Time, Being and Existence:

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1. Introduction:

One criterion of adequacy for a formal ontology, we have said, is that it should provide a logically perspicuous representation of our commonsense understanding of the world, and not just of our scientific understanding.

Now a central feature of our commonsense understanding is how we are conceptually oriented in time with respect to the past, the present and the future, and the question arises as to how we can best represent this orientation.

One way is to represent it in terms of a tenseless idiom of a coordinate system, as is commonly done in scientific theories. But that amounts to replacing our commonsense understanding with a scientific view.

A more appropriate representation is one that respects the form and content of our commonsense statements about the past, the present and the future.

Formally, this can be done in a logic of tense operators, or in what is called tense logic.

The most natural formal ontology for tense logic is conceptual realism. This is because what tense operators represent in conceptual realism are certain *cognitive schemata* regarding our orientation in time that are fundamental to both the form and content of our conceptual activity.

Thought and communication, in other words, are inextricably temporal phenomena, and it is the cognitive schemata underlying our use of tense operators that structures that phenomena temporally in terms of the past, the present and the future.

n Tense logic is important to conceptual realism as a formal ontology for another reason as well; and that is that it helps us understand the distinction between *being* and *existence*. The problem of the distinction between being and existence is one that must arise, and be resolved, in every formal ontology. Put simply, the problem is:

> **Can there be things that do not exist?**
>
> **Or is being the same as existence?**

In tense logic, the distinction between being and existence can be explicated at least partly in terms of the distinction between past, present and future objects, i.e., the distinction between things that did exist, do exist, or will exist, or what we call *realia*, as opposed to *existentia*, which are restricted to the things that exist at the time we speak or think, i.e., the time we take to be the present of our commonsense framework.

We will briefly describe logics for both possibilism and actualism, and then we extend those logics to both possibilist and actualist versions of quantified tense logic, where by possible objects we mean only *realia*, i.e., the things that did, do, or will exist. These logics will serve not only as essential component parts of our larger framework of conceptual realism as a formal ontology, but also as paradigmatic examples of how different parts or aspects of a formal ontology can be developed independently of constructing a comprehensive system all at once.

2. Possibilism versus Actualism:

If existence is the mode of being of the natural objects of the space-time manifold—i.e., of “actual” objects—then the question arises as to whether or not being is the same as existence, and how this difference, or sameness, is to be represented in formal ontology.

We call the two positions one can take on this issue possibilism and actualism, respectively.

> *Possibilism:* *There are* objects (i.e., objects that have *being* or) that possibly exist but that do not in fact exist.
> **Therefore:** Existence $\neq$ Being.
>
> *Actualism:* Everything that is (has being) exists.
> **Therefore:** Existence = Being.

In formal ontology, possibilism is developed as a logic of actual and possible objects. Whatever exists in such a logic has being, but it is not necessary that whatever has being exists; that is, there **can** be things that do not exist.

Much depends, of course, on what is meant here by ‘there *can* be things that do not exist”.

Does it depend, for example, on the merely possible existence of objects that never in fact exist in the space-time manifold? Or is there a weaker, less committal sense of modality by which we can say that there *can* exist objects that do not now exist?

The answer is there are a number of such senses, all explainable in terms of time or the space-time manifold.

We can explain the difference between being and existence, first of all, in terms of the notion of a local time (*Eigenzeit)* of a world-line of space-time. Within the framework of a possibilist tense logic, for example, *being* encompasses past, present, and future objects, while *existence* encompasses only those objects that presently exist. No doctrine of merely possible existence is needed in such a framework to explain the distinction between existence and being.

We can interpret modality, in other words, so that it **can** be true to say that some things do not exist, namely past and future things that do not now exist. In fact, there are potentially infinitely many different modal logics that can be interpreted within the framework of tense logic.

In this respect, tense logic provides a paradigmatic framework within which possibilism can be given a logically perspicuous representation as a formal ontology.

