context of use,” which provides a family of “parameters,” and to a quite possibly distinct family of

“evaluation” parameters.<sup>8</sup> We discuss context of use and evaluation parameters in turn.

The context of use is needed partly for indexicals such as “I” and demonstratives such as “this,” and partly as a semantic resting place for free-standing assertible sentences (p. 595). Kaplan generalizes from the former feature to think of the context of use as providing whatever is needed in order to determine a reference for every “directly referential expression” (p. 591). For this reason Kaplan flexibly takes it as “natural to treat the assignment of values to free occurrences of variables as simply one more aspect of context” (p. 591). At this point we depart a little from Kaplan’s usage: We want you to think of “context of use” not in this flexible way, and not tied to a theory of “direct reference”, but really and truly as an (idealized) context of use—nearly a context of utterance (but not quite, for the reasons given by Kaplan, e.g. p. 522). The context of use provides only what is in fact present in an idealized speech act using the given sentence as vehicle. The context provides only what Kaplan calls “fact-of-the-matter parameters” (p. 593). Therefore, contrary to the Kaplan usage of p. 511, there can be evaluation parameters for which there is no matching context parameter. Our paradigm of this is the assignment of values to the variables.

We shall use “ $c$ ” as ranging over contexts of use. How much information  $c$  supplies depends on how rich the language is. The individual items are called “context parameters.” For example, if the indexical “I” is present,  $c$  needs to contain a parameter for the speaker. For the mini-language presented here as a help in understanding indeterminism,  $c$  needs to provide a parameter only for the *moment*. We let  $m_c$  be the moment of use. We shall use  $m_c$  to name a moment of use of a free-standing assertible, and also in giving an account of a made-up indexical connective, *Settled-true-at-this-actual-moment:A*. We shall in effect take “this actual moment” to be  $m_c$ .<sup>9</sup>

Of special note to us is that, as we shall argue, the context of use does not determine a history (a Thin Red Line). Although our argument to this conclusion will be complex, it will begin with a simple premiss: If there be indeterminism nearby, the moment of use may admit of more than one historical continuation. Much of this paper is devoted to wrestling with the problems created by this fact.

So much for the context of use. The other parameters to which semantic values are relativized, the “evaluation parameters,” are needed for proper handling of nested constructions such as “It was true that it was true that  $A$ ” that take one away from the context of use. The indispensable Prior/Thomason idea is that a bare moment is not enough for evaluation; instead one needs a moment/history pair  $m/h$ , with the side requirement that  $m$  belong to  $h$ . The reason is simple: the truth of some sentences (most prominently those “about the future”) depends not only on the context of use,  $c$ , and on a moment of evaluation,  $m$ , but in addition on which historical continuation,  $h$ , of  $m$  is under consideration. It is

not enough to supply a moment; one must supply a history as well.

Thus, when both indexicals and future-dependent statements are present, as they are in the mini-language we shall describe, truth (etc.) is relative to three parameters: moment of use (as provided by the context of use), moment of evaluation, and history of evaluation. We will say this in three ways. In the first place, we will use the locution “ $A$  is true in  $c$  at  $m/h$ .” In the second place, we will sometimes speak of truth at a triple  $c/m/h$ . Thirdly, in later informal passages we will suppress reference to  $c$  as often as possible, thinking in those cases of some one fixed context. In all cases, we are thinking in Kaplan’s terms of a sentence as expressing a “content” in the context  $c$ .

$A$  is then said to be *settled true* {*false*} in  $c$  at  $m$  (rather than “at  $m/h$ ”) just in case  $A$  is true {false} in  $c$  at  $m/h$  for all  $h$  to which  $m$  belongs.

With truth relative to  $c/m/h$  but settled truth relative to just  $c/m$ , confusion beckons. To enhance clarity, first say that  $A$  is *moment-determinate* if for each  $c/m$ ,  $A$  is either settled true or settled false at  $c/m$ . There is then the following dangerous convention. It is all right to say that  $A$  is *true* {*false*} at  $c/m$ , dropping “settled,” but only in a conversational context in which one can see by inspection or argument that  $A$  is moment-determinate. Otherwise, one avoids confusion either by explicitly inserting “settled” or by explicitly mentioning a history as well as a moment. In particular, the unwary should not take this convention as somehow a definition of “real” truth. Quite to the contrary, real truth is relative to  $c/m/h$ . In a similar spirit, it is all right to say that  $A$  is *true* at  $c$  when  $A$  is settled true at  $c/m_c$ , but only if  $A$  is arguably either settled true or settled false at  $c/m_c$ . Otherwise there will be confusion. And again, one should not take this as an analysis of “real” truth. In particular, we shall argue at some length that to assert  $A$  in a given context  $c$  is *not* tantamount to asserting *Settled-true-at-this-actual-moment:A*. Truth may be connected to assertion, but the connection is subtle. There is more on this below.

