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REMARKS ON IDENTITY ACROSS POSSIBLE WORLDS

Abstract
Since our world could be otherwise than it was, is and will be, we might consider objects and their properties in other configurations than they actually occur. This means that other stories about our world, different than the actual narration, are fairly possible. For example, Aristotle could remain in Stagira and become a physician like his father. Thus, we have Aristotle in the real world and Aristotle in a possible world. Are both identical or different persons? If we affirmatively answer this question, we automatically admit identity as acting across possible worlds or transworld identity. This paper argues for the negative answer: there is no transworld identity, unless we apply a very abstract model-theoretic approach.

Key words: properties, Leibniz’s law, maximally consistent sets, models

Formally speaking, identity is introduced into first-order logic by the axioms

(A1) \( x = x \);
(A2) \( x = y \Rightarrow y = x \);
(A3) \( x = y \land y = z \Rightarrow x = z \),

together with the rule of replacement (for simplicity, I restrict it to monadic predicates)

(RR) if \( (x = y) \land P(x) \), then \( P(x/y) \).

The identity predicate is not definable in first-order logic. The situation changes in second-order logic via the Leibniz rule:

(LR) \( (x = y) \Leftrightarrow \forall P (Px \Leftrightarrow Py) \),
which says that identical objects have the same properties. In fact, the implication

\[(1) \quad (x = y) \Rightarrow \forall P (Px \iff Py)\]
suffices for defining identity. The reverse implication

\[(2) \quad \forall P (Px \iff Py) \Rightarrow (x = y),\]
expresses the famous \textit{principium identitatis indiscernibilium} (the principle of the identity of indiscernibles). Hence, (LR) is constituted by the conjunction of (1) (the principle of the indiscernability of identicals) and \textit{principium identitatis indiscernibilium}. It says that identical objects have the same properties and objects having the same properties are identical (indiscernible, indistinguishable). Although the formal properties of identity are (or seems to be) clear, the concept of identity provides several problems for logicians and philosophers (see [1], [4], [5], [9], [10], [22], [23], [28], [29]). The most frequently discussed are as follows (I add some comments, but they are not intended as exhaustive):

(A) Does identity hold between terms (early Frege) or objects (later Frege)? The present view favors the later view: identity holds between objects.

(B) Is identity a relation? Wittgenstein says ([30], 5.5303): Roughly speaking, to say of two things that they are identical is nonsense, and to say of one thing that it is identical with itself is to say nothing at all. According to Wittgenstein, identity is not a relation. Earlier (see 5.53) he declared that he expressed the identity of objects by the identity of signs “not by using a sign for identity”. Wittgenstein concluded (see 5.33) that the identity-sign \([\cdot]\) is not an essential constituent of conceptual notation. Although Wittgensteins treatment of identity is somehow cryptic (this concerns 5.53, in particular), his remarks arise an important point: does identity hold between objects which are numerically different, for example, two occurrences of ‘e’ in the word ‘different’ (see [5], [27], [29])?

Perhaps a more interesting problem concerns elementary physical particles which according to a fairly common view are indiscernible (see analysis in [4]). Tarskis view of identity was definitively contrary to that of Wittgenstein. The difference is well illustrated by the following quotation ([26], p. 49): Among the logical concepts not belonging to sentential calculus, the concept of \textit{IDENTITY}, or of \textit{EQUALITY}, is perhaps the one which has the greatest importance.
We can take 2 and 1 + 1 as examples of arithmetical object(s?) which are equal. According to Tarski, both are identical as well. However, one can say that equality does not always entail identity. In particular, 2 and 1 + 1 have different properties, because the function + is involved in the latter. In fact, the number 2 can be also defined as the successor of the number 1 and in many other ways. Yet Tarski could reply that we have to do all the time with the same object, named (or characterized) by signs ‘2’, ‘1 + 1’ and ‘the successor of 1’ and we should sharply distinguish numbers and numerals. Kleene (see [12], p. 158) points out that some uses of equality assume that it has properties expressed by (A1), (A2) and (A3), that is, reflexivity, symmetry and transitivity, but without (RR). He also remarks (pp. 163-164) that equalities in this weaker sense can be replaced by identities via equivalence classes. However, very much depends on the theoretical background. The elementary arithmetic of real numbers is decidable, although elementary Peano arithmetic is not. At first sight, this is surprising because the theory of real numbers is stronger than the arithmetic of natural numbers in the sense that the former is an extension of the latter and has a greater expressive power. The explanation is that in elementary arithmetic of real numbers we have no resources to characterize the predicate ‘is a neutral number’, although we can say that 2 and 1 + 1 belong to the same equivalence class. This illustrates that the concept of identity raises some problems even in pure mathematics.

