

## MODAL SEMANTICS OF THOUGHT EXPERIMENTS. TE MATRIX AND PWS

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**Abstract:** In this paper, we discuss a couple of nonclassical logics and their application in the analysis and interpretation of thought experiments (TE, e.g. Tamar Gendler, Roy Sorensen, Ronald Laymon), particularly modal logic. After discussing pros and cons (e.g. W. Van O. Quine) of modal logic, we opt for Saul Kripke's frame semantics, possibly described as possible world semantics (PWS), involving a set of (possible) worlds, considered as abstract entities (e.g. Kit Fine 2017), as pictured by search engines like Google and Baidu, an accessibility relation, and a satisfiability relation. On retaining principle of bivalence, we provide for underpinnings of the methodology of TE Matrix, whereby the possible worlds (PW) of TE arguments (premises and conclusions) pick out accessible PW (as from axioms to principles) unto the argument is both formally and informally logically validated (*i.e.* logical inference is valid, premises and conclusions are true—so, argument is sound) and we don't need to prescribe any forcing formal validation function (*Descriptive Semantics View*).

**Keywords:** semantics, thought experiments (TE), TE matrix, plausibility logic, modal logic, possible world

### INTRODUCTION

In this paper, we discuss modal logic, opponents, proponents, Saul Kripke's frame semantics and proposal of a descriptive (vs. prescriptive) semantics including a set of possible worlds (PW, pictured as a search engine like Google or Baidu), accessibility relation and satisfiability relation, as in their application to analyses

and interpretations of thought experiments (TE, *e.g.* Tamar Gendler, Roy Sorensen, Ronald Laymon), particularly, TE Matrix, a TE typical notation indicating (as by bracketing), first, that formulas represent thoughts, propositions—not facts nor states of affairs in reality—and, second, that TE are not formally valid arguments yet but still incomplete, unfinished, elliptical arguments or enthymemes. On retaining principle of bivalence<sup>1</sup>, application of TE Matrices may involve a procedure of some steps, of which the last one is a formally valid and sound argument that can do without brackets. TE steps may include [TE]<sub>RS</sub>, or TE in a restricted sense, [TE]<sub>BS</sub>, or TE in a broad sense, unto [TE]<sub>EX</sub>, or extended TE. Examples are many, *e.g.* Descartes's *Cogito* (see Hertogh 2016), mathematical TE, such as (Archimede's) *Proof of Surface Area of Sphere* and Euler's *0.999... Equals 1* (see Hertogh 2021a), Einstein's *Elevator* (see Hertogh 2024a).

## OPPONENTS OF MODAL LOGIC

It should be noted that there are philosophers who don't use modal logic because they think, *e.g.*, it is not a transparent or coherent methodology or apparatus.

W.V. Quine (a/o) restricts logic to extensional logic, and Ch 6 of *Word and Object* describes his 'flight from modality'. When one could expect realist modal entities, such as David Lewis's, to be cut away by Occam's razor, Quine's account seems rather moderate and directed against extreme sense of necessity as analyticity (*e.g.* necessarily  $9 > 4 = '9 > 4'$  is analytic) (Quine 1960, 196) and quantification in modal logic (debate with Ruth Barcan Marcus, *see* Marcus 1990). Nevertheless, logical modalities are seen as 'obscure idioms', associated with 'illustrations of opacity', necessity, an unconditional and impersonal 'absolute mode of truth', necessary and contingent related to 'venerable' but 'surely indefensible' distinctions as essence and accident, internal and external relation.

In any event, I feel that the best claim of modal logic upon our attention is rather as a by-product of positing propositions than as a purpose of positing them. (Quine 1960, 202)

Quine seems to adhere to logical modalities as necessarily and possibly as some sort of propositional attitudes, but eventually he decides to dispense with intensional objects altogether.

Though accepted and applied by many logicians and philosophers nowadays, encyclopaedias as *Wikipedia* still list modal logics (including binary truth value functions) and many-valued logics (as probability logic including truth values of any real number between 0 and 1) as nonclassical or nonstandard logics, restricting classical logic to Aristotle's theory of syllogisms, Boolean logic and Gottlob Frege's first-order predicate calculus, classical logic 'reached fruition' in Bertrand Russell, A. N. Whitehead's *Principia Mathematica*, and Ludwig Wittgenstein's *Tractatus Logico Philosophicus*<sup>2</sup>.