“*Implication*” ( $\models$ ) is preservation of truth at all context/moment/history triples  $c/m/h$ . The technical ideas of preservation of settled truth at  $c/m$  and of settled truth at  $c/m_c$  are pretty but obfuscating in discussions of indeterminism.

Here are some key illustrative semantic analyses.

*Future and past tenses.* *Will:A* {*Was:A*} is true at  $c/m/h$  iff for some  $m_1$ ,  $A$  is true at  $c/m_1/h$ , with  $m_1 \in h$  and with  $m < m_1$  { $m_1 < m$ }. It is striking that in spite of the settledness of the past, *Was:A* agrees with *Will:A* in its failure to be moment-determinate, as Prior carefully argues.

*Settled truth and historical possibility.* *Settled-true:A* {*Historically-possible:A*} is true at  $c/m/h$  iff  $A$  is true at  $c/m/h_1$  for every {some}  $h_1$  to which  $m$  belongs.

*Actuality.* *Settled-true-at-this-actual-moment:A* is true at  $c/m/h$  iff  $A$  is true at  $c/m_c/h_1$  for every  $h_1$  to which  $m_c$  belongs.

## 5. The Assertion Problem

There is a problem about speech acts using future-tensed sentences in the language of branching time. We take up assertion as a special—but surely central—case. In order clearly to see the nature of the problem, we lay out a perspective on a variety of linguistic devices that have been considered by philosophical logicians. All of the devices we consider involve relativization of truth to one or more relata such as world, time, place, speaker, addressee, demonstrated object, presupposition-set, and—above all—assignment of values to the variables of quantification. Our own treatment of the language of branching time has relativized truth to context, moments and histories. The devices we have in mind include modalities, tenses, indexicals, demonstratives, and quantifiers. In explaining each of these devices logicians have described truth as relative to something we have followed Kaplan in calling a *parameter* to be thought of as having *values*. In our own case, truth is relative to a context parameter (the moment of use) plus a pair of evaluation parameters, the moment of evaluation and the history of evaluation. For a while, however, we want to sort out concepts considering just a single evaluation parameter. For this purpose we will sometimes refer to the well-known *linear* semantics of tenses, which in place of moment/history pairs refers just to times.

Critical to our perspective is the observation that the values of a given evaluation parameter are of two kinds. In the first place a value for a parameter can be supplied by the context of use. We shall call such a value a *context value*. Among typically considered purported context values are the world, time, place, speaker, and audience of a context of use. In the second place some constructions require looking beyond context values to *auxiliary values*.<sup>10</sup> These are any values of the evaluation parameter other than the context value that are auxiliary in the process of spelling out the semantics of a certain linguistic device. For example, consider the expression ‘*Will*:the die shows six’ in linear tense logic. In order to determine a truth value for this sentence (taken as standing alone), we need first of all a context value, the time of use. But that is not enough. The future tense existentially quantifies over all times in the future of the time of use, so that we need a whole set of auxiliary values at which to evaluate the complement ‘the die shows six.’

The perspective at hand requires the observation that, as we said in the previous section, only some evaluation parameters are supplied with context values. The generic story for those parameters with context values, which we tell first, can be presented either from the outside of a stand-alone sentence, or from its inside; we choose the former. Starting from the outside, first we fix the value of the evaluation parameter to be the context value. As we work our way to the inside, we keep using this value as long as we can. We may, however, come to a construction (e.g. *Will*:*A* as a linear tense) that, in order to compute the truth value of the compound (e.g. *Will*:*A*) relative to the value of the parameter at

hand, directs us elsewhere. It may require us to look at the truth value of its complement (e.g.  $A$ ) at one or more auxiliary values of the parameter. We may also come to a construction such as 'I' that needs the context value of the speaker parameter (the speaker parameter has no auxiliary values). And there may be constructions such as *Now:A* that, as H. Kamp has explained, require remembering both the context value as well as a distinct auxiliary value. These constructions require the technical complication sometimes known as "double indexing." On our present perspective, however, they do not require a different story. We still need the possibility of shifting to auxiliary values other than the context value. And, crucially, we still need a context value to get started on the outside.<sup>11</sup>

Let us turn now to the story for evaluation parameters that do not come with context values. For these parameters there is no such thing as "the value of the parameter supplied by the context of use." All their values are auxiliary. Our prime example is the variable of quantification, e.g.  $x$ . Please bear in mind that we are not making a technical remark; of course you can define "context of use" as a technical concept in any way you like, and it may certainly include a value for  $x$ . Our point is that real contexts of use in fact do not provide a value for  $x$ . There just is no such convention; and if there were, it would have no discernible purpose.<sup>12</sup>

The generic story for parameters without context values is similar to the above, except with respect to how one starts when working from the outside. In evaluating a stand-alone sentence, since there is no context value with which to begin, we must start in some other way. What we do is always the same: we generate an auxiliary value of the parameter in an arbitrary way, *keeping in mind that the generation is arbitrary*. Then we proceed as above, working inward. For example, in a quantifier language we start from the outside with an arbitrary assignment of values to the variables. Then when we come to a quantifier using  $x$ , we shift consideration to each assignment that varies the value of  $x$  while keeping the values of the other variables intact. The upshot is that we consider the truth value of the stand-alone sentence relative to each possible value of the parameter (e.g., assignment of values). Then there are two cases.