(C) How to treat substitution in identity-sentences with respect to co-referential names and descriptions? Clearly, we accept (a) ‘London = London’ as a tautology. On the other hand, (b) London = the capital of the UK expresses more than (a), although the latter resulted from the former by substituting, pace co-referentiality, ‘the capital of the UK’ for ‘London’. The problem is that an application of a standard logical rule of replacement can change the cognitive content of a sentence.

(D) How to treat intensional context with respect to co-referential terms? Assume that a person S knows that London is the capital of the UK. Yet it is possible that S does not know that London is the largest city in England, although both terms ‘the capital of the UK’ and ‘the largest city in England’ are actually co-referential. The problem is that substitution pace co-referentiality can change the logical value of a sentence, not only its cognitive content.

(E) Are objects changing through time identical? Personal identity is a good example here. Assume that a person S committed a crime at
time \( t \), but he or she was prosecuted much later at time \( t' \). It seems that responsibility, moral or criminal, assumes the identity of \( S \) at \( t \) and \( t' \). On the other hand, \( S \) certainly changed physically as well as mentally between \( t \) and \( t' \). Hence, \( P \) is not identical in the sense of (LR). On the other hand, ordinary intuition suggests that some changes, for example psychical illnesses, demolish personal identity, but others, even very serious ones like new political views, fully allow us to ascribe sameness.

(I) Is identity a logical constant? Typically, the answer is affirmative because fundamental metalogical results (semantic completeness, compactness, undecidability; the Löwenheim-Skolem theorem, the Lindström theorem) concern first-order logic with identity as well. However, there are some differences. Having identity, we can define numerical quantifiers of the type ‘there are \( n \) objects’, where \( n \) is an arbitrary natural number. Consequently, we can characterize finite domains, although first-order logic is too weak in order to define the concept of finiteness. Now, if we add the sentence there are \( n \) objects to first-order logic, its theorems are valid not universally, but in domains that have exactly \( n \) elements. Hence, it seems that identity brings some extralogical content to pure logic. Perhaps this is a reason that many logicians speak about the identity-predicate, although they simultaneously remark that this is a very special predicate. Anyway, a qualification of identity as logical or extra-logical is conventional to some extent.

(J) Is identity an absolute or relative concepts? Geach (see [6], and [8], [22] for an extensive analysis) argues that all identity is relative, that is, we should say that \( a = b \) with respect to a property \( P \). However, it is unclear whether every \( P \) suffices to define two objects satisfying the formula \( Px \) as relatively identical or whether properties in question should be essential. Two fundamental further questions arise in this contexts. Firstly, absolute identity seems a special case of relative identity in which all properties are taken into account; this immediately follows from (LR). Thus, Geach should reject this rule. Secondly, relative identity in Geachs sense seems to be dispensed with by the concept of equivalence class.