Tense logic also provides a paradigmatic framework for actualism as well. Instead of possible objects, actualism assumes that there can be vacuous names, i.e., names that denote nothing.

Some names, for example, may have denoted something in the past, but now denote nothing because those things no longer exist.

What is needed, according to actualism, is not that we should distinguish the concept of existence from the concept of being, but only that we should modify the way that the concept of existence (being) is represented in standard first-order predicate logic with identity.

On this view, a first-order logic of existence should allow for the possibility that some of our object terms might fail to denote an existent object, which, according to actualism, is only to say that those object terms denote nothing, rather than that what they denote are objects that do not exist.

Such a logic for actualism amounts to what today is called a *logic free of existential presuppositions*, or simply *free logic.*

The logic of actualism = free logic, i.e., logic free of existential presuppositions regarding the denotations of object terms.

In what follows we first briefly describe a logic of actual and possible objects in which **existence** and **being** are distinct higher-order concepts that are represented by the universal quantifiers $\forall^e$ and $\forall$, respectively, and the existential quantifiers $\exists^e$ and $\exists$. The free logic of actual objects, where existence is not distinguished from being—but also where it is not assumed that all terms for objects denote—is described as a subsystem of the logic of actual and possible objects.

Note: It is only in possibilism that the logic of actual objects is viewed as a proper subsystem of the logic of being.

From the perspective of actualism, the logic of actual objects is all there is to the logic of being.

We first describe some theses of these logics without presupposing any larger encompassing framework.

We then describe a framework for tense logic where we distinguish an application of the logic of actual and possible objects from an application of the free logic of actual objects *simpliciter*.

After that, we will briefly explain how different modal logics can be interpreted in terms of tense logic, and how an application of the logic of actual and possible objects in modal logic can be distinguished from an application of the free logic of actual objects *simpliciter*.

Tense logic, as these developments indicate, is a paradigmatic framework in which to formally represent the differences between actualism and possibilism.

3. A First-Order Logic of Actual and Possible Objects:

We initially consider only the first-order logic of actual and possible objects. We then extend the logic to a fuller account of being and existence. We turn first to the grammar of the logic.

As *logical constants*, we have the following:

1. The negation sign: $\neg$
2. The (material) conditional sign: $\rightarrow$
3. The conjunction sign: $\wedge$
4. The disjunction sign: $\vee$
5. The biconditional sign: $\leftrightarrow$
6. The identity sign: $=$
7. The possibilist universal and existential quantifiers: $\forall$, $\exists$.
8. The actualist universal and existential quantifiers: $\forall^e$, $\exists^e$.

We take *a formal language* L to be a set of object constants and predicates of arbitrary (finite) degrees.

• **object constants:** symbolic counterparts of proper names.

• n**-place predicate constants:** symbolic counterparts of n-place predicate expressions of natural language, for some natural number n.

Whether or not predicate constants stand for concepts or properties and intensional relations depends on what formal theory of predication in a larger framework is assumed.

The *object terms*, or simply *terms*, of a formal language L are the object variables and the object constants in that language.

Atomic formulas of L are the identity formulas of L, i.e., formulas of the form $a = b$, or the result of concatenating an n-place predicate constant of L with n many object terms of L.

We use Greek letters as variables for expressions of the syntactical metalanguage (set theory).

We use two quantifiers—but only one style of object variable—one for quantification over possible objects, or possibilia, and the other for quantification over actual objects.

The formulas of a language L are those expressions that belong to every set K containing the atomic formulas of L and such that $\neg\varphi$, $(\varphi \to \psi)$, $(\forall x\varphi)$, $(\forall^e x\varphi) \in K$ whenever φ, $\psi \in K$ and x is an object variable.

Note: The possibilist quantifiers $\forall$ and $\exists$ do not occur in the formulas for actualism, which we call E-formulas.