In the first case, the stand-alone sentence has the same truth value for every auxiliary value of the parameter. This is the easy case. Given this condition, we may legitimately and usefully proceed to define the stand-alone sentence as having a truth value independent of the parameter, namely, the one it constantly has relative to each auxiliary value of the parameter. Example: '∃ $x$ ( $x$  is brindle &  $x$  is a Scottie)' in a standard quantificational language.

In the second case, the stand-alone sentence has different truth values for different auxiliary values of the parameter. Example: ' $x$  is brindle.' This is for us the important case. We describe it by saying that the stand-alone sentence is "open" with respect to the given parameter. That is, a sentence is *open* with respect to a parameter under two conditions (and is otherwise *closed* with respect

to that parameter). First, there is no context value; the sentence is not, as we might say, *closed by context* at that parameter. Second, the truth value of an open stand-alone sentence varies depending on the value of the parameter; the sentence is not, as we might say, *closed by constancy*. Our view may now be stated as follows: In the absence of a specific convention, there is no sense to saying that an open stand-alone sentence has a truth value independently of the evaluation parameter with respect to which it is open. If a sentence is neither closed by context nor closed by constancy, it has no truth value save relative to the parameter in question. This is not to say that open sentences have some third truth value or third special status. It is a mistake to think of open sentences as introducing “truth value gaps.” As a preventative against this mistake, it is healthy to intone that “given a context, open sentences in fact *always* have a truth value—once a suitable parameter value is supplied.” No one makes this mistake about our primary example, assignment-open sentences; we think it should never be made.

After two more observations we are ready to state the promised problem about assertion of future-tensed sentences in branching time. The first observation concerns not open sentences in general, but assignment-open sentences in particular: In the absence of a special convention, use of an assignment-open sentence in order to make an assertion is bound to be defective. It literally makes no sense to use ‘*x* is brindle’ as the vehicle for an assertion. No one could know what is asserted. Of course there could be a special convention permitting e.g. dropping universal quantifiers on stand-alone sentences, and indeed there is such a convention among some groups of mathematicians and other technical workers. The convention is, however, “merely conventional,” requiring addition to the underlying semantic agreement. Furthermore, it remains the case that the convention only covers a few cases.

*Nonassertability (of assignment-open sentences) Thesis.* It makes no sense to assert an assignment-open sentence such as ‘*x* is brindle’; or, more circumspectly, such an assignment-open sentence is not a proper vehicle for assertion. A purported assertion using such a sentence would be defective.<sup>13</sup> The defect is radical: Nothing is asserted.

The second observation is more subtle and somewhat more arguable, but we shall take it for granted.

*Assertability (of future-tensed sentences) Thesis.* In contrast to the senseless of asserting an assignment-open sentence such as ‘*x* is brindle,’ there is no radical defect in asserting a typical future-tensed sentence such as ‘The die will show six,’ even under conditions, even known to the speaker, of radical indeterminism. That is, although we might raise questions about justification, etc., what is asserted by the use of ‘*Will*:the die shows six’ is perfectly well determined. That is what stands in contrast to the purported assertion of ‘*x* is brindle.’

These background facts by themselves do not cause the assertion problem.

That problem arises when the two facts are conjoined with the following thesis (or theses), for which we will argue below.

*Historical Openness Thesis.* A typical future-tense sentence such as ‘*Will:the die shows six*’ is *historically open*.

This thesis is a conjunction of the following two parts.

*Not-closed-by-context Thesis.* Such a sentence is *not closed by context*. That is, the context of use does not (and, we shall argue, cannot) supply a history. There is no “history provided by the context of use.”

*Not-closed-by-constancy Thesis.* Such a sentence is *not closed by constancy*. There is no constant truth value as the history varies.

Thus, given the historical openness thesis, future tense statements in branching time are exactly like assignment-open sentences. According to the not-closed-by-context thesis, they are not like e.g. indexical-containing sentences that are closed by context; and according to the not-closed-by-constancy thesis, they are not like e.g. existentially quantified sentences that are closed by constancy. The sentence ‘*Will:the die shows six*’ is just as open with respect to the history parameter as ‘*x is brindle*’ is open with respect to the assignment parameter.

Given this, how can it possibly make sense to assert e.g. ‘*Will:the die shows six*’? Surely, it would seem, it must be incoherent to hold both that this sentence is historically open (historical openness thesis) and that it is a proper vehicle for assertion (assertability thesis). On the analogy we have worked out in detail, it should (it would seem) make no more sense to assert ‘*Will:the die shows six*’ than to assert ‘*x is brindle*’ (nonassertability thesis).