(K) Is there a criterion of identity? If we apply (RR) or (LR), no general criterion of identity is effective because nobody (at least, no human mind) can grasp infinite (or even very large) collections of properties. Hence, the only remaining way of how objects are to be characterized consists in constructing adequate theories related to selected domains. This question will be later illustrated by arithmetic of natural numbers.
(L) Does (RR) and (LR) concern arbitrary predicates or monadic predicates only? I decided to speak about monadic predicates for simplicity, but one could ask whether something more is behind that. Objects have not only properties, but they also stand in relations to other entities. Are relations also important for identity? Perhaps we should distinguish between internal relations as ensuing from the nature of things and external relations as accidental and conventional. For example, if $S$ is superior to $S'$ in an official hierarchy, this usually follows from a convention governing administrative dependencies in a given institution, but if we say that every person has parents, we appeal to natural internal relations. On the other hand, every relational n-termed predicate can be easily reduced to a monadic one. For example, instead of saying ‘$S$ (is the father of) $S$’, we might utter the sentence ‘$S$ is (the father of $S$)’. However, this grammatical move does not liquidate the difference between external and internal attributes.

(M) Are all identities necessary or are some of them accidental? Kripke argues (see [14]) that the axioms of identity entail that every identity is necessary. On the other hand, it seems that the identity ‘London = the capital of the UK’ is accidental. In general, every identity asserted on the basis of empirical evidence seems accidental. Let me only remark that the set \{(A1), (A2), (A3)\} contains one unconditional axiom, namely (A1) and two in the form of conditionals. Now, (A1) is the only theorem about identity which can be asserted unconditionally in the above sense, that is, preceded by the sign $\vdash$ without any application of (RR); thus we have $\emptyset \vdash (x = x)$ and no other identity formula has this property, except some trivial cases as, for example, $\vdash ((x = x) \land (x = x))$. This leads to the conclusion, that if we intend to keep the understanding of identity according to the Leibnizian intuitions, we should say that we assert substitutions of the formula $x = x$, according to (RR) and perhaps some additional assertions, empirical or not, dictating that all properties are taken into account.

Almost all noted problems are independent of the problem of transworld identity, although some of them, for example, (J), (K) and (L), seem more dramatic when the concept of possibility (possible world is involved). My further discussion requires some assumptions. I will consider only so-called hard or real possibilities (see [25]). This means that I will neglect worlds inhabited, for example, by unicorns or chimeras; the concept of hard possibility can be instantiated by the world in which Kazimierz the Great, the
Polish King in 1333-1370, would have a successor from the same dynasty (the Piast dynasty) or the world in which Aristotle stayed in Stagira for his entire life. My second assumption concerns the problem of how to read the formula

\((*) \ x = y\).

My reading is that it means

\((**\) \ d(x) = d(y),\)

that is ‘the denotation of the term \(x\)’ is identical with the denotation of the term \(y\). Thus, I adopt the objectual understanding of \((\ast)\). Thirdly, I recall the standard model-theoretical approach to individual constants, namely, that every such expression denotes something. This means that empty proper names are entirely excluded. Speaking otherwise, I do not use free logic. Eventually, proper empty names are always eliminable in favor of empty predicates. Fourthly, I will consider only interpreted languages; in formal considerations, it is sufficient to consider an interpretation as parametric, arbitrary, but fixed. Fifthly, I recall an elementary property of an interpretation: one object can be named by two individual constants, although every name has one and only one reference and the same concerns the denotations of predicates (they have sets, possibly empty, as semantic counterparts).