5. Some Theses of Possibilist Logic:

We assume classical sentential (propositional) logic throughout all of these lectures. We also assume for now that the logic of the possibilist quantifiers is just standard first-order logic with identity. For the logic of the actualist quantifiers we assume as a basic thesis that whatever is true of all possible objects is true of all actual objects,

$$(\forall x)\varphi \rightarrow (\forall^e x)\varphi,$$

and that every actual object is identical with an actual object (namely itself):

$$(\forall^e x)(\exists^e y)(x = y).$$

Note: This last thesis is weaker than assuming that every term a denotes an existent object, i.e., that a is something that exists:

$$(\exists^e y)(a = y).$$

This last contrasts with the possibilist thesis that every term (proper name) denotes **something** (i.e., a possible object):

$$(\exists y)(a = y).$$

The principle of universal instantiation,

$$\text{(UI)} \qquad (\forall x)\varphi \to \varphi(a/x),$$

where a can be properly substituted for x in φ, is a theorem schema of possibilist logic.

The law for existential generalization,

$$\text{(EG)} \qquad \varphi(a/x) \to (\exists x)\varphi,$$

is of course the converse of (UI) and therefore provable on its basis.

6. Some Theses of Actualist Logic:

The universal instantiation law for the actualist quantifier is qualified by the condition that the term a being instantiated denotes an actual, existent object (i.e., a value of the variable bound by $\exists^e$):

$$(\text{UI}^e) \qquad (\exists^e y)(a = y) \to [(\forall^e x)\varphi \to \varphi(a/x)].$$

Note that in addition to the higher-order quantifier concept of existence represented by $\forall^e$ (and its dual $\exists^e$), the predicable concept of existence can be defined in both actualism and possibilism as follows:

$$E!(a) =_{df} (\exists^e y)(a = x).$$

7. Tense Logic:

As already indicated, one of the most natural applications of the logic of actual and possible objects is in tense logic, where existence applies only to the things that presently exist, and possible objects are none other than past, present, or future objects, i.e., objects that either did exist, do exist, or will exist.

The most natural formal ontology for tense logic is conceptual realism. This is because as forms of conceptual activity, thought and communication are inextricably temporal phenomena, and to ignore this fact in the construction of a formal ontology could lead to a possible confusion of the conceptual view of intensionality with the Platonic view.

Propositions on the conceptualist view, for example, are not abstract entities existing in a platonic realm independently of all conceptual activity. Rather, according to conceptual realism, they are conceptual constructs corresponding to a projection on the level of objects of the truth-conditions of our temporally located assertions.

There are certain **cognitive schemata** characterizing our conceptual orientation in time and implicit in the form and content of our assertions as mental acts. These schemata, whether explicitly recognized as such or not, are usually represented or modeled in terms of a tenseless idiom, such as 'at (the moment of) time t', where reference can be made to moments of time as special type of objects.

Of course, for most scientific purposes such a representation is quite appropriate. But to represent them only in this way in a context where our concern is with a perspicuous representation of the form of our assertions as mental acts might well mislead us into thinking that the schemata in question are not essential to the form and content of an assertion after all—the way they are not essential to the form and content of a proposition on the Platonic view.

It is important to note that even though the cognitive schemata in question can be modelled in terms of a tenseless idiom of moments of time, they are really themselves the conceptually prior conditions that lead to the construction of our concepts for moments or intervals of time.

The temporal schemata implicit in our assertions, we have said, enable us to orientate ourselves in time in terms of the distinction between the past, the present, and the future.

The appropriate representation of these schemata, accordingly, is one based upon a system of quantified tense logic where we represent tenses by means of tense operators. As applied in thought and communication, what these operators correspond to is our ability to refer to what was the case, what is the case, and what will be the case—and to do so, moreover, without having first to construct referential concepts for moments or intervals of time.

In the simplest case we have operators only for the past and the future.

$\mathcal{P}$	it **was** the case that ...
$\mathcal{F}$	it **will be** the case that ...

We do not need an operator for the simple present tense, 'it is the case that', because it is already represented in the simple indicative mood of our predicates.

