

Commentary*
Past, Present and Future

Arthur Prior
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In the 50's and the 60's, Arthur Prior fathered and laid out the foundations of tense logic -the logic of sentential operators like e.g. 'it was the case that ...', 'it will be the case that...', or again 'it will be the case that... until...'- as we know it today. He also greatly contributed to other branches of modal logic,¹ most notably alethic modal logic, as well as to a number of other subjects of study, within logic and the philosophy of language, but also, amongst others, metaphysics and ethics.

Past, Present and Future (hereafter PPF) is one of the three books on tense logic Prior published before his early death in 1969; its publication follows *Time and Modality* (1957), and immediately precedes *Papers on Time and Tense* (1968). Although the main topic of these books is tense logic, they also all concern modal logic broadly speaking, and alethic modal logic in particular -indirectly, insofar as many considerations pertaining to tense logic are relevant to other parts of modal logic or to modal logic in general, but also explicitly. As Prior himself puts it, PPF is a sequel to *Time and Modality*. Published ten years later, at a time when the young modal logic was intensively investigated, PPF strikes the reader as a much more mature book than its predecessor. *Papers on Time and Tense* is a collection of articles of a less homogenous character than the other two books.

PPF covers a lot of material, part of it at great length and the rest in the form of shorter remarks. The topics and issues it deals with include: the pre-history of tense logic; the logical grammar of tensed discourse; the axiomatization of tensed logical systems given various alternative hypotheses about the structural properties of time, e.g. linearity, being branched, circularity / continuity, density, discreteness; the study of "non-standard" tense-logical operators, e.g. the so-called metric operators; tense logic and relativistic physics; the interaction of tense with alethic modality; determinism and fatalism; the interaction of tense and alethic modality with quantification and reference; presentism and the so-called growing-block theory; the problem of cross-temporal relations; the translation of tensed language into the language of times and truth-at-a-time, and the reverse translation. Like so many of Prior's writings, PPF mixes great philosophical insight and fine technical considerations, and displays a strong command of the relevant contemporary literature, as well as an acute knowledge of

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¹ I here follow a standard use of the phrase 'modal logic'. The expression is sometimes used only for what I hereafter call 'alethic modal logic'.



relevant figures of the history of philosophy -ancient, medieval and modern- which is always wittingly and fruitfully used for systematic purposes.

Despite its great importance, Prior's logical and philosophical work has always been in relatively great parts neglected, or even ignored. (To give but one striking example, what is now known as "hybrid logic" was invented by Prior in the mid-60's, completely forgotten soon after, and reinvented about twenty years later).² Part of the reason may lie in Prior's use of the unpopular Polish logical notation, as well as in the fact that in many of his writings, Prior often fails to neatly separate philosophical from formal considerations. Be it as it may, Prior's work definitely deserves to reach a wider audience than the one it currently has, and one only hopes that the recent reprint of PPF will help in this respect.

Since the publication of PPF in 1967, the amount of work in philosophical modal logic has been tremendous, and it is still constantly growing. The content of the book, and of Prior's writings in general, is accordingly in certain respects outdated. Yet, there is a substantial part of Prior's work which has been hitherto largely overlooked, and which deserves the attention of current philosophical logicians. It is not the place here to try and make a substantial list of the currently debated issues I take Prior's neglected logico-philosophical work to be relevant to. But let me mention, and briefly elaborate on, two of them.

The first issue, which I only touch upon here, is that of the analysis and logic of essentialist statements, namely of statements of type '*a* essentially *Fs*' and the like. It has long been taken for granted that such statements are to be analyzed in terms of the "metaphysical" alethic modalities. On that account, for instance, '*a* essentially *Fs*' is to be understood as 'it is metaphysically necessary that *a* *Fs*', or, according to a variant of the account, as 'it is metaphysically necessary that if *a* exists, then *a* *Fs*'. Such modal accounts have recently been questioned, most prominently by Kit Fine (Fine, 1994). Fine's view is that it is the concept of metaphysical necessity which is to be understood in terms of the concept of essence, rather than the other way around, and that the concept of essence itself cannot be understood in fundamentally different terms.

