The actual future is open

Abstract Open futurism is the indeterministic position according to which the future is 'open,' i.e., there is now no fact of the matter as to what future contingent events will actually obtain. Many open futurists hold a branching conception of time, in which a variety of possible futures exist. This paper introduces two challenges to branching-time open futurism, which are similar in spirit to a challenge posed by Kit Fine to (standard) tense realism. The paper argues that, to address the new challenges, (branching-time) open futurists must (i) adopt an objective, non-perspectival notion of actuality and (ii) subscribe to an A-theoretic, dynamic conception of reality. Moreover, given a natural understanding of "actual future," (iii) it is perfectly sensible for open futurists to hold that a unique, objectively actual future exists, contrary to a common assumption in the current debate. The paper also contends that recognising the existence of a unique actual future helps open futurists to avoid potential misconceptions.

Keywords Branching time; Open futurism; Thin red line; Indeterminism; Many-worlds; A-theory of time

1 Introduction

Objective indeterminism is the view that the present and the past, as a matter of fact, do not necessitate the future. It is indeterministic, because it entails that the future is unsettled, historically contingent. It is objective, for it takes historical contingency to depend on the very structure of reality, and not on our subjective or epistemic situation (see, e.g., Hoefer 2015 for an overview).

Objective indeterminism is often combined with the so-called *branching conception of time*: at any moment *m*, our universe is a bunch of alternative possible worlds or *histories*, which coincide up to *m* and divide afterwards, yielding a plurality of possible futures. Branching-time variants of objective indeterminism fall under two main brands, namely, the

thin red line (TRL) view (see, e.g., Øhrstrøm 2009, 2014, Malpass and Wawer 2012, Wawer 2014) and *open futurism*. It is common to classify as open futurists such philosophers as Thomason (1970, 1984), McCall (1976, 1994, 2009), Belnap (see, e.g., Belnap and Green 1994, Belnap et al. 2001), and MacFarlane (2003, 2008, 2014).

The label "open futurism" is sometimes used in the literature to denote other positions, that are not framed within a branching conception of time (e.g., Barnes and Cameron 2009, 2011; see Torre 2011 for an overview). In this paper, however, we focus only on branching-time variants of open futurism, and hereafter we use "open futurism" as shorthand for "branching-time open futurism."[1] Moreover, we assume that the distinction between open futurism and the TRL view is *metaphysical* rather than *semantical*—that it is based on different conceptions of *reality*, and not directly on different views concerning truth, meaning, and the like.

The aim of this paper is to bring to the fore certain ontological and metaphysical commitments of (branching-time) open futurism that are often unrecognised or left implicit in the literature. To this aim, we introduce two challenges to open futurism, which are similar in spirit to a challenge posed by Kit Fine (2005) to dynamic, A-theoretic conceptions of reality.

Based on these challenges, we draw three main conclusions. Firstly, we argue that, just like Fine's challenge can be met only if A-theorists avail themselves (among other things) of an objective, non-perspectival notion of presentness, so our challenges require that open futurists avail themselves of an objective, non-perspectival notion of *actuality*. Secondly, we show that all open futurists, even those who adopt a tenseless ontology, must endorse an A-theoretic, tensed conception of reality. Since the branching-time conception presupposes an eternalist ontology, open futurism turns out to be a variant of A-theoretic eternalism—a position also known as the *moving spotlight view* (see, e.g., Deasy 2015 and Cameron 2015). Thirdly, and finally, we show that open futurism smoothly combines with (a natural reading of) the following view:

(UF) There exists a unique objectively actual future.

This conclusion may be surprising, for open futurists are often contrasted to TRL theorists precisely in that they deny (UF). Moreover, as we shall see, if open futurists recognize the

existence of an indeterministically acceptable reading of (UF), they are in a position to avoid some possible misconceptions.

Let us look ahead. In § 2, we introduce the usual formal framework for objective (branching) indeterminism, that is, branching-time frames and the Ockhamist semantics. In § 3, we introduce open futurism, qua metaphysical view, and we compare it with the TRL view. In § 4, we outline Fine's challenge and the way it can be met. In § 5, we present our new, Fine-style challenges to open futurism. In § 6, we contend that these challenges force open futurists to adopt both an objective notion of actuality and a tensed conception of reality. Finally, in § 7–8, we discuss the notion of an actual future and its role within an open-futurist setting.

2 Branching-time frames

Let us start by introducing a few notions and formal tools related to the branching conception of time.

If we represent the universe as a tree-like structure, in accordance with the branching conception, a *moment* corresponds to a node in the tree. Moments are usually thought of as spatially unlimited, temporally instantaneous events (intuitively, possible states of the universe or temporal 'slices' of a world).

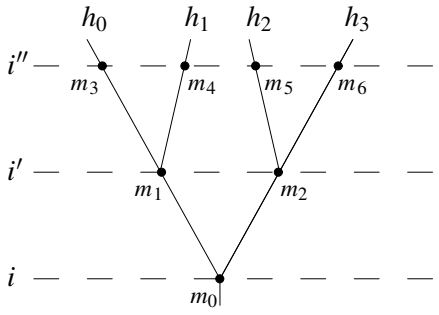

Figure 1: A partial representation of a (synchronized) tree, where h_0–h_3 are histories, m_0–m_6 are moments, and i–i'' are instants.

A *history* is a temporally complete, possible course of events. Intuitively, a history corresponds to a line that runs through the whole length of the tree. We assume, as is common, that histories extend indefinitely towards both the past and the future; this assumption is not meant to carry much philosophical weight. Histories can be formally defined as maxi-

mal $\leqslant$-*chains*, that is, maximal sets of moments linearly ordered by a relation of temporal precedence $\leqslant$ ($>$, $<$, and $\geqslant$ are defined in the obvious way). Histories are said to *pass through* their moments. In Fig. 1, e.g., history h_0 passes through moments m_0, m_1, m_3. Any two histories share some moment, and then *branch* or *divide*. In Fig. 1, e.g., h_0 and h_1 share any moment in $\{m : m \leqslant m_1\}$, and branch or divide at m_1. If a history h passes through a moment m, the set $\{m' : m' > m\} \cap h$ is called a (*possible*) *future for* m. In Fig. 1, e.g., $\{m : m > m_1\} \cap h_0$ is a future for m_1.