Note that with negation applied both before and after a tense operator, we can shorten the long reading of $\neg\mathcal{P}\neg$, namely, 'it was not the case that it was the case that it was not the case' to simply 'it was always the case'.

A similar shorter reading applies to $\neg\mathcal{F}\neg$ as well. In other words, we also have the following readings:

$\neg\mathcal{P}\neg$ it **always was** the case that ...

$\neg\mathcal{F}\neg$ it **always will be** the case that ...

We avoid going into all of the details here of a set-theoretical semantics for tense logic. Briefly, the idea is that we consider the earlier-than relation of **a local time** (*Eigenzeit*) of a world-line in space-time.

Note: we assume that the earlier-than relation is **a serial ordering**, i.e., that it is transitive, asymmetric and connected, but we initially impose no other constraints at all upon it, such as that it is discrete, dense, or continuous, has a beginning and end, or neither, etc. All of these different kinds of serial orderings are allowed.

What is important is that we distinguish the objects that exist at each point of a world line from the objects that exist at any of the other points of that line.

Special schematic formulas can be shown to characterize various types of temporal relations. For example, the tensed formulas

$$\mathcal{P}\mathcal{P}\varphi \rightarrow \mathcal{P}\varphi$$
$$\mathcal{F}\mathcal{F}\varphi \rightarrow \mathcal{F}\varphi$$

characterize the class of transitive relations, which we assume is a necessary feature of any local time. The converse schemas,

$$\mathcal{P}\varphi \rightarrow \mathcal{P}\mathcal{P}\varphi$$
$$\mathcal{F}\varphi \rightarrow \mathcal{F}\mathcal{F}\varphi$$

characterize the class of **dense** relations, i.e., where between any two moments of time there is always another moment of time. These would exclude the possibility that time is discrete, and hence are not necessary features of tense logic.

Connectedness is also a necessary feature of a local time, i.e., if t and t' are moments of a local time, then either $t = t'$ or t is earlier-than t' in that local time, or t' is earlier-than t.

This condition is represented by the following theses for the past and future respectively:

$$\mathcal{P}\varphi \wedge \mathcal{P}\psi \rightarrow \mathcal{P}(\varphi \wedge \psi) \vee \mathcal{P}(\varphi \wedge \mathcal{P}\psi) \vee \mathcal{P}(\psi \wedge \mathcal{P}\varphi),$$
$$\mathcal{F}\varphi \wedge \mathcal{F}\psi \rightarrow \mathcal{F}(\varphi \wedge \psi) \vee \mathcal{F}(\varphi \wedge \mathcal{F}\psi) \vee \mathcal{F}(\psi \wedge \mathcal{F}\varphi).$$

Note: The claim that Einstein's theory of special relativity shows that connectedness does not apply is based on a confusion of **the signal relation** with **the earlier-than relation** of a local time (Eigenzeit).

8. Temporal Modes of Being:

The assumption that whatever is (i.e., whatever has being) either did exist, does exist, or will exist is a thesis we call *temporal possibilism*.

We call the objects of temporal possibilism **realia**. Formally, this thesis is stated as follows:

Temporal Possibilism:

$$(\forall x)[\mathcal{P}E!(x) \vee E!(x) \vee \mathcal{F}E!(x)].$$

Realia = What did, does, or will exist.

Aristotle seems to have held such a view in that he thought that whatever is possible is realizable in time. But time, according to Aristotle, has no beginning or end.

A more restrictive view than temporal possibilism—but one that still falls short of actualism—is that only the past and the present are metaphysically determinate, and for that reason only objects that either do exist or did exist have being. On this view, the future has no being.