Since modal TE can be considered part of metaphysics, we may include Transformation Rules or Substitution Theses to the TE Matrix, whereby cumbersome, controversial or opaque TE can be replaced by non-TE experiments or non-TE, nonmodal analogues, examples and arguments (*see* Hertogh 2015a, Chap. 16 *TE Matrix and TR/ST*, specifically TR2/ST2 and TR3/ST3).

## HOW MODAL LOGIC HOOKS UPON THE WORLD

Many analytical philosophers have developed modal logics, such as C.I. Lewis (S1 - S5), David Lewis and Rudolf Carnap. In Wittgenstein, there are a couple of proposals on possibility. Carnap's proposal is said to come close to Kripke's.

We will discuss the issue for the same reasons as we discuss and accept the existence of I and God, that is, these notions are common usage not just in our Western societies but in societies all over the world, and are related to institutions and communities of believers.

E.g. believers in the I may read or study psychology, visit psychologists, and so on, believers in God may visit churches, synagogues, mosques, temples, etc. Believers in probability and statistics may be eager to read statistics on topics of their interest, e.g., go and see the blockbuster movie of the season, purchase the latest computer model X because it was proven to be the best one in recent market research, etc.

These considerations are on a par with the semantics of natural language that join ideals of logical calculi and ‘theoretical languages’ (Carnap) to ordinary language philosophy.

The existence of entities as I, God and possibilities are presupposed and mentioned in laws and constitutions all over the world as right on pursuit of happiness (as related to issue of pain in consciousness studies), freedom of practicing one’s (as related to religious thought experiments RTE), right on (statistical) information, personal freedom as concerning choice of lifestyles, cultures etc.

In most countries, the government is selected by use of statistical methods, such as counting of votes and the President is considered the best available politician on purely quantitative grounds as having received the highest number of votes. Next to this factuality, citizens are free to agree or disagree, assent or dissent, assemble and disassemble, have personal lifestyles and preferences, dreams and fears, but we should add, if and only if these are not fascist, racist, sexist, etc.<sup>3</sup>

Next to societal reasons, there is evidence from evolutionary biology, psychology and cognitive science that supports modal reasoning, e.g. Nicolas Rescher introducing his logical account of TE like this:

In intellectual regards, *homo sapiens* is an amphibian who can live and function in two different realms—the domain of actual fact, which we can investigate in observational inquiry, and the domain of imaginative projection, which we can explore in thought through reasoning. This second ability becomes crucially important for the first as well. (Rescher 1991, 310)

The realm of imagination consists of objective and subjective imagination. We include the former, objective imagination (or OI), in modal logical analyses as collective popular and academic imagery of a culture, possibly part of or additional to conceptual schemes (Quine 1951/1980, Davidson 1974), webs of belief (Quine and Ullian 1978), etc. We think of mass-produced imagery as after Walter Benjamin's *The Work of Art in the Age of Mechanical Reproduction* (1936/1968), which is about mechanically reproducible processes, such as photographs and movies, preferably global cross-cultural images and concepts, that occur in more than just one culture. Objective imagination consists of a corpus of narratologies and visualisations of a culture, which may account for the main additional features of TE.

Also subjective imagination is part of our modal logic, as we don't prescribe a finite set of PW (for **W**) and allow for unspecified accessibility relations (R).

### SAUL KRIPKE'S FRAME SEMANTICS

The preface to Saul Kripke's 1980 *Naming and Necessity* explains his 1970 Princeton University lectures on correct and incorrect conceptions of PW (possible worlds). In the next quotes from pages on relation to probability, Kripke calls on an example, in fact a TE from experience<sup>4</sup>, from statistics, throwing two dice A and B and describes PW as an idealisation and abstract entities like the main features we have identified in TE.

I will say something briefly about 'possible worlds' (...). In the present monograph, I argued against those misuses of the concept that regard possible worlds as something like a distant planet, like our own surroundings, but somehow existing in a different dimension, or that lead to spurious problems of 'transworld identification'. (Kripke 1980, 15)

An analogy from school—in fact, it is not merely an analogy—will help to clarify my view. Two ordinary dice (call them die A and die B) are thrown (...). The thirty-six possible states of the dice are literally thirty-six 'possible

worlds', as long as we (fictively) ignore everything about the world except the two dice and what they show (and ignore the fact that one or both dice might not have existed). Only one of these miniworlds—the one corresponding to the way the dice in fact come up—is the 'actual world', but the others are of interest when we ask how probable or improbable the actual outcome was (or will be). (Kripke 1980, 16)