Given his view of the concept of essence as primitive, Fine develops a proper logic of essentialist claims (Fine, 1995) and a world semantics for that logic (Fine, 2000).³ It turns out that that semantics is Priorean in character, insofar as its foundations are essentially the same -up to a detail (albeit of some philosophical importance) concerning existence and objecthood- as those of the natural world semantics for Prior's quantified modal logic *Q*.⁴ In a nutshell, the semantics for *Q* allows for truth-value gaps, and has it that a statement about an object, whatever its logical complexity, is neither true nor false at worlds where the object fails to exist. The above mentioned semantics for the Finean logic of essence also allows for gaps, and

² The first published writings on the topic are in PPF, Ch. V, § 6 and Appendix B, § 3. See (Blackburn, 2006).

³ Also see (Correia, 2000).

⁴ On *Q*, see e.g. (Prior, 1957), Ch. V and PPF, Ch. VIII.



has it that a statement about an object lacks a truth-value at worlds where the object fails to “be”, the notion of “being” at a world being weaker than that of existing at a world.

Let me finally mention that I recently argued that modifying the natural world semantics for Q in the way suggested above gives rise to a non-standard conception of the metaphysical modalities, which is richer than the standard conception, and which allows one to devise a modal account of essence which escapes Fine’s objections to the standard accounts. The advocated view is thus that although Fine’s claim that no modal account of essence is possible may be correct if ‘modal’ points to a standard conception of metaphysical necessity and possibility, it is incorrect if ‘modal’ is understood as encompassing the richer Priorean conception.⁵

The second issue I wished to mention is that of the reduction of eternalist talk to presentist talk, and it is the proper topic of the next section.

Presentists believe that everything -in the most unrestricted sense of the term- is present. Eternalists deny this. They believe that there are things which were present but are not so anymore, and, likewise, that there are things which will be present but are not yet so.

Although presentists disagree with eternalists, some of them may still think that (at least some) talk of merely past and merely future things makes *some* sense, and accordingly for them the task is to provide an account of *which* sense that talk may be taken to have. Prior was such a presentist, and in the following I will focus on those presentists who advocate that view. Let me use ‘ Σ ’ for the eternalists’ existential quantifier, reserving ‘ \exists ’ for that of the presentists. I take the task of our presentists to provide a translation of statements containing ‘ Σ ’ into statements which do not contain it, but which in some sense capture what eternalists take the former statements to say.

The way this can be done depends on which statements containing ‘ Σ ’ are taken into consideration. Let L^{Et} be a first-order tensed language, whose sole quantifier is the eternalist ‘ Σ ’, whose vocabulary comprises the predicates ‘ T ’ for ‘is a time’ and ‘ P ’ for ‘is present’, and whose sole tense-logical operators are ‘ P ’ for ‘sometimes in the past’ and ‘ F ’ for ‘sometimes in the future’. I will suppose that the statements under consideration are those of the form ‘ $\Sigma x \varphi x$ ’, where ‘ φx ’ is an open formula of L^{Et} which contains no occurrence of ‘ Σ ’. Thus, if L^{Et} comprises the predicates ‘...is a dinosaur’ and ‘...is a war between ... and ...’, and the names ‘Switzerland’ and ‘Swaziland’, then among the statements under focus are ‘ $\Sigma x \neg(x \text{ is present})$ ’, ‘ $\Sigma x P(x \text{ is a dinosaur})$ ’ and ‘ $\Sigma x F(x \text{ is a war between Switzerland and Swaziland})$ ’. The restriction to these statements is rather substantial, but being more general would require considerably more space.

I wish here to present three distinct candidate presentist-friendly translations of statements of the sort under consideration which, although never put forward by Prior himself, nevertheless rather naturally come to mind given some material found in PPF and other of his writings. The first two of them can be found in some writings where Fine pursues Priorean

⁵ See (Correia, 2007), and (Fine, 2007) for a response.



lines of inquiry about alethic modality and tense (see references below), but they are widely ignored by philosophers of time, probably in part because Fine's writings mostly concern explicitly only the alethic modalities.⁶ As far as I know, the third translation has never been put forward.