Being, on this account, covers only past or present existence. Future objects have no being on this view but only come into being in the present when they exist, and then continue to have being in the past. We can characterize this position by first defining quantification over past objects, and then quantification over past and present objects, as follows.

$$(\forall^p x)\varphi =_{df} (\forall x)[\mathcal{P}E!(x) \rightarrow \varphi],$$
$$(\forall^p_p x)\varphi =_{df} (\forall x)[\mathcal{P}E!(x) \vee E!(x) \rightarrow \varphi].$$

The metaphysical thesis that being comprises only what either did exist or does exist can now be expressed as follows:

$$(\forall x)(\exists^p_p y)(x = y).$$

9. Modality Within Tense Logic:

It is significant that the first modal concepts to be discussed and analyzed in the history of philosophy are concepts based on the distinction between the past, the present, and the future, that is, concepts that can be analyzed in terms of the temporal-modalities that are represented by the standard tense operators.

The Megaric logician Diodorus, for example, is reported as having argued that the possible is that which either is or will be the case, and that the necessary is that which is and always will be the case. Formally, the Diodorean modalities can be defined as follows:

$$\Diamond^f \varphi =_{df} (\varphi \vee \mathcal{F}\varphi),$$
$$\Box^f \varphi =_{df} \varphi \wedge \neg\mathcal{F}\neg\varphi,$$
$$\therefore \Box^f \varphi \leftrightarrow \neg\Diamond^f \neg\varphi.$$

Aristotle, on the other hand, maintained that the possible is that which either was, is, or will be the case in what he assumed to be the infinity of time, and therefore the necessary is what is always the case:

$$\Diamond^t \varphi =_{df} \mathcal{P}\varphi \vee \varphi \vee \mathcal{F}\varphi,$$
$$\Box^t \varphi =_{df} \neg\mathcal{P}\neg\varphi \wedge \varphi \wedge \neg\mathcal{F}\neg\varphi,$$
$$\therefore \Box^t \varphi \leftrightarrow \neg\Diamond^t \neg\varphi.$$

Both Aristotle and Diodorus assumed that time is real and not ideal. In other words, the Diodorean and Aristotelian temporal modalities are understood to be *real modalities* based on the nature of time.

In fact these temporal modalities provide a paradigm by which we might understand what is meant by a real, as opposed to a merely formal, modality, such as logical necessity.

These temporally-based modalities also contain an explanatory, concrete interpretation of what is sometimes called **the accessibility relation** between possible worlds in modal logic, except that worlds are now construed as momentary states of the universe associated with the moments of a local time.

The Aristotelian modalities are stronger than the Diodorean, of course, and in fact they provide a complete semantics for the quantified modal logic known as $S5$.

The Diodorean modalities, we have noted, are weaker than the Aristotelian modalities, and the corresponding quantified modal logic is not **S5** but the weaker system known as **S4.3**.

10. Causal Tenses in Relativity Theory:

These temporally-based modalities cannot account for certain situations that are possible in special relativity theory as a result of the finite limiting velocity of causal influences, such as a light signal moving from one point of space-time to another. For example, relative to the present of a given local time T_0, a state of affairs can come to have been the case, according to special relativity, without its ever actually being the case.

That is, where $\mathcal{FP}\varphi$ represents φ's coming (in the future) to have been the case (in the past), and $\neg\Diamond^t\varphi$ represents φ's never actually being the case, the situation envisaged in special relativity might be thought to be represented by:

$$\text{(Sp-Rel)} \qquad \mathcal{FP}\varphi \wedge \neg\Diamond^t\varphi.$$

This conjunction, however, is incompatible with the connectedness assumption of the local time T_0 in question. This is because, by connectedness,

$$\mathcal{FP}\varphi \rightarrow \mathcal{P}\varphi \vee \varphi \vee \mathcal{F}\varphi$$

is valid, and therefore, by definition of $\Diamond^t$, so is

$$\mathcal{FP}\varphi \rightarrow \Diamond^t\varphi.$$

That is, $\mathcal{FP}\varphi$, the first conjunct of (Sp-Rel), implies $\Diamond^t\varphi$, which contradicts the second conjunct of (Sp-Rel), $\neg\Diamond^t\varphi$.