This is the *Assertion problem*. Let us note for contrast that no such problem arises for the moment parameter, because free-standing sentences in the language of branching time are never “*moment-open*.” They are instead closed by context with respect to the moment parameter, since, as we conceive, the context of use supplies a moment—the very moment of use. The assertion problem arises only for the history parameter.

There are, at first glance, two ways to circumvent the assertion problem. The first way denies the not-closed-by-constancy thesis, replacing it with the view that typical future-tensed sentences are intrinsically closed by constancy. The most common form that this denial takes is the view that *Will:A* really means, *Settled-true:Will:A*. The trouble with the view is that it makes no sense of someone who purports to assert that the coin will come up heads even though it might not, that is, who thinks both that *Will:A* and that *Historically-possible:~Will:A*.<sup>14</sup>

The second, far more prevalent, response to the assertion problem is to hold that future-tensed sentences are closed by context. On this view, future-tensed sentences make reference to a particular history supplied by the context of use—The Thin Red Line. In the impending section we argue at length against this tempting evasion of the assertion problem. Then, in our final section, we

directly confront the problem. We show how a proper understanding of the speech act of assertion makes beautiful sense out of assertions of historically open sentences, and does so in a fashion keeping firmly in view *all* of the nonassertability thesis, the assertability thesis, and the historical openness thesis.

## 6. The Thin Red Line

We turn now to consider the denial of the not-closed-by-context thesis as a way of avoiding the assertion problem. It is tempting to hold that there is a distinguished history, the Thin Red Line, which we might call *TRL*. *TRL* represents the actual history, the one and only actual history in all of *Our World*. If you metaphorically stand outside *Our World*,<sup>15</sup> you will see it clearly marked. One may posit a *TRL* without shifting from an objective to a subjective construal of indeterminism (a contrast discussed in Section 2), and we shall understand the *TRL* proposal in this objective way. The proposal succeeds in avoiding the assertion problem by postulating a “history provided by the context of use” in addition to the “moment provided by the context of use.” This permits future tense sentences to be closed by context.

In the semantic theory of branching+*TRL*, the *future tense* moves you forward along *TRL*, and the *past tense* moves you backward along it. Any talk of *possibility* or *necessity* or *inevitability* refers to some histories other than *TRL*. The semantics/pragmatics of ‘actually’ is likewise bound to *TRL* itself.

Branching+*TRL* has the defect that it gives no account of the future tense relative to moments that do not lie on *TRL*. For this reason the theory seems to give us no account of the following:

The coin will come up heads. It is possible, though, that it will come up tails, and then *later* (\*) it will come up tails again (though at that moment it could come up heads), and then, inevitably, still *later* it will come up tails yet again.

The trouble is that at (\*) the example says that tails *will* happen, not merely that it *might*, whereas the explanation of the future tense given above presupposed that the moment of evaluation was in the *TRL*. The use of ‘possible’ here, however, moves us off of that privileged history. The theory does not tell us how to trace forward in interpreting those occurrences of ‘will.’ Surely it would make no sense to come back to the uniquely given *TRL*. Which of the many histories through the possible event of the coin coming up tails should we use for our forward tracing? This is a rhetorical question without any answer.

Having found wanting the theory that adds to branching time a postulate that one history is absolutely actual—actual in a context-independent way—it is natural to try next doing without the fancy that there is a Thin Red Line given



once and for all. Replace this with a *context-dependent* theory asserting that each possible moment determines its own Thin Red Line. Technically, we change TRL from a simple name of a history to a function,  $TRL(m)$ , which picks out a unique Thin Red Line for each moment,  $m$ . Surely we assume that

1.  $m \in TRL(m)$ ,

or else what was the point? Then when we are given a future tense to evaluate at  $m$ , we trace forward on  $TRL(m)$ . We might read  $TRL(m)$  as “the actual history from the perspective of (or just ‘at’)  $m$ .” This gives us hope of articulating the coin-tossing example, and more generally of avoiding the assertion problem, by letting “the history provided by the context of use” be defined as  $TRL(m_c)$ .

But the theory of  $TRL(m)$  faces what seems a damning dilemma. One either postulates that

2.  $m_1 \leq m_2$  implies  $TRL(m_1) = TRL(m_2)$

or not.

Suppose that we postulate (2). Then let  $m_1$  define two incomparable future possibilities,  $m_2$  and  $m_3$ . First use (2) to calculate that

3.  $TRL(m_2) = TRL(m_3)$ .

Also argue by (1) that  $m_2 \in TRL(m_2)$ ,  $m_3 \in TRL(m_3)$ . But then by (3),  $m_2 \in TRL(m_3)$ . Therefore, both  $m_2$  and  $m_3$  belong to  $TRL(m_3)$ . But this contradicts that  $TRL(m_3)$  is a chain (since  $m_2$  and  $m_3$  were supposed incomparable), and therefore contradicts that  $TRL(m_3)$  is a history.