The thirty-six possibilities, the one that is actual included, are (abstract) *states* of the dice, not complex physical entities. (Kripke 1980, 17)

'Possible worlds' are little more than the miniworlds of school probability blown large. (...) A practical description of the extent to which the 'counterfactual situation' differs in the relevant way from the actual facts is sufficient; the 'counterfactual situation' could be thought of as a miniworld or a minisate, restricted to features of the world relevant to the problem at hand. (Kripke 1980, 18)

There is nothing wrong in principle with taking these [possible worlds], for philosophical or for technical purposes, as (abstract) entities. (...) The notion of a 'possible world', though it has its roots in various ordinary ideas of ways the world might have been, comes at a much greater, and subsequent, level of abstraction. In practice, no one who cannot understand the idea of possibility is likely to understand that of a 'possible world' either. (Kripke 1980, 19 incl. n18)

Kit Fine (2017) adds: “[t]he abstract approach to modal logic championed by Kripke’s early work (in which possible worlds are simply regarded as arbitrary points rather than as models or sets of sentences) has been a great boon to the formal development of modal logic”<sup>5</sup>, explaining about truth maker semantics:

It should be noted that our approach to states is highly general and abstract. We have formed no particular conception of what they are, nor have we assumed that there are 'atomic' states, from which all other states can be obtained by fusion. Nearly all of the existing literature on the topic has failed to adopt such a neutral perspective. Thus, states are often identified with sets of possible worlds (where the worlds themselves might be identified with sets of sentences), or it is assumed that all states are constructed from atomic states which are somehow isomorphic with the atomic sentences of the language under consideration. (...) Nothing is gained by this lack of generality or abstraction, and a great deal is lost. For one thing, the particular identifications or assumptions may not be appropriate in certain contexts. (...) The technical development of the subject also requires a more abstract approach. For one

will want to perform certain constructions on state spaces (forming product spaces, for example, or congruent spaces) in which the special identifications of or restrictions on the original spaces are lost.

As with regard to application to analyses and interpretations of TE, we will consider PW theoretical constructs, that is, theories and arguments and their constituents as propositions, presuppositions, premises, conclusions, axioms, theorems, derivations, regularities, laws, properties of theories, epistemological and scientific principles.

As all parts of a TE are abstract or modal, we propose to bracket all of the TE argument in TE Matrices instead of having only the TE minor preceded by, e.g., a diamond operator as in hypothetical, counterfactual, etc. analyses (Häggqvist 2009). In both features of idealisation and abstract entities, PW are close to our basic theory of TE (*see* Hertogh 2021a on mathematical thought experiments MTE). If more qualitative aspects are at stake, PW can be additionally pictured with the help of narratology and visualisations.

Kripke's quote on page 17 may be directed against David Lewis's realist ontology of PW, and the quote from page 15 may possibly argue against TE as *Twin Earth*, *Doppelgangers*, *Twins*.

Pictured as abstract entities, PW subsume firstly under the category of *Symbolic TE*; PW are quite consistent with conceptions of theoretical constructs. Qualitative properties are added in *Indexical* and *Iconic TE* (*see* Hertogh 2015a), and sometimes they are reduced to modal-logical possibilities by thought experiment philosophers like Robert Kirk and David Chalmers (*see* Kirk 1974a,b and Chalmers 1996). *Zombie Replica* and *Zombie World*, when zombies are defined from “[t]he conceivability argument for the possibility of zombies”, as in Kirk 2023 (*see* also Hertogh 2023a, and e.g. Gendler and Hawthorne 2002 on conceivability and possibility).

## MODAL SEMANTICS

We will now turn to the underpinnings of modal assessments of TE

arguments, although modal TE arguments are rather rare. We propose some possible changes to available proposals of modal semantics, and in the next sections, we discuss usual elements of frame semantics  $\langle W, R, |= \rangle$  on a descriptive (instead of prescriptive) semantic interpretation.

We guess a descriptive semantics is needed that is in accordance with natural languages, conceptual schemes, webs of belief and (advanced, fundamental, and applied) scientific developments, as well as our semantics don't enclose, nor imply a prescriptive set of (P)W, accessibility relation R or truth functional validation interpretation (apart from satisfiability relation " $|=$ ").

#### DESCRIPTIVE SEMANTICS

Even though we use terminology of frame semantics and Kripke's PWS, our treatment of TE remains within descriptive semantics; that is to say, we withhold from prescriptive truth-functional interpretations.