Now consider the following example. Although Kazimierz the Great had no successor from the same dynasty in our historical world, let us say \(W\), and was the last Piast on the Polish throne, we can consider the possible world, let us say \(W'\), in which he had a son, let us say Bolesław, who would become the Polish king. We might speculate about the future course of history, for example, think about the prospects of the Polish-Lithuanian union in the case of having a male successor by the last Polish king from the Piast dynasty. The last sentence is deliberately obscure because the last Polish king from the Piast dynasty in our historical world \(W\), would not be the last Polish king from this dynasty in the world \(W'\). Thus, we must introduce relativizations of our stories to particular worlds. The narration about \(W'\) has to be changed in many respects as compared with actual history. For example, Władysław Łokietek, Kazimierz's father would be the grandfather of Bolesław and so on. Hard possibilities, assuming that they are realized, lead to more than one change. The following questions arise: (i) Does the term ‘Kazimierz, the Great’ denote the same person in
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worlds $W$ and $W'$? (ii) Provided that we consider still another world, let us say, $W''$ in which Boleslaw had a younger brother, let say, Janusz, who became his royal successor, we ask whether the name ‘Boleslaw’ refers to the person in $W'$ and $W''$? (iii) What about the denotation of ‘Boleslaw’ in $W$, because Kazimierz had no son in our historical world? (iv) Do we need to assume that all possible worlds have the same individuals, which presupposition is certainly counterintuitive? All the above questions lead to the main problem of this paper, namely to the question of whether objects “living” in different possible worlds can be identical and, if so, under which conditions.

There are several proposals for answering the questions listed above. Kripke ([15]) distinguishes between rigid designators and non-rigid nominal phrases; the latter are instantiated by definite descriptions. Whereas rigid designators have the same reference in all possible worlds in which they exist, definite descriptions can possess different denotations in different possible worlds. For instance, ‘Kazimierz’ has the same reference in $W$, $W'$ and $W''$, ‘Boleslaw’ in $W'$ and $W''$, but the description ‘the last Piast on the Polish throne’ provided that Boleslaw and his brother had no sons, points to Kazimierz in $W$, Boleslaw in $W'$ and $W''$ and Janusz in $W'$ and $W''$. Hence, the referents of ‘Kazimierz’ are identical across $W$, $W'$ and $W''$, the referents of ‘Boleslaw’ are identical across $W'$ and $W''$; the same concerns ‘Janusz’, provided that Boleslaw had a son. This solution has a defect (see [2]), because Kazimierz in $W$ and $W'$ have different properties. A simple test for that consists in observing that the sentence ‘Kazimierz had a son’ is false in $W$, but true in $W''$. Kripke’s argument that sentence (v) ‘Kazimierz is Kazimierz’ is logically valid, but (vi) ‘Kazimierz was the last Piast on the Polish throne’ could be false in a possible world is not relevant here because if the denotation of ‘Kazimierz’ is fixed, any change in this respect does not result in a negation of this tautology. On the other hand, (vi) is not so stable. One can try to solve this difficulty by invoking essentialism or relative identity (see [1], [6], [8], [22]). However, we must meet already mentioned difficulties concerning essential properties and those deciding whether their possession suffices for relative identity. In general, any identity in which existing objects and non-existents are paired arises very serious metaphysical objections. An additional aspect of this difficulty consists in that we have a practically unlimited possibility of proliferating many possible worlds, even if we restrict our imagination to hard possibilitiers only. In our example, we can stipulate that Kazimierz
would have many children, including a daughter who could become the queen, contrary to Polish law in the 14th century and so on.

D. Lewis tried to overcome this difficulty by his theory of counterparts (see [16]). According to him, there are many possible worlds, different from our actual reality. Objects from our world have counterparts in other worlds. For example, Kazimierz in W has Kazimierz in W as the counterpart. The identity relation is replaced by the counterpart relation. Speaking otherwise, Lewis rejects transworld identity in favor of transworld counterparthood. Thus, individuals are world-bounded, that is, attached to particular worlds. Lewis treats all possible worlds, including the actual world as equally real. This assumption allows us to overcome the ontological difference between actuality and the realm of possibility. The Lewisian theory is strongly contested for its very high metaphysical cost (see several papers in [18]). Although I prefer a less expensive ontology, I am not convinced by the argument from the general ontological position. A more appealing problem seems to be the same as in the case of the idea of transworld identity, because it is unclear what is necessary for holding the counterpart relation. Lewis is fully conscious of this difficulty and tries to overcome it by a kind of mereological essentialism [see [19]), but I will not enter into this question. Perhaps I only note that every criterion of essentiality proposed hitherto seems to me problematic.