Suppose we do not postulate that comparable moments determine the same actual history. Then when we attempt to nest tenses we obtain unreasonable results. For example, *Will:Will:A* no longer implies *Will:A*. And *Was:Was:A* no longer implies *Was:A*. *A* no longer implies *Was:Will:A*. To see why one should regret the loss of this last implication, recall that coin, flipped at  $m$ .  $TRL(m)$  tells us that the coin will come up heads. But it could also happen that the coin comes up tails (since *Will:A* does not imply *Settled-true:A*). Then at this moment we would be obliged to say,

The coin came up tails, but this is not what was going to happen. The coin was going to come up heads. It’s just that it didn’t.

This is an odd thing to say. As Diodorus would have it, if the coin comes up heads, then the coin’s coming up heads is what was to be.<sup>16</sup>

We have considered two alternatives to the open future doctrine, and have found each of them wanting. Let us note also that each of these forms of actualism about the future involves commitments to facts that do not supervene upon any physical, chemical, biological or psychological states of affairs. The fact, if it is one, that at a given indeterministic moment  $m$  there is some history

such that it is the one that will occur, is not a state of affairs that supervenes upon what is true of particles, tissues or organisms that exist at  $m$ . Those of us who do not postulate a Thin Red Line have no need of such a mysterious realm of fact. (We hope you join us in regarding as spurious a reassurance having the form, "but it's only a *logical* fact." That's bad logic.)

Each of the above approaches also has troubles with actuality.<sup>17</sup> As Lewis (1970) has argued, this world's being the actual world does not favor it over any others, but is just a reflection of the fact that this is the world at which we are conversing. Thinking now about *Our World*, suppose we have arrived at an indeterministic moment  $m$ . To suppose that there is one from among the histories flowing out of  $m$  that is the actual history is rather like purporting to stand outside Lewis' realm of concrete possibilia and pointing to the one that is actual. But this is wrong. For a world to be actual is for it to be the world we inhabit. For a history to be actual would be for it to be the history to which the moment we inhabit belongs. It is not, however, in general the case that the expression 'the history to which the moment we inhabit belongs' secures a referent, since uniqueness fails in the face of indeterminism. One does on the other hand always succeed in referring with the expression, 'the set of histories to which the moment we inhabit belongs,' for which an alternative description might be, 'the actual situation.'

These remarks do not apply to branching+TRL alone, but hold *mutatis mutandis* of branching+TRL( $m$ ). Do not be misled by the fact that the latter may be thought of as indexical. For suppose you agreed that 'the actual world' does not, in Lewis' framework for modality, privilege any one world over any other. Then we hope you will agree that from among the Lewisian worlds that are exactly alike up to a given time, no one of them has a firmer claim to actuality than any of the others. It would then be most natural as well to say that at a given indeterministic moment  $m$  of *Our World*, there is no privileged actual history or future from among those on which  $m$  lies.

Each of the alternatives to the open future also has the consequence that a person might not, at a given moment, know whether she is actual. In branching+TRL, the point is simply that an inhabitant of a given moment  $m$  mightn't know whether  $m \in \text{TRL}$ . In branching+TRL( $m$ ), the form that the point takes is that a person might not know whether what is happening is what was going to happen.

## 7. Time's winged chariot hurries near

We have argued that responding to the assertion problem by denying either the not-closed-by-constancy thesis or the not-closed-by-context thesis faces grave difficulties. In this section we shall argue that the nonassertability thesis, the assertability thesis, and the historical openness thesis form a consistent triad.

This will augment our case for the doctrine of the open future by removing an alleged difficulty.

Using the term “branching” to refer to the open future doctrine, Lewis has objected to that doctrine in the following way:

The trouble with branching exactly is that it conflicts with our ordinary presupposition that we have a single future. If two futures are equally mine, one with a sea fight tomorrow and one without, it is nonsense to wonder which way it will be—it will be both ways—and yet I do wonder. The theory of branching suits those who think this wondering *is* nonsense. Or those who think the wondering makes sense only if reconstrued: you have leave to wonder about the sea fight, provided that really you wonder not about what tomorrow will bring but about what today predetermines. (1986, pp. 207-8).

Consider Lewis’ suggestion that on the open future view the only way to make sense of a person purporting to wonder what the future will bring is to construe her as wondering what the present predetermines.<sup>18</sup> If this suggestion is right, then it is a strike against the open future view, since it would appear to be a mistake to identify wondering whether there will be a sea battle tomorrow with wondering whether it is settled true that there is to be a sea battle tomorrow.<sup>19</sup>

We shall argue that it makes sense to wonder about what history has not yet decided so long as history *will* decide the matter. We shall also argue that it makes sense to assert that *A* when *A*’s truth value is not settled at the moment of assertion; the idea is that assertion is an act that has consequences for the speaker no matter how things turn out.