A key role in the debate surrounding indeterminism is played by the so-called future contingent statements (or simply *future contingents*),[2] such as:

(1) Tomorrow there will be a sea battle.

To account for sentences like (1), it is usual to require that a metric has been defined on the tree. Accordingly, we assume that for any two moments m, m' on a same history, there exists a number n, which indicates the distance between m and m' expressed in time units. Two moments m, m' are said to be in the same *instant* iff there exists a moment $m'' \leqslant m, m'$ such that m and m' are at the same distance from m''. Intuitively, instants may be represented as horizontal lines on the tree. We require that the tree be *synchronized* (cf. Di Maio and Zanardo 1994, pp. 269–273, see also Belnap et al. 2001, pp. 195–196): each instant intersects each history at precisely one moment, and instants preserve the order of the corresponding moments (that is, if m is in the same instant as m', and m'' as m''', then $m < m''$ entails $m' \not\geqslant m'''$). If i, i' are instants, we write $i < i'$ to mean that some moment in i precedes some moment in i'.

A metric branching-time frame $\mathcal{F}_{BT}$ may be defined as a tuple (*Tree*, $\leqslant$, *D*, *Domain*), where *Tree* is a nonempty set of moments; $\leqslant$ is a partial order on *Tree*; *D* is a duration function that assigns, to any pair (m, m') of $\leqslant$-related moments in *Tree*, a number n expressing the distance between m and m' in time units (see Koymans 1990 for details); *Domain* is a *domain function*, viz., a function from moments in *Tree* to non-empty sets of entities. Let us note that, by adopting a domain function instead of a unique, fixed domain, we allow the domain of what exists to vary across moments (more on this choice below, towards the end of the present section). We define the *global domain* of frame $\mathcal{F}_{BT}$ as the set $\bigcup\{Domain(w) \mid w \in Tree\}$ of all entities that exist relative to some moment.

A *branching-time model* $\mathcal{M}_{BT}$ is a pair $(\mathcal{F}_{BT}, \mathcal{I})$, where the interpretation function $\mathcal{I}$ associates each k-ary predicate to an *intension*, viz., a function that maps each moment $m \in \mathit{Tree}$ to a k-tuple of entities. These entities, in accordance with common practice in varying domain semantics (see, e.g., Fitting and Mendelsohn 1998, pp. 101–104), are drawn from the global domain of $\mathcal{F}_{BT}$ and not just from $\mathit{Domain}(m)$.

The standard open futurist semantics are extensions or refinements of the so-called Ockhamist semantics. The Ockhamist semantics is peculiar—compared with other semantics for tensed languages—due to its somewhat complicated points of evaluation. In the Ockhamist semantics, the extensions of formulas and predicates are relative to pairs of a moment m and a history h passing through m (m/h for short). To illustrate, let $\mathcal{L}$ be a first-order language enriched with a metric temporal operator $\mathit{Will}(n)$ ("In n time units, it will be the case that") and a historical necessity operator $\Box$ ("It is inevitable that"). The notion of Ockhamist satisfaction is defined recursively, as follows (we omit reference to models for brevity; g, g' vary over assignments, v over variables, p_k over k-ary predicates, and $\mathcal{A}$ over formulae):

(i) $p_k(v_1, \ldots, v_k)$ is satisfied by g at m/h iff $(g(v_1), \ldots, g(v_k)) \in \mathcal{I}(p_k)(m)$;

(ii) $\neg\mathcal{A}$ is satisfied by g at m/h iff $\mathcal{A}$ is not satisfied by g at m/h;

(iii) $\mathcal{A} \vee \mathcal{B}$ is satisfied by g at m/h iff either $\mathcal{A}$ or $\mathcal{B}$ is satisfied by g at m/h;

(iv) $\exists v\mathcal{A}$ is satisfied by g at m/h iff $\mathcal{A}$ is satisfied by g' at m/h for some g' such that $g'(v) \in \mathit{Domain}(m)$ and $g'(v') = g(v')$ for all $v' \neq v$;

(v) $\mathit{Will}(n)\mathcal{A}$ is satisfied by g at m/h iff $\mathcal{A}$ is satisfied by g at m'/h, where m' lies n time units in the future of m;

(vi) $\Box\mathcal{A}$ is satisfied by g at m/h iff $\mathcal{A}$ is satisfied by g at m/h' for all $h' \ni m$.

Henceforth, we omit reference to assignments when not strictly needed, and will simply speak of sentences being (Ockham-)true at moment-history pairs. Ockhamist logical truth and validity are defined in the usual way.

Thus far, in defining branching time frames, we have made no assumption concerning the relation between ontology and time. However, open futurism is far from neutral on this matter. Open futurists think that all past, present and historically possible future things exist. This view is consistent with two different ontological stances. The most common choice is adopting a tenseless ontology, that is, holding that existence is time insensitive

(see Thomason 1984, Belnap et al. 2001, MacFarlane 2014). The other choice is adopting a decreasing ontology, in which, intuitively, some things go out of existence as time goes by, while no novel thing ever comes into existence. Such a decreasing ontological view is often attributed to McCall, according to which our universe is a tree that grows or ages by loosing branches (and all their inhabitants; see 1976, 348). To keep our varying domain semantics in tune with both ontological stances, we impose on frames $\mathcal{F}_{BT}$ the constraint that, intuitively, 'local' domains be either fixed or decreasing, viz.:

Anti-monotonicity: If $m \leqslant m'$, then $Domain(m') \subseteq Domain(m)$.[3]

With these technical precisifications in mind, let us see the main metaphysical tenets of both the TRL view and (branching) open futurism.

3 Open futurism and the thin red line

As mentioned in the Introduction, we understand open futurism as a metaphysical view, concerning reality, and not as a semantical view, concerning truth, reference, or the like. In this section we lay down as precisely as possible the metaphysical tenets that underlie open futurism, as opposed to the TRL view (see also Torre 2011).