Our semantics are descriptive as mediated by available and accessible intermediary PW instead of a prescribed valuation or validation function. The intermediary PW can relate again to the actual world, whereby a particular disputable proposition as a TE premise may be satisfied.

A disadvantage of descriptive semantics may be the intermediary step of intermediary PW, while in daily reality a TE is as direct, arises as spontaneous, as any other thought, although quite often, even in real-life conversation, it is introduced by a TE indicator (like 'imagine', 'consider', etc.).

This disadvantage, however, hardly weighs against the obvious disadvantages of prescribed semantics that can't really be considered a scientific account of natural language or reasoning. Truth value prescriptions are a part of formal logic that may cause criticisms of authoritarianism, dogmatism, otherworldliness, being out of touch with reality, and so on.

Also in descriptive semantics, we can assign truth values in a metalanguage, like this:

[1]

*Suppose*

$\langle W, R, | \Rightarrow \rangle$  triple of set of PW, accessibility Relation, satisfaction relation

$w_0$  actual world

$\varphi$  proposition variable

Metalanguage

T True

F False (not True)

= =truth value

$w_0 | \Rightarrow \varphi$   $\varphi_{w_0} = T, \varphi = T_{w_0}, \varphi$  is true in the actual world, exists in  $w_0$

$w_0 | \Rightarrow \neg \varphi$   $\varphi_{w_0} = F, \varphi = F_{w_0}, \varphi$  is false in the actual world, does not exist in  $w_0$

This vocabulary is, of course, too complex for nonmodal statements, where we can keep on using nonmodal logic and don't have to relate propositions to any PW.

[1] is an example that shows how truth values T and F can be assigned to modal PWS propositions in these K(-like) semantics without any additional formal validation interpretation, except possibly the equality sign "=", which wants to say "=truth value", e.g., " $\varphi = T$ " signifies the truth value of  $\varphi$  is T(rue), which is part of the metalanguage.

Our research is only about TE, and we have given some examples of how to analyse modal TE applying modal K semantics in previous publications (particularly Hertogh 2023a on *Zombies*).

Descriptive semantics may be in need of some more explanation, and we will give an example of how to analyse and interpret fictional entities. As we will see, it depends on how we define our relevant concepts.

In a statement like:

There are flying humanoids. (1)

The predicate 'flying humanoids' can be satisfied by PW of fictional entities, myths, religious imagery, etc., but probably not by the actual

world, unless it is a mediated actual world in fiction, as when the sentence is from a fictional discourse.

The concept of flying humanoid is rather abstract and general, but it satisfies the *global cross-cultural thesis*, since it can be exemplified in more than one way, in more than just one culture. It can be pictured by, e.g., attributes like wings as in Western cultures, or (invisible) *qi* (氣) as in Chinese cultures. We exclude from the property flying of flying humanoids any possible help of external attributes, objects, like broomsticks, magical carpets (Arabic and Indian cultures), and aeroplanes in contemporary (post)modern culture.

(1) is grammatical, makes sense, etc., because of satisfaction in PW of fictional entities, but as none of this set is satisfied by reality, the statement itself is considered false.

This is a usual analytical interpretation of (1).

On analysis:

[2]

*Suppose*

$\langle W, R, |= \rangle$  set of PW, accessibility Relation, satisfaction relation

$w_0$  actual world

$w_1$  PW of fictional entities

FHx x is a Flying Humanoid, being a Flying Humanoid

$\exists x \text{ FHx}$  there are flying humanoids

$w_1 |= \exists x \text{ FHx} \wedge w_0 |= \neg \text{FHx}$

This analysis depends on the definition of the actual world. Usually it is (mesolevel of) Planet Earth, but in this case it is relevant if it is Planet Earth in a mere physical sense, or a humane Earth including conceptual schemes, webs of belief, objective imagination (OI), etc.

The formula is false (not true) in the mere physical actual world ( $w_0$ ), but the same formula can be true in a broad humane sense of  $w_0$ , say,  $w_{OI}$ , where  $w_{OI}$  includes objective imagination, of which flying humanoids are a traditional element.

On additional analysis

[3]

*Suppose* $w_{OI}$  actual world including OI (objective imagination) $w_{OI} \models \exists x FHx$ 

On this analysis, (1) is true. This analysis is usual in semiotics, and analytical philosophy has already been extended to enclose intensions next to extensions, analytical analogues of resp. connotation and denotation.

Nevertheless, we will hold on to postanalytical analyses where the existence of fictional entities, such as flying humanoids, can be expressed by stipulation of  $w_{OI}$ , but the criterion of real existence remains satisfaction by the actual world  $w_0$ .