In many cases, the adequacy of a reduction of eternalist talk to presentist talk turns on considerations relative to the structure of time. I will assume that time is linear, rather than e.g. branching towards the future or cyclic. This assumption is substantial, but dealing with other views would require too much space.⁷

Consider, then, the statement:

$$(1) \quad \Sigma x \varphi x$$

where ' φx ' is an arbitrary open sentence of the sort under consideration. The first presentist-friendly translation of (1) I wish to present is done into a first-order tensed language L^{Pr} , which is just like L^{Et} except that its sole quantifier is ' \exists ' rather than ' Σ '. I will informally present that translation in two main steps. The first takes us from (1) to a translation in the language of times and truth-at-a-time, namely (3) below. The second takes us from (3) to the final translation (4).

The eternalist will say that (1) is true at a time t_0 iff there is an object x , past, present or future, such that it is true at time t_0 that φx . Using 'at t :' for 'it is true at t that', and, as before, 'T' for 'is a time' and 'P' for 'is present', the view is that (1) is true at t_0 iff the following holds:

$$(2) \quad \Sigma t' (Tt' \wedge \text{at } t': \Sigma x (Px \wedge \text{at } t_0: \varphi x)).$$

Given that for the eternalist, for all times t and t' , t' belongs to the extension of the presentness predicate at t iff $t = t'$, (1) is, from the eternalist perspective, equivalent to (i.e. true at the very same times as) the more complex:

$$(3) \quad \Sigma t (Tt \wedge Pt \wedge \Sigma t' (Tt' \wedge \text{at } t': \Sigma x (Px \wedge \text{at } t: \varphi x))).$$

This completes the first step.

The second step can be presented in four sub-steps. The first three are rather obvious. (3) has the form ' $\Sigma t (Tt \wedge Pt \wedge \dots)$ '. Eternalists typically view the presentists' quantifier ' \exists ' as a

⁶ It is well known that lots of considerations about the alethic modalities apply *mutatis mutandis* to the tenses -this is the case here- and *vice versa*. Yet, sadly enough, specialists in one of these two topics are often ignorant of relevant bits of literature on the other topic. It should also be emphasized that, strangely enough, Fine's writings on the reduction of possibilist discourse to actualist discourse seem to be largely ignored even by philosophers of the alethic modalities.

⁷ I should also mention that I do not aim at absolute formal precision, so at several points I will leave aside certain considerations, some of detail and others of a more substantial character, as well as certain technical niceties.



restriction of their ‘ Σ ’ to present things. On that account, ‘ $\Sigma t (Tt \wedge Pt \wedge \dots)$ ’ can be rendered into ‘ $\exists t (Tt \wedge \dots)$ ’. The first sub-step of the translation thus takes us from (3) to:

$$(3_1) \quad \exists t (Tt \wedge \Sigma t' (Tt' \wedge \text{at } t': \Sigma x(Px \wedge \text{at } t: \varphi x))).$$

Given the same considerations, ‘ $\Sigma x(Px \wedge \dots)$ ’ can be rendered into ‘ $\exists x \dots$ ’. The second sub-step of the translation takes us from (3₁) to:

$$(3_2) \quad \exists t (Tt \wedge \Sigma t' (Tt' \wedge \text{at } t': \exists x(\text{at } t: \varphi x))).$$

Let me use ‘ $S\alpha$ ’ for ‘ $P\alpha \vee \alpha \vee F\alpha$ ’ (read: ‘sometimes, α ’) -and ‘ $A\alpha$ ’ for ‘ $\neg S\neg\alpha$ ’ (read: ‘always, α ’). Eternalists typically take it that a statement of type ‘ $S\alpha$ ’ is true (at a time) iff ‘ $\Sigma t'(Tt' \wedge \text{at } t': \alpha)$ ’ is true (at that time). The third sub-step is inspired by that account, and it takes us from (3₂) to:

$$(3_3) \quad \exists t (Tt \wedge S\exists x(\text{at } t: \varphi x)).$$

All that remains to be done is then to translate ‘at $t: \varphi x$ ’ in (3₃).