Like many theories in the metaphysics of time nowadays, open futurism and the TRL view share an eternalist ontology, according to which all past and present things exist, along with all possible future things. At least as far as the future is concerned, their disagreement is primarily about *reality* rather than existence.[4] TRL theorists think that, just like there is a fact of the matter as to which present and past moments are (absolutely) actual, similarly there is a fact of the matter as to which *future* moments are actual. Therefore, they believe that no account of reality is complete unless it specifies, for any instant i, which moment in i is actual. Thus, for any moment m, they hold that either the fact[5] that m is actual or the fact that m is nonactual is part of reality. In contrast, according to open futurists, only those facts that are now inevitable are part of reality. Hence, *qua* indeterminists, they hold that, for any future contingent moment m, the fact that m is actual is not part of reality. The distinction between the TRL view and open futurism, so conceived, is illustrated in Table 1.[6]

	TRL view	**Open futurism**
Merely possible future moments/events	In the ontology	In the ontology
Historically contingent facts (e.g., the fact that future moment *m* is actual)	Part of reality	Not part of reality
Historically inevitable facts (e.g., the fact that past moment *m* is actual)	Part of reality	Part of reality

Table 1: A comparison between the TRL view and open futurism

This distinction bears a telling analogy to the distinction, familiar from the debate on the nature of time, between the B-theory and the moving spotlight view (as mentioned above, and as we shall see in § 6.2, the analogy goes even deeper than first meets the eye). From an ontological viewpoint, B-theorists and moving spotlighters both endorse eternalism. Their disagreement is chiefly metaphysical in character. As opposed to B-theorists, who have a tenseless conception of reality, moving spotlighters think that reality includes tensed facts (e.g., the fact that it is Tuesday).

4 Fine's challenge

We have just seen that the distinction between open futurism and the TRL view bears a relevant analogy to the distinction between A- and B-theoretical views. In this section, we discuss a challenge that, according to Kit Fine, A-theorists must face. In the next section, we introduce two new challenges for open futurists, which are construed in analogy with Fine's.

Here is how Fine (2005, p. 287) presents his challenge.

> [S]uppose we ask: given a complete tenseless description of reality, then what does [an A-theorist] need to add to the description to render it complete by his own lights? The answer is that he need add nothing beyond the fact that a given time *t* is present, since everything else of tense-theoretic interest will follow from this fact and the tenseless facts. But then how could this solitary 'dynamic' fact, in addition to the static facts that [the B-theorist] is willing to accept, be sufficient to account for the passage of time? [...] Even if present-

> ness is allowed to shed its light upon the world, there is nothing in his metaphysics to prevent that light being 'frozen' on a particular moment of time.

Fine's original challenge is addressed to all (standard) versions of A-theory; however, in what follows we restrict our attention to the moving spotlight theory.

To understand Fine's point, it is useful to distinguish between two notions of presentness (see, e.g., Merricks 2006, p. 103). First, we have a (so-called) *subjective* notion of presentness. Subjective presentness has no metaphysical import. "The present," subjectively understood, is just an indexical expression that—like Kaplan's (1989) "now"—can be used to pick up a time from a perspective internal to the timeline. For our purposes, we can stick with the following, rough-and-ready characterization:

> m is **subjectively present** relative to m' iff $m = m'$.

A-theorists are perfectly comfortable with subjective presentness. However, they take another, different notion of presentness as a distinctive feature of their own position. In a dynamic conception, they maintain, presentness can also be understood as an intrinsic property, which a moment (or an event, or an object) possesses independently of any temporal perspective. This further, *objective* notion of presentness can be characterized as follows:

> m is **objectively present** iff it (absolutely) possesses the intrinsic, substantial property of being present.

The difference between objective present, past, and future is genuinely metaphysical and not perspectival, as opposed to the difference between subjective present, past, and future.

Back to Fine's challenge. To make for a conception of time that is genuinely dynamic, Fine contends, it is not enough to maintain that some time is objectively present, for an objectively present time may exist also within a static conception. Fine invites us to consider the view that a unique moment is objectively present, but presentness is 'frozen.' A certain time, say the time that is now subjectively present, is objectively present as of now *and* will remain objectively present in the future as well. Those who hold a genuinely dynamic conception must be able to tell their own position apart from such a static, 'frozen present' view. This is Fine's challenge.

Fine's challenge may sound perplexing. Why, one is tempted to ask, A-theorists cannot

just point out that in their own view a sentence like (2) is true, whereas in the frozen present view it is false?

(2) Some future moment m will be present.

This reply, albeit not technically wrong, is problematic and in wait of substantial clarification. First of all, if we adopt the usual, Priorean semantic treatment of the (nonmetric) future tense, we can rewrite (2) as:

($2'$) For some future moment m', some m is present at m'.

Now, obviously, the notion of presentness at play in ($2'$) cannot be the subjective one. Otherwise, ($2'$) would boil down to the sheer triviality that some future moment is identical to some future moment, a claim that even an advocate of a static conception can subscribe to. More generally, A-theorists cannot appeal to the subjective notion of presentness in order to tell their position apart from the frozen present view.

However, if ($2'$) ascribes an objective, non-perspectival notion of presentness to m, then it should be possible to omit the relativization to a further time m'. To see the point, suppose that *featuring a sea battle* is an objective property of moments, a property that we can ascribe to them irrespective of the temporal perspective we occupy. If so, we can safely drop the future tense in:

Some future moment m will feature a sea battle,

thus obtaining:

Some future moment m features (tenselessly) a sea battle.

The reason is that the future orientation introduced by the tense is redundant, as far as it is clear that m is a future moment and the property we are ascribing to it is objective, non-perspectival. However, if we apply the same policy to (2), what we get is:

($2''$) Some future moment m is (tenselessly) objectively present.

But ($2''$) is absurd: no future moment can be objectively present.

The standard reply to these MacTaggart-esque qualms appeals to a common A-theoretic tool, that is, the Prior-inspired notion of *primitive tenses* (see, e.g., Skow 2009, Pooley 2013,

Cameron 2015, ch. 2).[7] The idea is that, in tensed ascriptions of objective presentness, tenses must be 'taken seriously.' They do not send us back and forth through a timeline ordered by B-relations; rather, they express a primitive content, grounded in A-properties, which cannot be analysed away in terms of a quantification over moments. Thus, (2) is to be understood as:

(2‴) Some future moment m' WILL be (objectively) present,

where the capitalized "WILL" expresses a primitive future tense.[8] The frozen present view is inconsistent with (2‴), for it entails that no future moment WILL be present in the objective sense. Fine's challenge is met: by resorting to objective presentness and primitive tenses, A-theorists can tell their view apart from static proposals such as the frozen present view.