So, we conclude the next formula for (1)

[4]

 $w_{OI} \models \exists x FHx \wedge w_0 \models \neg FHx$ 

Please note that the logical analyses don't only depend on the definition of the actual world but also on the definition of a flying humanoid. When including aeroplanes, the statement is satisfied in the actual world, too, and we don't need OI to decide upon its intensional truth value. Furthermore, when someone or something exists in the actual world, she/he/it also exists in  $w_{OI}$ .

We suppose—possibly with Yablo—that if there are any disagreements about statements on fictional entities or any other entities, conceptual analyses are a first device for resolving conflicting interpretations.

We may conclude with reference to PhD thesis, Hertogh 2015a, 301 (Section 10.3.3). Descriptive Semantics View (DSV): We remain within descriptive semantics by avoiding unnecessary and possibly overcomplex detailing of methods, as by stipulation of finite sets of (P)W, accessibility relations R and validation functions. In this way we are able to account for the richness of natural language, conceptual schemes, objective imagination etc. and, thus, we allow for a(n) (near-)infinite set of PW and don't specify accessibility relations in advance (as to include subjective imagination as in the

field of language, use of metaphors, personifications etc. that may give sense to sentences that were traditionally considered nonsensical).

Prescriptive semantics is in need of adjustments and criticisms from descriptive semantics, quoting from Carnap's 1950 *Empiricism, Semantics and Ontology*:

To decree dogmatic prohibitions of certain linguistic forms instead of testing them by their success or failure in practical use is worse than futile; it is positively harmful because it may obstruct scientific progress. (Carnap 1956, 221)

#### SET OF PW (W)

First, we suppose a(n) (near-)infinite set of PW without attempting to specify them apart from  $w_0$  and  $w_{01}$  as, respectively, the physical actual world and the humane actual world including objective imagination.

We particularly apply PWS in definitions of (metaphysically) 'necessary' and 'possible' as *universal* and *existential quantification* over PW. On the presupposition of a(n) (near-)infinite set of PW, 'necessary' could only be stated with the help of infinitesimal calculi, where 'infinite' still does not need to have traditional literalist or metaphysical senses, but could metaphorically mean something like *near-infinite*, i.e., a near-innumerably, near-uncountably or near-inexplicably large number.

However, if we were to *prescribe* a *finite* set of PW, the semantics proposal would not be scientific and realist anymore, as with the goal of describing a natural language, a conceptual scheme, etc., for any natural language has a larger number of possible sentences (including examples from objective imagination) than can be predefined in a prescriptive semantics.

The advantage of (K-style) PWS (of universal and existential quantification over PW) over (S-style) modal logic with *box* and *diamond operators* is that, in the former, particular PW can be

exemplified, and truth or falsity in specific PW can be asserted, which is not possible in the latter. We could also add subscripts to box and diamond operators like  $\Diamond_{w_0}$  and  $\Box_{w_0}$ , but this is rather unusual.

One more advantage is that we can include box and diamond operators in K and thus express the six modalities (as properties of propositions) within a (set of) PW as by applying Carnap’s table (Carnap 1956, 175), respectively, necessary, impossible, contingent (factual), non-necessary, possible, noncontingent.

[5]		
$w_1 \mid = \Box \varphi, \neg \Diamond \neg \varphi$		in $w_1$ it is necessary/necessarily true that $\varphi$
$w_1 \mid = \Box \neg \varphi, \neg \Diamond \varphi$		in $w_1$ it is impossible/it can’t be true that $\varphi$
$w_1 \mid = \neg \Box \varphi \wedge \neg \Box \neg \varphi, \Diamond \neg \varphi \wedge \Diamond \varphi$		in $w_1$ it is contingent(ly)/a fact/factual(ly) true that $\varphi$
$w_1 \mid = \neg \Box \varphi, \Diamond \neg \varphi$		in $w_1$ it is not necessary/necessarily true that $\varphi$
$w_1 \mid = \Diamond \varphi, \neg \Box \neg \varphi$		in $w_1$ it is possible/possibly true that $\varphi$
$w_1 \mid = \Box \varphi \vee \Box \neg \varphi, \neg \Diamond \neg \varphi \vee \neg \Diamond \varphi$		in $w_1$ it is not contingent(ly)/a fact/factually true that $\varphi$

The third and sixth formula, contingent and noncontingent, are that intricate including conjunction or disjunction that one can preferably keep on using nonmodal proposition and predicate logic for factual statements within a world—as we already did in analyses of the TE for we usually restrict the use of modal analyses to some cases, as when thought experimenters (David Chalmers) state a TE (as *Zombie World*) as a logical possibility.