Clearly, the discussed problem is closely connected with the ontological status of possible worlds. For formal semantics this question has no particular relevance. The standard construction of semantics for modal logic supposes that we have the triple \( (K, W^*, R) \), where \( K \) is a non-empty set of possible worlds, \( W^* \) belongs to \( K \) and is considered as the actual world and \( R \) is a binary relation defined on \( K \). The expression \( W'R\ W^* \) is read as “the world \( W' \) is accessible from (is an alternative to, is possible with respect to) the world \( W^* \); in the present considerations, it is proper to use the formula \( W'R\ W^* \), expressing that the world \( W' \) is accessible from the real world. In our example, we think about the world in which Kazimierz the Great had a son Bolesław as accessible from the real world, according to our ways of describing possible courses of history. What are possible worlds? The answer depends on our tasks. Semantics for modal logic requires that one world is distinguished as a point of reference and no philosophical commentary is needed. However, the issue becomes much more complicated, when we enter philosophy, ontology in particular. There are several an-
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I claim that the simplest way to analyze the issue is to use the standard metological construction. I will identify possible worlds with models of maximally consistent sets. An example from arithmetic is helpful here. It is well-known that Peano arithmetic ($\mathbf{PA}$) has the standard or intended model $\mathbb{N}$ and uncountably many non-standard models, not isomorphic with $\mathbb{N}$. The standard model forms the initial segment of every non-standard model. Consequently, we have uncountably many maximally consistent sets related to particular models of $\mathbf{PA}$. Speaking otherwise, these sets are true in some models and we can consider them as theories of models in question; in fact, any description of theories of non-standard models might be very general. Now, we can regard $\mathbb{N}$ as the real model of arithmetic and non-standard ones as its alternatives. In this case, the alternatives are equally ontologically real as $\mathbb{N}$. All models are abstract set-theoretic structures, having different universes, partly different objects; in particular, they differ with respect to the type of ordering relations (see [11], [13]). Since $\mathbb{N}$ is the initial segment of every non-standard model of $\mathbf{PA}$, a natural suggestion is that elements of $\mathbb{N}$ are identical in all models. However, we encounter here a difficulty.

Assuming that we have an interpreted first-order language $L$ and a given theory $T$ formulated in $L$, a semantic model of $T$ is the structure $(U, u_1, u_2, u_3, \ldots, U^1, U^2, U^3, \ldots)$, where $U$ is a non-empty set (the universe of discourse), $u_1, u_2, u_3, \ldots$ are distinguished elements of $U$ (references of individual constants, if they occur in $L$) and $U^1, U^2, U^3, \ldots$ are subsets of $U$ (possibly empty) and can serve as denotations of predicates from $L$. I recall that $L$ has unary predicates only. If $M$ and $M'$ are models of $L$, they can differ (a) by universes, (b) by distinguished individuals or correlation of constants with their references, and (c) by distribution of individuals over subsets of $U$. Now, if $u_n \in U^n \subset U(M)$, $u_n \in U'^n \subset U(M')$ and $U^n \neq U'^n$, this object can have different properties: properties are treated here extensionally. If $U$ is arbitrary, no individual constant is distinguished and predicates are interpreted parametrically, that is, without selecting some subsets of $U$, we have to do with pure logic; other cases lead...
to applied logic. A special situation arises when \( M = \langle U, U \rangle \). This means that we depicted the only property (or quasi-property), namely ‘to be an object in \( M' \). Nevertheless, I will not consider this possibility. Similarly, I neglect \( M \)'s in which some objects are distinguished, but without including them into some subsets of \( M \); such objects are usually regarded as bare particulars.