5 The frozen actuality and the many-ways challenges

Thus far, we have seen that any dynamic form of eternalism faces Fine's challenge. We have also seen that the challenge cannot be met insofar as one sticks to a purely subjective notion of presentness. In this section we introduce other two, Fine-style challenges for open futurists. While the original challenge has to do with presentness, the new ones involve actuality.

Before introducing these new challenges, it is useful to spend a few words on the relation between actuality and (in)determinism. Indeterminism, it is tempting to think, is the view that there are many possible futures. Tempting or not, however, this idea is not quite right. Let us see why.

As a matter of fact, the branching conception of time is consistent with the many-worlds interpretation of quantum mechanics.[9] In the many-worlds interpretation, at any instant, every physically possible outcome of any quantum interaction actually occurs. Suppose, for instance, that Schrödinger's cat will be in a superposition of being alive and dead in n time units. The many-worlds view states that, in n time units, actuality will split into two sets of branches. One set contains the branches in which the cat is alive; the other, the ones in which the cat is dead. In general, many-worlds theorists hold that

> [t]his universe is constantly splitting into a stupendous number of branches, all resulting from the measurement like interactions between its myriads of

> components. Moreover, every quantum transition taking place on every star, in every galaxy, in every remote corner of the universe is splitting our local world on earth into myriads of copies of itself. (DeWitt and Graham 2015, p. 161)

Within the branching conception, each instant in the tree includes a multiplicity of moments. In the many-worlds understanding of branching-time frames, these moments all represent real situations, that is, actual events (see, e.g., Earman 1986, p. 224). Hence, no moment remains a sheer possibility, any moment in the tree is (was, will be) actual. As a consequence, there is nothing contingent in the future evolution of actuality: as of now, it is already determined, albeit in a somewhat vacuous way, which future possible moments are actual. This is but the metaphysical counterpart of the common claim that a many-worlds interpretation of quantum mechanics counts as a deterministic view (see, e.g., Greaves 2004, p. 425; Papineau 2010, p. 206).

More generally, a branching conception of reality, in which more than one possible future exists, is consistent with determinism. For we can coherently hold that many futures are possible and, at the same time, maintain that *all* of them will *actually* obtain or, alternatively, that *none* of them will. Either way, future actuality is (vacuously) settled. The moral is that genuine objective indeterminism requires that (i) there is a wide collection of possible futures *and*, in addition, that (ii) a nonempty proper subset of this collection will actually obtain. The new challenges have to do with requirement (ii). They force open futurists to be very precise as to the *number* of possible futures that are going to be actual.

The first challenge relates to a position that may be called the *frozen actuality view*. Like in Fine's frozen present view no future moment will become present, so in the frozen actuality view actuality will 'freeze': from a certain future instant onward, no moment will obtain, become actual, all will remain unrealized possibilities.[10] For reasons just discussed, the frozen actuality view does not count as a form of objective indeterminism *about the entirety of the future*, for it entails that future actuality will be, from a certain instant onward, vacuously determined. But are open futurists able to tell their own view apart from the frozen actuality view? If they are not, their view does not count as a genuine form of objective indeterminism (about the entirety of the future). This is what we call the *frozen actuality* challenge.

Let us turn to the second challenge. The following principle:

(3) For some future instant, more than one moment in that instant will be actual,

is consistent with a family of views (which includes the many-worlds view) according to which, from a certain time onward, actuality *splits*, flowing on two or more divided paths. Here, we shall focus on a particular instance of this family, which lies somewhere in between open futurism and the many-worlds view. We call it the *many-ways* view. The many-ways view perfectly agrees with open futurism about the present and the past. When it comes to the future, however, it agrees with thesis (3). Accordingly, sooner or later, actuality will split, engendering two or more actual futures. Granted, the many-ways view is not, as such, a form of determinism about the future; however, no open futurist can reasonably adopt something like (3), unless she is prepared to maintain that all histories are actual. (It seems arbitrary to hold that a certain plurality of futures is actual and a few others are not.) In other words, if open futurists subscribe to (3), they commit themselves to a many-worlds metaphysics. Do they?

As a matter of fact, two philosophers that are usually classified as open futurists, Belnap and MacFarlane, have flirted with a deterministic, many-worlds understanding of the branching-time picture.[11] If this flirting is to be taken seriously, as a wholehearted adoption of a many-worlds metaphysic, then Belnap and MacFarlane do not count as indeterminists (for a similar conclusion, see Rosenkranz 2013)—and so neither as open futurists according to our characterization. Thus, we shall simply ignore this option in what follows.

In any event, there is evidence that open futurists are not prepared to adopt anything like (3), as witnessed by the following quotations:

> Of all the possible futures represented by space-time manifolds which branch off from the first branch point on the model, one and only one becomes 'actual,' i.e. becomes part of the past. The other branches vanish. The universe model is a tree that 'grows' or ages by losing branches. (McCall 1994, p. 3)

> The emergence of actuality, and the progressive vanishing of all but one future branch, is one of the two principal differences between the present theory [i.e., open futurism] and the many-worlds interpretation of quantum mechanics. (McCall 2009, pp. 420–421).

> On the one hand, each continuation from a branch point is individually possi-

> ble; on the other hand, it is impossible that more than one of these continuations should be realized. (Belnap et al. 2001, p. v)
>
> Current possibilities drop off (McCall 1994) with passage into the future [...]. (Belnap et al. 2001, p. 207)

If open futurism counts as an indeterministic position at all, then it is not a many-ways (or a many-worlds) view. Therefore, unless open futurists are not in a position to adequately formulate their own view, they should be able to tell it apart from the many-ways view. This is the many-ways challenge.

To recap, here are our two new challenges to open futurists:

The frozen actuality challenge. Either open futurists have the resources to tell their view apart from the frozen actuality view—the position that agrees with open futurism about the present and the past, but entails that, sooner or later, actuality will 'freeze'—or they do not count as objective indeterminists (about the future).

The many-ways challenge. Either open futurists do not have the resources to tell their view apart from the many-ways view—the position that agrees with open futurism about the present and the past, but allows two or more actual moments to lie within a single, future instant—or they do not have the resources to adequately express their own view.

6 Meeting the challenges

6.1 Objective actuality

To meet our challenges, open futurists must show that their position is inconsistent with both the frozen actuality and the many-ways views. Therefore, they must be in a position to express, and to endorse, the negation of these views.