Let us note first that wondering, asserting, hoping, betting are each of them moment-determinate affairs: whether a person asserts (wonders, hopes, bets) that *A* does not depend upon what history has not yet settled. Second, it is not the case that if a complex sentence  $\Delta(A)$  is moment-determinate, then *A* is. The fact that *Settled-true:Will:A* is moment-determinate does not imply that *Will:A* is moment determinate. One might nevertheless reason that since *Will:A* requires both a moment and a history if it is to merit a truth value (unless *Will:A* be settled true), we will try in vain to evaluate ‘*a* asserts that *Will:A*’ at a moment *m*, without choice of a history. Attempting to do so may seem like attempting to evaluate ‘*a* asserts that *x* is brindle’ without knowing what values have been assigned the variables. An analogous line of thought would apply to attempts to evaluate other attitude and performative verbs, such as ‘believe,’ ‘wonder’ and ‘predict.’

It would be inadequate to attempt to be quick with the assertion problem by pointing out that even *Will:A* has a semantic value, represented e.g. by a set of *m/h* pairs, which can be a “content” available for such relations as asserting. The problem is that even ‘*x* is brindle’ has a semantic value, represented e.g. by a set of assignments. It would be arbitrary for us to insist without discussion that a set of assignments cannot serve as the content of an assertion, whereas a set of *m/h* pairs can. After all, it is the heart of the assertion problem that assignments and histories are just alike in respect of having evaluation parameters without

context parameters. We therefore are obliged to give some reason why the semantic value of '*Will:A*' is the sort of thing that can be the content of an assertion, while the semantic value of '*x is brindle*' is not.

To this end we shall offer an account of assertion that undergirds a distinction between the content of '*x is brindle*' and the content of *Will:A*. This account is doubly skeletal because (i) it only makes assertion out to be intensional, rather than intentional, which it surely is, and (ii) even the intension that we attach to assertion is approximate, ignoring much of the interesting subtlety.

Asserting that *A* is among other things sticking one's neck out, staking one's reputation on *A*. We suggest treatment of this feature of assertion in terms of what ought to become of a person who asserts, depending on whether her claim is borne out. The simple provisional idea is this:

*a* asserts that *A* just in case, if *A* is true, then *a* deserves credit, and if *A* is false then *a* deserves discredit.

This is schematic, since credit and discredit may come in many forms, depending in part upon the speaker and the subject matter. A forecaster of financial trends who makes a string of predictions that turn out false will receive discredit in the sense that few people will rely upon his opinion in choosing how to invest. But if he has a successful track record then "people listen," and his increased credibility will have a tangible payoff for him. If however that forecaster makes a series of predictions about the weather that turn out to be incorrect, this will matter little for the weight of his financial pronouncements although it may keep people away from the next picnic he organizes.

Credit is schematic; so is desert. Which people owe credit to one whose assertion is borne out will vary from case to case, and may never be strictly delineated. Fleshing out the interaction of desert and time, however, is more to our purpose. If *A*, asserted by *a* at *m*, is true on *m/h*, then on that history *h*, *a* is owed credit as of *m*. This means that beginning with but not including *m*, *a* is owed credit on *h* until *a* is given credit on *h*—if he ever is. We are now in a position to see that on the present account of assertion it makes sense to talk of asserting that there will be a sea battle because assertion involves a kind of quantification over histories. For fleshing out the above suggestion we have:

'*a* asserts that *A*' is true at *m/h* just in case for every history *h'* passing through *m*, if *A* is true at *m/h'*, then *a* is owed credit on *h'* as of *m*, and if *A* is false at *m/h'*, then *a* is owed discredit on *h'* as of *m*.

Assertion therefore involves a quantification over histories *not* in the sense that an assertion of *A* is an assertion that *A* is historically possible or settled true. Rather assertion involves a quantification over histories in the sense that assertion is an act that has implications for the speaker no matter how things eventuate.

By itself, the above account might suggest that a speaker can pile up credit simply by asserting trivial theorems of Peano arithmetic. One would like an account of assertion to help explain what is defective about such speech acts. We shall provide this indirectly by incorporating a feature of assertion that has been brought out by Stalnaker 1973, 1978.<sup>20</sup> Let  $S$  be a set of indices, which in the present context means a set of  $m/h$  pairs. Then  $S$  is the *presupposition set* for interlocutors  $a_1, \dots, a_n$  in conversation  $C$  just in case each  $a_i$  presumes for purposes of  $C$  that  $m_j/h_j$  is possible, for each  $m_j/h_j \in S$ . Now we say provisionally that ' $a$  asserts that  $A$ ' is true at  $m/h$  just in case  $a$  reduces the presupposition-set  $S$  by removing all and only the  $m/h$  pairs at which  $A$  is false. *Will:A* has as its semantic value a set of  $m/h$  pairs; hence to assert that it will rain requires expunging from  $S$  all and only the  $m/h$  pairs on which it is false that it will rain.