Nevertheless, modal logic can lead to complex discussions, as in Kripke 1980’s (where nonquality sign is informally used as part of object language):

$$\text{pain} \neq \text{C-fibers firing} \tag{2}$$

Because this statement can have a second modal, necessary sense now:

pain  $\neq$  C-fibers firing (3)

which may be equivalently indicated by  $\neq \square$  (or  $\neq \equiv$ , no strict or necessary equivalence).

We have argued that in this and more antimaterialist TE, the TE only defeat strong, necessary theories of materialism (*see* Hertogh 2015a and 2023a).

S-style modal interpretations can express shades of meaning within a PW, that is, differentiate between slight nuances of meaning as:

[6]  
 $w_0 \models \neg \diamond \varphi$   $\varphi$  is not possible or does not exist in the actual world

Example:

Today it is February the 30th. (note 5) (4)

possibly disambiguating from [1]

[7]  
 $w_0 \models \neg \varphi$   $\varphi$  (does possibly exist but) is F in the actual world

Example:

Today it is March 2nd. (5)

when, in fact, today it is August 12th.

Possibly (4) can be understood metaphorically or just a (human or computer) mistake or a line from fiction, in fact, indicating (5) or a fictional world, on which interpretation (4) is metaphorically true or false, or true or false after error elimination, or true or false in a fictional world (e.g. a novel with different calendar or involving a character that makes mistakes stating dates etc.).

Natural language is usually ambiguous, and these disputable differentiations may come down to logically intrusive translations. However, these disambiguations do prove useful in philosophical and scientific discussions, as on (2) and (3), Kripke's proof that we are all intuitive dualists.

We define only athletic modal TE designators, concepts, properties, etc., but on a pragmatic presupposition of S(peaker) and H(earer) communication situation, as from narrow to broad:

physical possibility--nomological possibility--metaphysical possibility--logical possibility

Physical possibility is about physics, nomological possibility about derived sciences such as chemistry, biology, etc., metaphysical possibility about what goes beyond physical or nomological possibility.

We use the notion of objective imagination (OI) to account for metaphysical possibility, e.g. flying humanoids are physically and nomologically impossible, but they are metaphysically possible; they have never been observed in the real world, but they are a familiar part of OI, although exemplified slightly differently in different cultures.

An alternative to Chomsky's (1957/2002) famous nonsensical example:

Colourless purple ideas walk furiously. (6)

We consider grammatically and logically possible (though sortal incorrect), the latter on a metaphorical interpretation of (6) as a statement on nerd culture. Because of sortal incorrectness, it is a connotative statement without denotation, intension without extension--it does not denote or refer to anything but has a variety of connotations, intensional senses.

And only a statement like:

Vxrqqz w,,,, ... wnmn i ... p k. (7)

we consider nonsense or an unidentified string of signs or sounds.

Examples from OI that satisfy additional cross-cultural conditions are many, flying men (e.g. Ibn Sīnā's *Flying Man*, Einstein's *Chasing a Beam of Light*), invisibility (e.g. Plato's *Ring of Gyges*), humanoids (e.g. *Zombies*, *Aliens*), humanoid horror (e.g. Bram Stoker's *Dracula*, Mary Shelley's *Frankenstein*), humanoid extraterrestrials (e.g. *Martians*,

*Doppelgangers*, Steven Spielberg’s *ET*), humanoid animals (e.g. Nagel’s *Bat Personification*, fables), humanoid objects (e.g. Chalmers’s *What Is It Like to Be a Thermostat*, cartoons e.g. talking snowman), humanoid divinities (e.g. religious arts), extraordinary human physical or mental properties (e.g. strength, size, patience, endurance etc., giants, fakirs, martyrs, saints), extraordinary virtues and vices, longevity (e.g. the wise), immortality (e.g. The Seven Immortals), disembodiment (e.g. Ibn Sīnā’s *Flying Man*, ghosts, life after death), magical beings both good and evil (e.g. good and evil spirits, voodoo), teleportation, time travel (e.g. H.G. Wells’s *Time Machine*, communication with ancestral spirits), metamorphoses (e.g. Zhuangzi’s *Butterfly*, Locke’s *Prince-Cobbler*), transformations (e.g. Kirk’s *Brain Team*, Zulliver, Putnam’s *Brain in a Vat*), aquatic humanoids (e.g. mermaids), avian humanoids (e.g. angels), heaven (e.g. Akanishtha, 天), hell (e.g. Hades), distant places (Putnam’s *Twin Earth*, 淨土宗 Jìngtǔ zōng from Pure Land Buddhism) etc.