The connectedness assumption, however, cannot be given up without violating the notion of a local time or of a world-line as an inertial reference frame upon which that local time is based.

Note, however, that the situation represented by (Sp-Rel) does not involve just one local time, but a system of local times (inertial reference frames) that are causally connected by a signal relation based on the speed of light.

Now the geometric structure at a given momentary state of a local time of a causally connected system of local times (inertial frames) is that of a Minkowski light-cone. That is, at each momentary state X of a local time there is both **a prior light cone (the causal past)** consisting of all the momentary states (or space-time points) of the local times that can send a signal to X and **a posterior light cone (causal future)** of all the momentary states (or space-time points) of the local time that can receive a signal from X.

> **The causal past** (prior light-cone) of the here-now momentary state X of a world-line (continuant) = the momentary states of world-lines that can send a signal to X.
>
> **The causal future** (posterior light-cone) of the here-now momentary state X of a world line (continuant) = the momentary states of world-lines to which a signal can be sent from X.
>
> A momentary state X of a world-line W_1 is **simultaneous** with a momentary state Y of a world-line W_2 if, and only if, no signal can be sent from X to Y, nor from Y to X.

Because the signal relation has a finite limiting velocity, **simultaneity** will not be a transitive relation. As a result any one of a number of momentary states of one world-line can be simultaneous with the same momentary state of another world-line.

This is what leads to the type of situation described by (Sp-Rel) in special relativity theory. Consider the following account by Hilary Putnam:

> Let Oscar be a person whose whole world-line [local time] is outside of the light-cone of me-now. Let me-future be a future 'stage' of me such that Oscar is in the lower half of the light cone of me-future [i.e., the prior cone of me-future]. Then, when that future becomes the present, it will be true to say that Oscar *existed*, although it will never have had such a truth value to say in the present tense 'Oscar exists now'. Things could come to *have been*, without its ever having been true that they *are*!

Now the possibility of a state of affairs coming to have been the case without its ever actually being the case should not be represented in terms of the standard tenses based on the past and present of a local time, but in terms of tense operators based the causal past and the causal future of a local time.

Let us use for this purpose P_c and F_c as such tense operators.

P_c : it causally was the case that ...
F_c : it causally will be the case that ...

Semantically, these causal-tense operators go beyond the standard tenses by requiring us to consider not just a single local time but **a causally connected system of local times.**

Now the signal relation is assumed to contain as a proper part the connected temporal ordering of the moments of each of the local times in such a causally connected system. The following, in other words, are valid theses of such a causally connected system:

$$\mathcal{P}\varphi \rightarrow P_c\varphi$$
$$\mathcal{F}\varphi \rightarrow F_c\varphi$$

But note also that, because the signal relation has a finite limiting velocity according to special relativity theory, the converses of these theses will not also be valid in such a system.

Now one important consequence of the divergence of the causal-tense operators from the standard tense operators is the invalidity of

$$F_cP_c\varphi \rightarrow P_c\varphi \vee \varphi \vee F_c\varphi$$

and therefore the consistency of

$$F_cP_c\varphi \wedge \neg\Diamond^t\varphi.$$

This formula, and not the earlier one, is the appropriate representation of the possibility in special relativity of a state of affairs coming (in the causal future) to have been the case (in the causal past) without its ever actually being the case (in a given local time).

Finally, it should be noted that there is also a causal counterpart to Diodorus's notion of possibility as what either is or will be the case, namely, possibility as what either is or causally will be the case:

$$\Diamond^{cf}\varphi =_{df} \varphi \vee F_c\varphi.$$

Instead of the modal logic **S4.3**, this causal Diodorean notion of possibility results in the modal logic **S4**.

Many other modal concepts can also be characterized in terms of a causally connected system of local times, including, e.g., the notion of something being necessary because of the way the past has been. What is distinctive about them all is the unproblematic sense in which they can be taken as real modalities based on the space-time manifold.