The credit/discredit formulation of assertion made use of the idea that assertion has implications for the speaker no matter what comes to pass; Stalnaker's presupposition-update formulation of assertion makes implicit use of the idea that assertion has an upshot for the conversation in which the speaker is taking part, no matter what comes to pass. In light of this we would flesh out Stalnaker's idea as follows: ' $a$  asserts  $A$ ' is true at  $m/h$  just in case for each  $h'$  passing through  $m$ , if  $a$ 's interlocutors do not demur on  $h'$ , then  $S$  is updated by having removed from it all and only those  $m/h$  pairs on which  $A$  is false. This, together with the credit/discredit formulation of assertion, gives us:

' $a$  asserts that  $A$ ' is true at  $m/h$  just in case for each  $h'$  passing through  $m$ ,

- (i) if  $A$  is true at  $m/h'$ , then  $a$  is owed credit on  $h'$  as of  $m$ , and if  $A$  is false at  $m/h'$ , then  $a$  is owed discredit on  $h'$  as of  $m$ .
- (ii) if  $a$ 's interlocutors do not demur on  $h'$ , then  $S$  has removed from it all and only those  $m/h$  pairs on which  $A$  is false.

The above formulation allows us to represent what is wrong with the assertion of trivialities. Such speech acts are indeed assertions, on the present view, but they violate general constraints upon cooperative conversation that have been sketched by Grice 1967 and elaborated by Kasher 1976, 1977. According to these authors interlocutors are as much expected utility maximizers as anyone else; hence the credit got by asserting that  $2+2=4$  must be weighed against the opportunity cost incurred by foregoing conversational moves that update the presupposition set in a substantive way.

The formulation also puts us in a position to see why the intension of *Will:A* differs in principle, and not just technically, from that of ' $x$  is brindle.' For the semantic value of *Will:A*, unlike that of ' $x$  is brindle,' is the sort of thing that can be borne out or not, depending upon what comes to pass. Time will tell whether we arrive at an  $m/h$  pair that is among the set of such pairs representing the intension of *Will:A*—and whether we do or not determines how

we ought to treat the person who put forth *Will:A*. On the other hand, finding an object that is brindle gives us no guidance as to how to treat one who purports to claim that *x* is brindle. Similarly, the above construal of assertion shows us how it makes sense to presuppose, accept, deny or hold in suspension for purposes of discussion, the semantic value of *Will:A*, while this much cannot be said of attempts to do so with the semantic value of '*x* is brindle.'<sup>21</sup>

We turn to the case of wondering.<sup>22</sup> It may seem that if a person is to be able to wonder whether *A* at moment *m*, then it must either be the case that *A* is settled true at *m*, or that *A* is settled false at *m*. Perhaps this lies behind the oddity of describing someone as wondering whether the largest prime is a sum of primes. More generally, it may seem that if one is to be able, at *m*, to ask whether *A*, then *A* must be settled at *m* (in the sense that either *Settled-true:A* or *Settled-false:A* holds at *m*). If *A* is not settled at *m*, then it may appear that the question whether *A* is badly posed.

It is indeed bad practice to ask questions that have no answer. However, there are questions that have no answer now, and questions that will, or may, never admit of an answer. A question that will never admit of an answer (Is the largest prime a sum of primes?)<sup>23</sup> is badly posed. A question that may never admit of an answer (Is the sea battle to be followed by a full-scale war?) may turn out to be badly posed (if there turns out to be no sea battle), and is therefore risky. Shall we reject those questions that do not admit of a settled answer at the moment at which they are posed, but which will be answered no matter how things eventuate? No matter how things eventuate, the question posed on Monday, "Will there be a sea battle tomorrow?" will be answered. If on Tuesday there is a sea battle, then we may say, "The answer to the question is 'yes'," while if on Tuesday there is no sea battle, then we may say, "The answer to the question is 'no'" Rather than reject the question, put on Monday, "Will there be a sea battle tomorrow?", as badly posed, one has the option of responding, "We cannot provide a settled answer to that question now, but must wait and see." Yet another option is responding by taking a stand, by e.g. asserting that there will be a sea battle. The person who had posed the question, if she does not demur, will now have more to go on in deciding how to act, and will know whom to blame if no conflict ensues.