Let us start with the frozen actuality view, and consider (where n is such that there exists an n-time-unit future instant):

(4) For any n, some n-time-unit future moment m will be actual (in n time units—hereafter, we omit metric specifications when not strictly needed).

On the face of it, this claim is (equivalent to) the negation of the frozen actuality view. However, things are not so simple. When dealing with Fine's challenge (§ 4 above), we have seen that a claim like (2) ("Some future moment m will be present") is inconsistent with the frozen present view only if "present" receives a non-subjective, objective reading therein. Analogously, suppose that the notion of actuality in (4) is understood to be a subjective feature, which a moment only satisfies relative to a moment (or a history):

> m is **subjectively actual** relative to m' (or to h) iff $m = m'$ ($m \in h$).

If so, (4) boils down to:

> For any n, for some n-time-unit future moment m', some m is such that $m = m'$,

a claim that is perfectly consistent with the frozen actuality view. By the same reasoning, we can conclude that a claim like:

(5) For any n, at most one n-time-unit future moment m will be actual

is perfectly consistent with a many-ways view, if "actual" receives its subjective reading therein. Therefore, a subjective notion of actuality is of no help in addressing the challenges. A more robust, objective notion is needed. Objective actuality can be characterized in analogy with the above (p. 8) characterization of objective presentness:

> m is **objectively actual** iff it (absolutely) possesses the non-relational, substantial property of being actual.[12]

The distinction between objectively actual and non-actual moments is not perspectival but metaphysical, exactly like the distinction between objectively present, past and future moments. Like Fine's original challenge requires a non-perspectival, objective property of presentness, so our challenges require an objective property of actuality.

6.2 Primitive tenses

As just seen, open futurists (and, more generally, branching-time indeterminists) can tell their view apart from both the frozen actuality and the many-ways views only if they are in a position to endorse principles (4) and (5), provided that "actual" is understood in its objective reading therein:

(4′) For any n, some n-time-unit future moment m will be objectively actual,

(5′) For any n, at most one n-time-unit future moment m will be objectively actual.

However, for essentially the same reasons we stated when discussing Fine's challenge, in a tenseless, B-theoretic environment, (4′)–(5′) are equivalent to:

(4″) For any n, some n-time-unit future moment m is objectively actual,

(5″) For any n, at most one n-time-unit future moment m is objectively actual.

But in a B-theoretic environment, (4′)–(5′) entail the TRL view. The reason is that, in the B-theory, the present, the future, and the past are on a par from a metaphysical viewpoint. Therefore, just like facts concerning past or present actuality are part of reality—as objective indeterminists hold—so are facts concerning future actuality. But the claim that future actuality facts are part of reality is precisely the key metaphysical tenet that TRL theorists—as opposed to open futurists—subscribe to.

To summarize, if open futurists accept principles (4′) and (5′), they must adopt a tensed, A-theoretic conception of reality. Since this is an important point, let us stress it. If open futurists are in a position to meet our challenges (and so to qualify themselves as genuine objective indeterminists), they must subscribe to some version of the A-theory, that is, they must admit some tensed facts.[13] Otherwise, their view collapses into a TRL theory.

Armed with tensed facts, open futurists can subscribe to some version of (4′)–(5′) without endorsing a TRL perspective. For they can hold that actuality is a tensed notion, and, accordingly, that the future tense in (4′)–(5′) must be understood as an A-theoretic, primitive tense WILL[14] (from now on, we understand "actual" in its objective reading, and omit such specifications as "objective" or "objectively"):

(4a) For any n, it WILL be the case that some n-time-unit future moment m is actual,

(5a) For any n, it WILL be the case that at most one n-time-unit future moment m is actual.

Once (4a) and (5a) are in place, the new challenges are met, for these statements are inconsistent with the frozen actuality and the many-ways views, respectively. It is also difficult to see how open futurists can meet the challenges without resorting to tensed facts and to principles (equivalent to) (4a) and (5a).

7 Scope issues

Thus far we have seen that open futurists, to address our challenges, must endorse principles (4*a*) and (5*a*). Now consider the *de re* versions of these principles:

(4*b*) For any n, some n-time-unit future moment m WILL be actual,

(5*b*) For any n, at most one n-time-unit future moment m WILL be actual.

In this section, we argue that, from an open futurist perspective, it is natural to hold that (4*a*)–(5*a*) entail (4*b*)–(5*b*), respectively.

It is standard to assume that primitive tenses are inferentially indistinguishable from their B-theoretically acceptable counterparts (this clearly holds for Prior's (1968b) primitive tense operators – see above, note 7). The use of primitive tenses marks the will to 'take tenses seriously' and not the adoption of novel logical or inferential tools. If so, we should expect that the primitive future tense WILL displays the same inferential behaviour as the object language operator $Will(n)$. With this in mind, consider the following principles, where $\mathcal{A}x$ is a condition entailing (objective) actuality and "=" is understood to express the identity relation on the global domain:

(6) $Will(n)\exists x\mathcal{A}x \rightarrow \exists x Will(n)\mathcal{A}x$;

(7) $Will(n)\neg\exists xy(x \neq y \wedge \mathcal{A}x \wedge \mathcal{A}y) \rightarrow \neg\exists xy(x \neq y \wedge Will(n)(\mathcal{A}x \wedge \mathcal{A}y))$.

If the inferential behaviour of WILL reflects that of $Will(n)$, and if (6), (7) are valid, then (4*a*), (5*a*) entail (4*b*), (5*b*), respectively. So if open futurists deny the latter principles, then they should reject (6) and (7) as invalid.

However, it is immediate to check that, under minimal assumptions, (6) and (7) are Ockham-valid. The validity of principle (6), which is a (metric) temporal version of the so-called Barcan formula, immediately follows from the assumption that frames $\mathcal{F}_{BT}$ are anti-monotonic (see above, p. 6).[15] This is but a specific instance of a general fact: Barcan formulae are valid in every normal modal logic based on anti-monotonic frames (see Fitting and Mendelsohn 1998, p. 112). The latter principle, (7), is valid under the assumption, which we take to be completely uncontroversial, that actuality is existence-entailing, viz., that an assignment g satisfies $\mathcal{A}x$ at m/h only if $g(x) \in Domain(m)$.[16] Let us note that (6) and (7) remain valid for other open futurist semantics of choice, including supervalua-

tionism and relativism, which inherit all Ockhamist validities (see Thomason 1970, p. 274, Thomason 1984, p. 145, and MacFarlane 2014, pp. 69 and 226). Therefore, open futurists are committed to (4*b*)–(5*b*), provided that they understand WILL in accordance with standard Ockhamist-based semantics, for all these semantics happen to validate (6) and (7).