Following Hertogh 2021a on mathematical TE, we propose that a set of PW of TE semantics could be pictured with the help of a search engine, such as Google or Baidu, when PW may be defined as entities involving theoretical worlds, theories, parts or elements of theories, etc., thereby partly mechanising the process of thought experimentation. “Thinking is like googling”<sup>7</sup>, although still some serendipity, creativity, etc. may be required to choose and construct, analyse and synthesise input and output (as after Lakatos 1976) (*see* Hertogh 2021a).

#### ACCESSIBILITY RELATION (R)

Like it is not necessary nor possible to specify all PW, it is not necessary nor possible to stipulate for any infinite set of PW, for which PW are accessible from which PW.

Rather than stipulating accessibility for a particular world, we could (pre)suppose accessibility for a particular set of speakers and hearers, or a particular (set of) character(s) in fiction.

Some modal conundrums can be resolved by specification to a particular imaginary S (speaker, subject) or character, as *Colour Scientist Mary* in Frank Jackson's TE, or Einstein's *Elevator* and *Chasing a Beam of Light*, where there are two seemingly conflicting points of view of an internal and an external observer (Hertogh 2024a).

#### SATISFIABILITY RELATION ( $|\Rightarrow$ )

A satisfiability relation connects a (set of) statement(s) to a (set of) possible world(s). Example:

$$\begin{array}{l} [8] \\ w \mid = \varphi \quad \text{for } w \text{ it holds that } \varphi \end{array}$$

By specification to a particular (set of) PW as  $w_0$  or  $W_0$  (when considering a set instead of just one world) or  $w_{OI}$  or  $W_{OI}$  we can say that a proposition  $\varphi$  is true or false in a particular (set of) PW, and with help of modal operators we can additionally express that a state of affairs does not exist or is rather unusual in a particular world.

The advantage for TE semantics is that we can thus logically express differences between traditional notions of physically and metaphysically contingent, possible and necessary.

#### PROVISIONAL CONCLUSION

Modal semantics are richer in logic symbolisms and applications than classical logic, they may be capable to represent more states of affairs, situations, arguments etc. and resolve more problems in

philosophy, logic, linguistics, as comparable to progress of science and society from extensional logic of ideal, mathematical or theoretical (meta)languages to richer and more complex intensional, modal, many-valued etc. logics of natural language, analyses of which may resolve many more problems in philosophy, logic and linguistics, possibly including—in terminology of argumentation theory—transition from analytical argumentation model (e.g. Aristotle’s syllogisms) to substantial argumentation model, e.g., adding W(arrant), B(acking), (modal) Q(ualifier) and R(ebuttal) to inference procedure from D(ata) to C(laim) (e.g. Toulmin 1958/2003)<sup>8</sup>.

## NOTES

1. Difference between so-called basic logical laws or principles, such as principle/law of non-contradiction (LNC), principle/law of excluded middle (LEM), principle/law of identity (LID) may seem to be only ‘playing with words’ (see Wittgenstein 1953/1958, Section 67: ‘Now you are only playing with words’, a mere metaphysical endeavor without relevance to our pragmaticist living world (as on a pragmaticist interpretation of e.g. Wittgenstein’s *Philosophical Investigations*), which may have triggered, paraconsistent logic (e.g. Béziau et al. 2007), but it is not the place here to elaborate on it and we may refer to analyses of (e.g. Tarski’s) *Liar* (Hertogh 2025), which may have incited quite a few philosophers to adopt many valued-logic, which are, however, already present in well-known proposals of classical bivalent predicate logics as, Wittgenstein’s *Tractatus*, Russell and Whitehead’s *Principia Mathematica* or Carnap’s extensional logic in *Logical Structure of the World*, distinguishing real problems from pseudo-problems, just like Popper in *Logic of Scientific Discovery*, that may acknowledge a third truth value, like undefined / ‘sinnlos’ / ‘senseless’ / ‘meaningless’ / no truth value applied, and possibly even a fourth truth value, like not applicable (NA) / ‘Unsinn’ / ‘unsinnig’ / ‘nonsense’ / ‘nonsensical’ / no truth value application possible.