Now, let me return to arithmetic. Assume that \( M \) and \( M' \) are two models of \( \text{PA} \) such that the former is standard (= \( N \)), but the latter non-standard. If we take any natural number \( n \in U \), we immediately obtain \( n \in U' \). Since \( U \neq U' \), we should conclude that \( n \) has different properties in \( M \) than in \( M' \). How to avoid this counterintuitive conclusion? Nothing is given by adopting the intensional understanding of properties because it has no importance for the concept of interpretation and model. The only way is to say that \( N \) is isolated in every non-standard model in such a way that the difference \( U' - U \) has no importance for properties of natural numbers. There are some ways to justify this claim. Firstly, \( \text{PA} \) as the theory of \( N \) characterizes completely the concept of natural numbers. Yet \( \text{PA} \) must be taken here as the set of all truths about \( N \), but not as the set of consequences of Peano axioms. This follows from the (first) Gödel incompleteness theorem interpreted as the assertion that no finite set of axioms completely characterizes the concept of natural number. At first sight, this seems to support the conclusion that ordinary natural numbers have different properties in different models. However, we observe that all models of second-order Peano arithmetic (\( \text{PA}^2 \)) are isomorphic, assuming that the concept of set is absolute. Although \( \text{PA}^2 \) does not overcome the incompleteness theorem, the existence of non-standard models is not relevant to the properties of ordinary natural numbers. Speaking otherwise, the difference \( U' - U \), due to isomorphism of \( \text{PA}^2 \), does not block the isolation of \( N \) as parts of non-standard models. In fact, going to higher-order logic raises the problem of how sets should be characterized but this question does not determine the metamathematical properties of theories, at least in the case of \( \text{PA} \). We have here an example of how the criteria of identity work. The only way is to believe that theories of particular objects are adequate and thereby sufficient in this respect. However, no uniform and complete formal criterion is available even in mathematics and we must combine the extensional treatment of properties with their intensional understanding. Formally speaking, one can argue that, due to the difference \( U' - U \), ordinary natural numbers have some additional
properties, although we are not able to grasp them by a theory of \( M' \); in fact, such a theory is not available. Anyway, we have an intuitive reason for establishing identities across different models (transmodel identities, so to speak), between standard elements as well as between non-standard objects.