Let us stress that our conclusion is not that open futurists *cannot but accept* principles (6) and (7). We are well aware that there are branching-time semantics that do not validate them. And we are also conscious that many philosophers regard (6) as controversial. (Principle (7) is arguably less contentious than (6) and, for the sake of brevity, we shall restrict our attention to the latter.) However, we think that accepting (6) (along with (7)) is a *natural choice* for open futurists, for at least two reasons.

The first reason is that rejecting (6) is problematic within an open futurist perspective. For, intuitively, (6) says that whenever something exists relative to a certain future time, it exists relative to the present time as well—which is essentially the same condition imposed by the anti-monotonicity constraint. This is reflected in the formal fact that, if $\mathit{Will}(n)$ is understood as a simple tense operator, (6) *corresponds* to the anti-monotonicity constraint, in the sense made familiar by correspondence theory (cf. Van Benthem 1984, pp. 215–216). Thus, from an open futurist viewpoint, rejecting (6) is akin to adopting a sort of double-speech, viz., denying object-language principles while happily accepting their metalinguistic (and metaphysical) counterparts.

The second reason is that the open-futuristically acceptable semantics that do not validate (6) are problematic. To the best of our knowledge, there are only two ways to block (6) within a branching-time semantics. (Here we are only considering semantic frames for which the anti-monotonicity constraint holds, for anti-monotonicity is a non-negotiable part of the open futurist ontological framework.) The first one is to treat $\mathit{Will}(n)$ as a sort of future necessity operator. The main option here is Prior's (1967) Peircean semantics, in which $\mathit{Will}(n)\mathcal{A}$ is true at *m* if and only if $\mathcal{A}$ is true *n* time units after *m on all the histories passing through m*. (In this way, $\mathit{Will}(n)\mathcal{A}$ receives essentially the same meaning that $\Box\mathit{Will}(n)\mathcal{A}$ has in an Ockhamist framework.) The Peircean semantics notoriously gets most of our ordinary talk about the future wrong, and virtually all contemporary open futurists reject it (see Thomason 1970, p. 267, Belnap et al. 2001, p. 159, MacFarlane 2014, p. 217; see the next section for an exception to the rule). To have a feeling of why one may be uncom-

fortable with Peirceanism, it suffices to note that all future contingents are Peirce-false at their moment of use, including the ones that, retrospectively, turn out to be true. Things get a little better if further restrictions are imposed on the set of histories that are relevant to the evaluation of future-tensed sentences (see, e.g., Rumberg 2015), but it is very hard to envisage a principled way to motivate such restrictions.

The second way to block (6) is to adopt a non-normal modal logic, in which the usual correspondence relations between validities and frame properties break down. The main options here are variants of Łukasiewicz's three-valued semantics (see Łukasiewicz 1968a,b; see Bourne 2004 and Briggs and Forbes 2012 for recent semantic proposals building on Łukasiewicz's). Blocking (6) by adopting this kind of approach is a costly option, however, for it requires us to abandon a number of *very* plausible principles.[17] Maybe this price will sound reasonable to those philosophers who, like presentists and growing blockers, are deeply skeptical towards quantifying over future moments or objects, but it is unclear why open futurists may be willing to pay it, given their general commitment to future entities.

8 The unique actual future

We have just seen that principles (4*b*) and (5*b*), which allow to address our challenges, smoothly combine with open futurism. However, under the following, uncontroversial assumption:

(8) If a moment m WILL be actual, then any moment m' that precedes m WILL be actual as well (intuitively, future actuality makes no 'leap'),

the conjunction of (4*b*) and (5*b*) entails:

(9) There exists exactly one possible future all moments of which WILL be actual.

The proof runs as follows. If m is n time units in the future of the present actual moment $\mathbf{m}$, we shall say that the set $\{m' : \mathbf{m} < m' \leqslant m\}$ is a $\leqslant_n$-*chain*. Premises (4*b*), (5*b*) and (8) ensure us that, for any n, there exists precisely one $\leqslant_n$-chain all moments of which WILL be actual. Let us consider the union $\mathbf{U}$ of all these chains and suppose, for contradiction, that $\mathbf{U}$ is not a future for $\mathbf{m}$ (viz., a maximal $\leqslant$-chain of future moments). There are two possibilities:

(i) **U** is a *non-maximal* $\leqslant$-chain of future moments, i.e., for some future moment $m \notin \mathbf{U}$, the set $\mathbf{U} \cup \{m\}$ is a $\leqslant$-chain;

(ii) **U** is not a $\leqslant$-chain, i.e., **U** includes two moments m, m' that are *incomparable* (viz., are such that $m \not\leqslant m'$ and $m' \not\leqslant m$).

If (i) is the case, then there must exist some future moment $m \notin \mathbf{U}$ that is either earlier than some moment in **U** or later than all moments in **U**. However, (8) entails that, if a future moment m is earlier than some $m' \in \mathbf{U}$, then $m \in \mathbf{U}$. So let us focus on the case that some $m \notin \mathbf{U}$ is later than any $m' \in \mathbf{U}$, and assume that m lies n time units in the future. Then either there is another moment $m' \in \mathbf{U}$ in the same instant as m, and so m is not later than all moments in **U**, or there is no n-time-unit future moment in **U**, against (4*b*). Now consider possibility (ii), that is, suppose that **U** includes incomparable moments m, m'. Assuming that m is in instant i and m' in instant i', there are two relevant possibilities, namely, either $i = i'$ or $i < i'$. If $i = i'$, then i includes two moments that WILL be actual, against (5*b*). Now let $i < i'$, and consider the moment $m'' < m'$ that lies in the same instant i as m. We know by (8) that m'' WILL be actual and, being comparable with m', is distinct from m. Hence, a same instant includes two distinct moments that WILL be actual, against (5*b*). Therefore, (9) follows. ■

It is very natural to take (9) as equivalent to (UF), i.e., the claim that there exists a unique actual future (we will come back to this putative equivalence in a few lines). As we stated in the introduction, it is a standard view that (UF) is inconsistent with open futurism. On the contrary, in our mind, there is a sensible reading of (UF), the one corresponding to (9), that is perfectly compatible with open futurism. Moreover, recognizing this compatibility helps shed light on the metaphysical commitments of open futurism. In the remainder of this section, we try to make our view as clear as possible.