This can be done by exploiting an idea put forward by Prior in the context of his reduction of times to “instantaneous world-states” (see below). The suggestion is to translate the expression into ‘ $S(Pt \wedge \varphi x)$ ’. In order to appreciate why the suggestion is adequate, it is enough to notice that for the eternalist who endorses the previous view about statements of type ‘ $S\alpha$ ’, a statement of type ‘ $S(Pt \wedge \alpha)$ ’ is true (at a time) iff the statement ‘ α ’ is true at time t . The fourth sub-step accordingly takes us from (3₃) to:

$$(4) \quad \exists t (Tt \wedge S\exists xS(Pt \wedge \varphi x)).$$

(4) is the first candidate presentist-friendly translation of (1) I wanted to present.⁸

Prior was against quantification over times as *sui generis* entities,⁹ and he would accordingly not have accepted (4) as a translation of (1) as it stands. Yet he advocated a reduction of talk about times and truth-at-a-time to talk of “instantaneous world-states”,¹⁰ which naturally yields a corresponding translation.

⁸ Notice that granted that always, there is one and only one present time -in the presentist language: $A\exists!t Tt$, (4) is equivalent to any of the following:

- $\exists t (Tt \wedge S\exists xA(Pt \supset \varphi x))$
- $\forall t (Tt \supset S\exists xP(Pt \wedge \varphi x))$
- $\forall t (Tt \supset S\exists xA(Pt \supset \varphi x))$

and also to ‘the present time t is such that sometimes, there is a present thing x such that sometimes, both t is present and φx ’.

⁹ See PPF, pp. 74-6.

¹⁰ See PPF Ch. 5, and Appendix B § 3.



An instantaneous world-state is a proposition which represents the totality of what is true at a given time. Prior suggests to define ‘ α is an instantaneous world-state’ -abbreviated below as ‘ $Q\alpha$ ’ - as ‘ $S\alpha \wedge \bar{\forall}\beta(A(\alpha \supset \beta) \vee A(\alpha \supset \neg\beta))$ ’, where ‘ $\bar{\forall}$ ’ is a universal propositional quantifier. In proper English: an instantaneous world-state is a proposition which is sometimes true, and which is maximal, in the sense that for every proposition, either it implies that proposition or it implies the negation of that proposition. For Prior, thus, quantification over times is to be replaced by quantification over instantaneous world-states. And he suggests that truth-at-time be accordingly understood in terms of permanent implication, i.e. that ‘it is true at time t that β ’ should be understood as ‘ $A(\alpha \supset \beta)$ ’ -which is equivalent to ‘ $S(\alpha \wedge \beta)$ ’ -where α is the instantaneous world-state corresponding to t .

In that setting, to the notion of a time *being present* naturally corresponds the notion of an instantaneous world-state simply *being true*. The natural translation of (4) in the appropriately defined language of instantaneous world-states is thus:

$$(5) \quad \bar{\exists}\alpha(Q\alpha \wedge \alpha \wedge S\exists xS(\alpha \wedge \varphi x)).$$

This is the second candidate presentist-friendly translation of (1) I wished to present. Interestingly, something equivalent to (5) can be obtained directly starting from (3) and using Prior’s reduction of talk about times and truth-at-a-time. First, move from (3) to:

$$(3_4) \quad \Sigma t (Tt \wedge Pt \wedge \Sigma t' (Tt' \wedge \text{at } t': \exists x(\text{at } t: \varphi x))).$$

By the Priorean reduction, one then directly gets:

$$(3_5) \quad \bar{\exists}\alpha(Q\alpha \wedge \alpha \wedge \bar{\exists}\beta(Q\beta \wedge S(\beta \wedge \exists xS(\alpha \wedge \varphi x)))).$$

Given that ‘ $\bar{\exists}\beta(Q\beta \wedge S(\beta \wedge \delta))$ ’ is equivalent to ‘ δ ’,¹¹ (3₅) is equivalent to (5).

Prior did not himself come up with (5) as a presentist-friendly translation of (1).¹² Yet, as I just stressed, the suggestion is natural given his own reductive views, and this is actually confirmed by some of Fine’s work elaborating on Priorean views about alethic modality and tense.¹³

Taken at face value, (4) involves quantification over times and (5) quantification over propositions. Accepting (4) or (5) as an appropriate translation of (1) thus leads to the question

¹¹ The left-to-right direction is straightforward. For the other direction, see PPF p. 190.

¹² He only briefly raises the question of the reduction of ‘ Σ ’ in a context similar to the one which occupies us here in (Prior, 1968a).