One might reply by suggesting that wondering whether *A* is, as a first approximation, wanting to know whether *A*, and that since furthermore one cannot know, at *m*, whether there will be a sea battle,<sup>24</sup> one cannot wonder, at *m*, whether there will be a sea battle. This objection, if it is to be made forceful, would have to show that in order to want, at moment *m*, to know whether *A* it must be possible, at *m*, to know whether *A*. We all want things we cannot have. What is more, one who wants, at *m*, to know whether *A* wants something that she eventually will have. It is an impetuous soul that would give up wanting relief from sloppiness upon being told that he will have to wait a bit.<sup>25</sup>

## Notes

1. Throughout this essay we shall use a variety of hackneyed examples: coin tosses, die throws, sea battles, horse races. In each case the example will serve its purpose only if understood as indeterministic in the sense delineated in §2. Not wishing to prejudge any questions about free will and the like, we invite the reader to supply her own examples if the ones that we employ tread on her sensibilities.
2. For an introductory account of the A- and B-orders, see Gale 1968, pp. 65-86. For important work on indeterminism from the point of view of an A-theorist, consult papers by McCall as given in the References.
3. See Ryle 1954 for motivation of the view that whatever happens was to be.
4. "The Russians dashed on towards that thin red-line streak tipped with a line of steel." (W.H. Russell, to *The London Times* from the Crimea, 1854).
5. See Belnap 1992 for an exploration of indeterminism in a relativistic setting.
6. In the theory of branching space-time, Belnap 1992 uses "*Our World*" for a similarly motivated set of point events (instead of moments). In both cases the defined term names a set that exhausts—to the extent admissible for an idealization of the given kind—our world.
7. For the remainder of this section and in the next, unadorned page references will be to Kaplan 1989.
8. Kaplan packages the evaluation parameters into a single "circumstance of evaluation." That usage might deliver the wrong connotation for our taxonomy.
9. We can't have H. Kamp's "now" because we have forsworn the ability to trace "same time" between histories. We therefore make no sense of 'I have a dog now, but I might instead have had a horse now.' We can't have Lewis's "actually" (see Lewis 1970), which refers tenselessly to "the actual world," because of a dilemma. If "actually" refers to *Our World*, that's all right as far as it goes, but in the ontology we have (so far) provided, there is no contrasting other world that would enable "actually" do any work. If on the other hand "actually" purports to refer to "our history," then it purports, as we argue below, to do what cannot be done.
10. This usage, which seems to us helpful, has the fault of not deriving from Kaplan. The idea is there, however, on p. 595.
11. Kaplan stresses this point on p. 595.
12. We mean that there would be no purpose for the users. It is not germane that pretending that such a convention exists might make things a little easier for some descriptive logician. We mean to be agreeing with Kaplan 1989, pp. 592-593, which contains the only pertinent discussion known to us.
13. We note again the irrelevance of invoking a special convention for e.g. suppressed universal quantifiers.
14. See the discussion of "Antactualism" in Burgess 1979 for an elaboration of this view. A variation on the denial of the not-closed-by-constancy thesis is offered in McArthur 1974, according to which there are in general two things that could be meant by an assertion of *Will:A*, namely either *Settled-true:Will:A* or *Historically-possible:Will:A*. According to this view, which of these two things is meant depends upon the speaker's intentions.
15. "To stand outside *Our World*" has a clear non-metaphorical meaning, namely, to use only sentences whose truth value does not depend on moments or histories provided by the context of use. Quantificationally closed sentences based on quantifying over moments and histories of *Our World*, using  $\leq$  as the only nonmathematical predicate, and perhaps containing one or more proper names of histories, would fall into this class.
16. McKim and Davis 1976 sketches another variation on the TRL idea according to which each moment provides a future, rather than a history, where (putting the idea in our own terms) *f* is a future of moment *m* just in case (i) *f* is a chain, (ii) for all  $m' \in f$ ,  $m \leq m'$ , and (iii) *f* is maximal. An analogue of the dilemma that we

- posed for branching+TRL(*m*) arises for the McKim/Davis view.
17. Thomason (1984, p. 145 and p. 160), makes remarks that the argument of this paragraph may be seen as elucidating.
  18. Lewis is mistaken in saying that according to the view in question "it will be both ways." The reason is that both *Will:(Sea Battle & ~Sea Battle)* and (*Will:Sea Battle & Will::~~Sea Battle*) are settled false no matter when they are uttered.
  19. See also Burgess 1978. We are additionally indebted to C. Hitchcock for formulating an objection along these lines.
  20. Our need is not for the letter of Stalnaker's treatment but for the spirit. In particular, the commitment that we undertake to Stalnaker's "coarse grained" account of semantic content is corrigible.
  21. Our treatment of assertion as involving a normative dimension has points of contact with Brandom 1983, and Thomson 1990 (ch. 12). The temporal aspect that we ascribe to assertion is in part inspired by an analogy between assertion and betting to be found in Dummett 1973.
  22. Belnap 1982 discusses some related aspects of the problem for wondering.
  23. We assume that the response, "There is no largest prime" is not an answer to this question, but is rather a rejection of the presupposition of that question.
  24. See Belnap 1992a forthcoming, section 9, for the argument.
  25. We wish to thank C. Bicchieri, B. Brandom, J. Burgess, R. Gale, C. Hitchcock, M. Lange, J. Moore, R. Neta, and D. Turner for useful discussion on various of the topics treated in this essay.

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