Before discussing (UF), it is useful to briefly address a natural objection. According to the objection, we are improperly conflating *present* and *future* actuality. A sentence like (UF), rightly understood, is not equivalent to (9). Rather, it is tantamount to:

(10) There exists exactly one possible future all moments of which *are presently* actual.

Typically, however, open futurists regard (10) as false. They take an event to be presently actual only if it is inevitable. If so, the truth of (10) entails, against indeterminism, that a

unique future exists, all moments of which are inevitably actual, viz., historically necessary. Thus, it is simply a mistake to suppose that (UF), properly understood, is open futuristically acceptable. Or so the objection concludes.

In our mind, the objection does not cut much philosophical ice. To say that a future moment (event) is actual and to say that it will be actual are just two ways of saying that it *will happen*. And intuitively enough, the actual future is precisely the course of all and only those moments (events) that will happen. Therefore, we can use (UF), as ordinarily understood, to summarize both (9) and (10). But this only means that (UF) is ambiguous. It is precisely because there is a tendency to neglect this ambiguity and understand (UF) in an unduly strong way, that the existence of a unique actual future is often taken to be inconsistent with open futurism. In any event, we cannot see but terminology at play here. We can use two different expressions, say "actual†" and "actual*", to indicate the notions of actuality at play in (9) and (10), respectively, and distinguish two readings of (UF), as follow:

(UF†) There exists exactly one actual† future.
(UF*) There exists exactly one actual* future,

We stipulate that, throughout this paper, (UF) is to be understood as (UF†).[18]

Whether a unique actual future exists is not an idle issue from a philosophical viewpoint. To best appreciate this point, it is useful to briefly discuss a recent proposal by Patrick Todd (2016). Todd observes that the ordinary understanding of future-tensed statements involves the notion of an actual future. Accordingly, he regards the following analysis of future-tensed sentences as a reasonable starting point:

(T) It will be the case that *p* iff there exists a unique actual future, and that future features *p*, (789)

where "the unique actual future features *p*" means something like *it is the case that p at some moment on the unique actual future*. Todd endorses open futurism and, at the same time, subscribes to the standard view that open futurism is inconsistent with the existence of a unique actual future. Therefore, he thinks that (T) entails the following, obviously unwelcome conclusion:

(11) For any p, it is not the case that it will be the case that p; viz., future-tensed statements (not just future contingents) are all false at their moment of use.

As it should be clear at this stage, we believe that Todd is wrong in supposing that, within an open-futurist framework, (T) entails something like (11). We agree with Todd that principle (T) is intuitively plausible. However, we think that, if one takes "actual future" in (T) to be equivalent to "future all moments of which are already determined to be actual" – as Todd is prepared to do – the principle immediately loses plausibility. After all, we are definitely not prepared to infer, from the truth of any future-tensed statement, the truth of determinism (or fatalism). By contraposition, (T) is intuitively appealing only if, in the relevant reading of "actual future," the existence of a unique actual future is not meant to entail determinism. But as we have just seen, there exists a perfectly natural reading of "actual future" on which the left hand of (T) has no deterministic consequence (i.e., "future all moments of which WILL be actual"). Therefore, it is only natural to conclude that (T), *qua* intuitively appealing principle, involves such an open-futuristically acceptable reading.

In the end, the plausibility of (T), and the need to avoid (11), give to the open futurists further reasons to agree with the view, (UF), that a unique actual future exists. In any event, distinguishing different readings of (UF) is important in order to avoid misconceptions about open futurism.

9 Conclusions

In this paper, we have shown that open futurists, in order to tell their view apart from alternative positions such as the frozen actuality and the many-ways views, must make room for an objective notion of actuality. Moreover, to avoid that their position collapses into the TRL view, they should adopt a dynamic, A-theoretic conception of reality. Finally, it is perfectly sensible for them to accept a natural reading of the principle, (UF), that a unique actual future exists. The actual future is not an idle ingredient to the open futurists' framework, for subscribing to (UF), suitably understood, enables them to dispel a few potential confusions.

Notes

[1]Let us note that such views as presentism and the growing block view do not count as forms of open futurism in our sense. Albeit we are not willing to press this point here, we think that there is an obvious rationale for our terminological choice. Growing blockers and presentists deny the (Quinean) existence of the future, and it is reasonable to regard existence as a minimal necessary condition for openness. More generally, in our mind, saying that there is nothing like the future is very different from saying that the future is open.

[2] Future contingents are statements that predict future events (states, processes, ...) that are neither inevitable nor historically impossible at their moment of use (see, e.g., Øhrstrøm and Hasle 2011). Statement (1) is the standard, Aristotelian example of a future contingent; we assume that it is uttered today and that it *is* a future contingent (if anything is).

[3]Let us note that, in our framework, the entities that are in the domain of a moment *m* are not just the objects that are located at *m*, but also all the things that, at *m*, can be said to exist (in the sense relevant to ontology). Thus, for instance, if a standard, tenseless ontology is assumed, then all historically possible things or events, including all moments within the tree, are in the 'local' domain (see, e.g., Belnap et al. 2001, p. 141). The reason for this choice is that we are interested in the ontological commitments of open futurism and not on empirical facts concerning the temporal location of objects.

[4] As hinted above, we are conscious that McCall's version of open futurism can be construed as different from the TRL view also from an ontological viewpoint. For reasons that will be clear on due course, however, such ontological difference is virtually irrelevant to our purposes.

[5] Throughout the paper, we make reference to facts, a widespread practice in contemporary metaphysics. We assume, however, that 'facts' talk is ultimately dispensable, for instance, by appeal to Fine's (2001) "In reality" operator.

[6] As a matter of fact, two philosophers who are usually classified as open futurists, Belnap and MacFarlane, are sometimes ambiguous as to their underlying metaphysical commitments. More precisely, they seem to flirt with a 'static' form of determinism—and consequently, with a position very different from what we call open futurism (see below, note 11). We shall broadly ignore these flirts.