Are we entitled to apply the above analysis of \( M \) and \( M' \) to empirical matters? First of all, the difference between the real world and only possible worlds is important also from the ontological point of view, contrary to pure mathematics. Assume now that \( T \) is a maximally consistent set of statements about empirical reality. Yet it is very dubious whether this reality is a model conceived as a set-theoretic structure. If we assert that \( M \) is such a structure, we should add that we are dealing with a representation of the real world. Similarly, we can speak about other maximally consistent sets as representations of possible worlds. This approach has advantages and disadvantages. The main profit consists in the ontological equating of all worlds: they are formal constructs, that is, semantic models. The minus is that there is no direct relation between \( L \), \( M \) and entities belonging to worlds, in particular to the real world \( W^* \). This might be improved in the following way. Let the function \( f \) map \( L \) into \( M \) and the function \( g \) correlate \( M \) with \( W^* \). Consequently, a relation between \( L \) and \( W^* \) is indirect as given by composing \( f \) and \( g \). Formally, we have \( f : L \rightarrow M \), \( g : M \rightarrow W^* \) and \( g(f) : L \rightarrow W^* \). Due to this manoeuvre, one can speak about semantic relations between \( L \) and \( W^* \), for instance that a formula \( Px \) is satisfied or not by an object \( o \). The same is to be said about relations between \( L \) and other possible worlds. To some extent, this solution recalls the counterpart theory but the fundamental difference is that formal representations of the world are ontologically equalized, not worlds themselves. The function \( g \), essential in the above scheme, is not produced by interpretation of \( L \) in \( M \) only and works in various ways, difficult to describe in advance. Sometimes it is a result of empirical investigations, sometimes it is determined by theories, but sometimes it depends on imagination; of course, mixed cases are also possible. However, one should sharply distinguish truths based on empirical investigations from a situation where the content of possible worlds is imagined, for example, when we stipulate that Kazimierz the Great had sons as well as daughters. The only indispensable requirement which is related to the assumption that we consider hard possibilities claims that our counterfactual imagination should be coherent with accumulated knowledge, but even this constraint must be taken cum grano salis.
What about the transworld (transmodel) identity with respect to the empirically given $W^*$? First of all, the ontological difference between the real world and its possible alternatives must be taken seriously. Hence, any identity in which existing objects and non-existents simultaneously function as arguments of the function $= \,$ is problematic. Speaking otherwise, the concept of the transworld identity holding between objects belonging to worlds having different ontological status seems meaningless. Thus, the only way is to stay with models as abstract structures. The next step should consist in explaining how to point out the model related to the real world (I follow some points presented in [31]). It seems that we have no chance to choose a maximally consistent set of sentences related to $W^*$, although we know that such a set exists. If we think about possible scenarios of Polish history in the 14th century, we isolate a certain fragment of historical reality and construct its various possibilities. This suggests considering the real world as the common part of all possible worlds, perhaps relative to a selected time $t$. Assume that this object is described by a set $X$ of true (or considered as true) sentences. Since, $X$ is consistent by our assumption, it possesses a semantic model $M$. Now, we add new truths to $X$. For example, $X$ can be the set of truths about Polish history until 1370 (the death of Kazimierz the Great). We add a new sentence $A$, namely ‘Kazimierz the Great’ had a son who became his royal successor’. Another possibility is to add the sentence $B$ which says that Kazimierz the Great had a daughter who became his royal successor. The sets $Y = X \cup \{A\}$ and $Y' = X \cup \{B\}$ are consistent, but only provided that the term ‘Kazimierz the Great’ denotes a different person. Although this move is very problematic in our real (empirical) historical world, it can be easily executed in formal semantic models. Now, we can employ an analogy with arithmetic in the following way. Let us take the model restricted to the selected historical past as standard and constituting the initial segment of every model related to historically possible worlds. These additional models are non-standard and contain non-standard elements, for example, Kazimierz the Great as the father of the king, Kazimierz the Great as the father of the queen, and so on; strictly speaking, we should distinguish Kazimierz the Great, Kazimierz the Great’, Kazimierz the Great”, etc.. Speaking otherwise, non-standard worlds are variants of the real world. Due to our historical knowledge, we can isolate standard parts of models from their non-standard fragments, although we have no metamathematical resources helping here.
This is a peculiarity of empirical knowledge.

Identity can hold either between standard objects or between non-standard ones. Thus, Kazimierz the Great is the same person in all models; the same concerns ‘Bolesław’, the imagined son of Kazimierz in all worlds in which he exists and has the same properties. Possible stories about Aristotle provide another example. The standard Aristotle was born in Stagira as a son of a physician, went to Athens, studied with Plato and became a philosopher. However, he could remain in Stagira, continue his father’s profession, never go to Athens and have nothing to do with philosophy. Alternatively, he could go to Athens and become a student of Aristipus. Thus, we have to distinguish the standard Aristotle and several non-standard Stagirites. This approach allows us to say that all non-standard variants of real objects are their counterparts in the Lewisian sense, although, to repeat once again, equal ontological status concerns only models as formal structures. It seems that Lewis confuses the real world in the normal sense and as a semantic representation. The latter is simply a space of points with some distinguished subsets extensionally representing properties, whereas the former consists of real things and their attributes, probably composed mereologically, not set-theoretically. This idealization much simplifies the situation and allows us to solve the transworld identity problem in a way.

In fact, we define the identity predicate on this abstract space, not on the domain of empirically given objects. At least two questions remain open. Firstly, we should explain the ontological status of formal structures. I can say nothing here, except pointing out that no additional difficulty arises as compared with discussions in the philosophy of logic and mathematics. The concept of possibility is eliminated in favor of a plurality of maximally consistent sets and their models. I consider this as an advantage. Secondly, the problem of the identity of empirical objects remains untouched. However, it is largely independent of the issue of transworld identity.

References