¹³ See the appendix to (Prior & Fine, 1977), in particular § 6, subsection “Possibilist quantifiers”. For the view of (4) as a candidate presentist-friendly translation of (1), see (Prior & Fine, 1977), § 6, subsection “No sorts”, as well as (Fine, 1985) and (Fine, 2003). In all these texts, Fine’s focus is on the alethic modalities and the reduction of possibilist discourse to actualist discourse, but the relevant considerations apply *mutatis mutandis* to the temporal case in a straightforward way (but see the appendix to (Prior & Fine, 1977), in particular §8, for considerations about time).



whether quantification over the relevant entities should really be countenanced or whether it should be reduced to something else, and, if it should be reduced, how the reduction should go. As we saw, Prior was unhappy with a full-fledged ontology of times and preferred to reduce talk about times to talk about propositions. In addition, he held a view about propositional quantification according to which such quantification is not objectual, and accordingly does not *per se* commit one to entities such as propositions or other abstract entities.¹⁴ Clearly, there are various other views in this area. And equally clearly, every such view is bound to be rejected by some philosophers. For that reason, it would be nice to be able to put forward a translation of (1) which does not involve quantification over times or propositions or other potentially problematic entities.

For those who view quantification over *numbers* as unproblematic, a suggestion can be put forward, which invokes certain tense-logical operators discussed by Prior in PPF (Ch. VI), and which have actually been studied for the first time by Prior himself (Prior 1957 Ch. II) -the so-called *metric* operators. Prior never used the metric operators for the purpose of reducing eternalist talk to presentist talk, but he could easily have done so since, as the reader will realize, the idea of using them for that purpose is extremely natural.

The familiar tense-logical operators ‘sometimes in the past’ and ‘sometimes in the future’ are blind to temporal distance: ‘sometimes in the past, α ’, for instance, if true, does not say *how long ago* ‘ α ’ was true. The metric operators are simply tense-logical operators which do express temporal distances. For the sake of illustration, let me choose the day as the unit for temporal distances, and let me use ‘... days ago, ---’ and ‘... days hence, ---’ as basic metric operators. Each of these two operators takes a term (name or variable) for a strictly positive number in its first position and a (closed or open) sentence in its second position to make a (closed or open) sentence. Which strictly positive numbers can be referred to, or ranged over by, terms filling in the first place of these operators depends on the structure of time: if time is continuous, for instance, an appropriate choice of numbers will be all the strictly positive reals, while if time is discrete, an appropriate choice will be all the non-null natural numbers. I shall represent ‘... days ago, ---’ by ‘ P_{---} ’ and ‘... days hence, ---’ by ‘ F_{---} ’.

The proposed translation of (1), the third I wanted to present, is done into the language L^{*Pr} , which results from L^{Pr} by replacing the standard operators ‘ P ’ and ‘ F ’ by their metric counterparts, and by adding special variables for temporal distances -call them distance-variables- with the following requirement: (i) in a formula, a distance-variable can only appear after ‘ \exists ’ or as filling in the first position of a metric operator, (ii) in a formula, no term other than a distance-variable can appear as filling in such a position.¹⁵ The translation is:

$$(6) (\exists n P_n \exists x F_n \phi x) \vee (\exists x \phi x) \vee (\exists n F_n \exists x P_n \phi x).$$

for ‘ n ’ any chosen distance-variable.

¹⁴ See PPF p. 76, fn 1, and the reference therein.

¹⁵ Notice that the standard tense-logical operators are definable in terms of the metric operators in an obvious way (see PPF p. 95), so L^{*Pr} is more expressive than L^{Pr} .



The adequacy of (6) turns on two assumptions.¹⁶ The first one is that time is structured in such a way that the relevant talk of temporal distances makes sense. The second one is that the numbers over which the distance-variables range eternally exist, i.e. are always present. These assumptions surely require further discussion. But they have some plausibility, and once they are in place it is clear that (6) is adequate: the expression ' $\exists nP_n\exists xF_n$ ' then works just like a restriction of ' Σx ' to past objects, ' $\exists x$ ' like a restriction of ' Σx ' to present objects, and ' $\exists nF_n\exists xP_n$ ' like a restriction of ' Σx ' to future objects.

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¹⁶ Apart from the assumption that time is linear, which I made from the very beginning.