[7] The basic idea underlying primitive tenses was adumbrated in Prior 1967, Appendix B, and 1968a, p. 4. In (1968b), Prior shows that a B-theoretical temporal logic can be reduced to an A-theoretical tense logic, whose tense operators are taken as primitive and are not dealt with in terms of B-theoretical relations between times. In the literature, when reference is made to primitive tenses, these are understood in (more or less close) analogy to Prior's primitive tense operators.

As a matter of fact, there is another possible reply to the MacTaggart-esque perplexity expressed in the text, namely, appealing to a second temporal dimension or 'meta-time;' see again Pooley 2013. See also Leininger 2015, pp. 4–7, for a critical assessment of this possibility. Our main point can be restated, *mutatis mutandis*, even if this alternative, much less popular reply is adopted.

[8] In passing, we note that the very same expression "WILL" is used in a different sense by Prior (1967, p. 131 ff.) to indicate the Peircean future tense.

[9] For explicit adoptions of branching-time structures by many-worlds theorists, see Bacciagaluppi 2002, Wallace 2005, Saunders and Wallace 2008. For a critical discussion, see Wilson 2012.

[10] Recall that we are assuming that all histories extend indefinitely toward the future (see above, p. 3), so this view is to be understood not as the claim that some future moment will be the last one, but, rather, as the claim that some future instant, and all the subsequent ones, will contain distinct possible moments but no actual ones. In this respect, the frozen actuality view is analogous to Fine's frozen present view, which entails the negation of ($2'''$), but not the view that the objectively present moment is the last moment in the timeline.

[11] Consider, for instance, the following quotations:

> In what follows I will try to avoid indexical language. In particular, I will not draw a distinction (inevitably indexical when not relational) between the actual and the possible except in motivating or giving examples. 'Possible point events' are thus just 'point events'. These point events are to be taken not as mere spatiotemporal positions open for alternate concrete fillings, but as themselves concrete particulars. (Belnap 1992, p. 388)

> There is nothing in the branching model that corresponds to a car moving along the branching road, and nothing that corresponds to the decision the car will have to make to go down one branch or the other. If worlds branch, then *we branch too*. (MacFarlane 2014, p. 212; see also p. 202)

[12] The distinction between subjective and objective actuality closely corresponds to Stalnaker's (1976, 67–69) distinction between an indexical analysis of actuality and an absolute property of actuality. See also Lewis 1973, p. 86. Note that such an objective property need not be *called* actuality. For instance, the statement that a moment m is (or will be) objectively actual translates, within McCall's (1994) framework, into the claim that m will never drop out of existence.

[13] This conclusion is also suggested by Borghini and Torrengo (2013). For the sake of brevity, here we ignore non-standard A-theories such as Fine's (2005) fragmentalism.

[14] For reasons introduced above (note 7), we ignore the other dialectical possibility at the open futurist's disposal, that is, resorting to a 'meta-time.'

[15] To prove this, suppose that $\mathit{Will}(n)\exists x\mathcal{A}x$ is satisfied by g at m/h, and let m' be the moment located n-time units in the future of m on h. Then, by the Ockhamist clauses (iv), (v) (see above, p. 5), some g' is such that $\mathcal{A}x$ is satisfied by g' at m'/h, and $g'(x) \in \mathit{Domain}(m')$. Since $m \leq m'$, anti-monotonicity entails that $g'(x)$ is also in $\mathit{Domain}(m)$. Accordingly, some g'' is such that g'' satisfies $\mathcal{A}x$ at m'/h and $g''(x) \in \mathit{Domain}(m)$. Therefore, again by (v) and (iv), also $\exists x\mathit{Will}(n)\mathcal{A}x$ is satisfied by g at m/h.

[16] Here is a quick proof. Suppose that the antecedent of (7) is satisfied by g at m/h, and let m' be the moment located n-time units in the future of m on h. Then, by the Ockhamist clauses (ii) and (v) (see above, p. 5), g does not satisfy $\exists xy(x \neq y \wedge \mathcal{A}x \wedge \mathcal{A}y)$ at m'/h. Now assume, by contradiction, that $\exists xy(x \neq y \wedge \mathit{Will}(n)(\mathcal{A}x \wedge \mathcal{A}y))$ is satisfied by g at m/h. By the clauses (iv) and (v), and by standard assumptions concerning identity, it follows that, for some g', g' satisfies $\mathcal{A}x \wedge \mathcal{A}y$ at m'/h and $g'(x) \neq g'(y)$. Since $\mathcal{A}x$ is existence-entailing, we can conclude that $g'(x)$ and $g'(y)$ are both in $\mathit{Domain}(m')$. Therefore, by (iv), g satisfies $\exists xy(x \neq y \wedge \mathcal{A}x \wedge \mathcal{A}y)$ at m'/h, against our hypothesis.

[17] For instance, in both Łukasiewicz's original semantics and in its refinement proposed by Briggs and Forbes (2012), even an instance of the excluded middle $Will(n)\mathcal{A} \vee \neg Will(n)\mathcal{A}$ is untrue when $Will(n)\mathcal{A}$ is a future contingent. As another example, in Bourne's (2004) semantics, $Will(n)\neg\mathcal{A}$ is not always equivalent to $\neg Will(n)\mathcal{A}$, agains strong intuitions (see, e.g., MacFarlane 2014, p. 216).

[18] As a matter of fact, there is another way to make the ambiguity of (UF) explicit. As we have seen (p. 15), open futurists should endorse a tensed conception of reality. But if so, they do not need to regard actuality as a special, tensed property—no more than they need to regard quickness or humility as special properties. The role of the distinction between present and future actuality can be played by another distinction, namely, the one between facts that are (now) part of reality and facts that are not. Accordingly, we can distinguish between a strong understanding of (UF), which only TRL theorists can accept:

(UF′) A unique future is such that it is part of reality that it is objectively actual.

and a weak, open futuristically acceptable reading:

(UF″) It is part of reality that there exists a unique, objectively actual future.

Recall that open futurists admit only inevitable facts as part of reality. Therefore, they regard (UF′) as equivalent to the indeterministically unacceptable claim that a unique possible future is such that, *inevitably*, all of its moments will obtain. In contrast, they regard (UF″) as equivalent to the indeterministically acceptable view that, inevitably, a unique future is such that all of its moments will obtain.

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