For the moment we hold on to pragmaticist and possibly naive notions of adhering to these binary principles in application of TE Matrix, e.g., as formulated as principle of bivalence, bivalent logic etc., two truth values (as T and F, in fact, reducible to only one, T, and logical operators as negation, constructing second truth value  $\neg T$ ) etc., apart from second TE

methodology of TE Diagram, which could be considered like a survey using near-statistical plausibility values as between 0 and 1 (or, say, 0 to 100%) to measure relative plausibility values of a set of TE within a scientific, scholarly community (*see* Hertogh 2022b).

2. *See* entry of Classical Logic in *Wikipedia*, [https://en.wikipedia.org/wiki/Classical\\_logic](https://en.wikipedia.org/wiki/Classical_logic) (retrieved April 30, 2026). *See* also note 1.
3. We admit that God and I are more closely associated with subject and religion than statistics is to modal logic. However, there is no closer candidate for a societal statistics correlate in logic than modal logic involving possibilities (PWS) for probability logics are usually many-valued—and thus nonclassical—logic, and within the field of modal logic there are many attempts to have modal logical systems obey the principle of bivalence as by prescription of bivalent truth value functions. Our semantics is descriptive as mediated by available and accessible intermediary PW instead of a prescribed valuation function. Nevertheless, modal logical systems are also still considered nonclassical.

The last paragraph of Yablo 1993 explains the rise of modal logic or ‘substantive modal metaphysics’.

Part of the explanation might be that our methods of modal conflict management have been, in a real sense, improving. Already it takes an effort to recall the dispiriting conditions of, say, thirty years ago: the various half-related ideas jumbled unconsciously together under the headings of possibility and conceivability; how crude the controls were on propositional content; the anxiety about collateral information as a factor in imaginability. Especially one forgets how much easier it was then for the conversation to bog down at the first clash of modal intuition. The extent to which we have moved beyond this should not be exaggerated (more often than we *still* bog down), but meanwhile, it seems that modal dialectic has achieved an unaccustomed degree of clarity and system in a surprisingly short time. (Yablo 1993, 40)

4. Like many TE from mathematics, this *Statistical TE* of Kripke has a tacit TE indicator, e.g. (‘Imagine...’). There are two hints in the text that it is indeed about a TE:

An analogy from school—in fact, it is not merely an analogy—will help to clarify my view.

(and ignore the fact that one or both dice might not have existed).

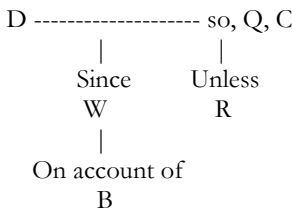
The second clue is more evident—the experiment takes place in the mind, so one or both dice ‘might not have existed’. The subclause of the first clue

indicates that it is something different from an analogy, so a TE, therefore, we may only suppose.

5. Full quotation from Fine 2017, end of Section on ‘State Spaces’.

The abstract approach to modal logic championed by Kripke’s early work (in which possible worlds are simply regarded worlds as arbitrary points, rather than as models or sets of sentences) has been a great boon to the formal development of modal logic; and it is to be hoped that future researchers will appreciate that there are similar benefits to be gained by adopting a more abstract approach to the truthmaker framework as well.

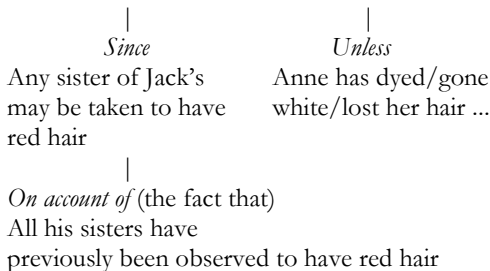
6. Such error or miscomprehension situations may occur in more calendars, not only in Gregorian, but also in Hebrew, Islamic, Hindu, and Chinese calendars, both solar and lunar, which calendars may also have leap years (e.g. Chinese and Hindu calendars have leap years featuring leap months, extra months).
7. Marcin Milkowski in plenary lecture June 29, 2019, XV Philosophers’ Rally Krakow (Milkowski 2019), referring to Newell and Simon 1972 (*see* Hertogh 2021a).
8. (Toulmin 1958, 97). Generic substantial argument form.



There are examples from cosmology, law, demographics, biology, etc. in Toulmin 1958/2003.

(Toulmin 1958, 117). Example from biology, inheritance patterns.

Anne is one of ----- so, *presumably*, Anne now has  
 Jack’s sisters red hair



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