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Gersonides' Modal Syllogistic as An Interpretation of Aristotle: A First Reading

Paul Thom

Abstract
For Gersonides, a necessary proposition is one that is true and cannot in future not be true. Other modalities are defined accordingly. Gersonides distinguishes essential from accidental terms (*human* versus *geometer*). Based in part on whether they have essential or accidental terms, he distinguishes propositions that are essentially necessary from those that are incidentally necessary, and those that are essentially contingent from those that are incidentally contingent. He also distnguishes those that are perpetually necessary (or contingent) from those that are so non-perpetually. Aristotle's modal syllogisms reduce to perfect syllogisms in one of the configurations: 2 necessary premises, 2 contingent, one necessary and one contingent, one necessary and one assertoric, one contingent and one assertoric. It turns out that all of Aristotle's perfect syllogisms in any of these configurations are valid for on at least one of Gersonides' readings of the premises. For example, the perfect uniform necessary syllogisms are valid if both premises are essential necessities with both terms essential, or if both are incidental necessities. But Gersonides does not accept all the syllogisms that Aristotle reduces to these perfect syllogisms, because he rejects some Aristotelian conversion principles. A semantic analysis of Gersonides' modal proposition is given, based on notions of essential term, inseparability and compatibility, underlying subject, 'in virtue of' and 'per se', and a principle concerning the actualization of potentialities. The semantics agrees with Gersonides' results.

> Inasmuch as we saw some things in Aristotle's *Book of the Syllogism*, as understood by the philosopher Averroes, that appear to us to be incorrect – namely, in the conversion of modal sentences, simple and mixed – we have seen fit to investigate the truth of these matters in this book.
> Ch.H. Manekin, *The Logic of Gersonides...*, Kluwer, Dordrecht 1992, §1.

Gersonides's book takes issue with Aristotle on many points, and contains many contributions to logical theory that go beyond anything found in Aristotle. Nevertheless, I will argue that Gersonides' modal syllogistic contains the basis on which Aristotle's modal syllogistic is built, namely the perfect syllogisms of the first figure. My argument will have five parts, corresponding to the five combinations of modalities that structure the perfect Aristotelian syllogisms. These five combinations of modalities are:

two necessary premises (*LL*),
two contingent premises (*QQ*),
a contingent and a necessary premise (*QL*),
a necessary and an assertoric premise (*LX*),
a contingent and an assertoric premise (*QX*).[1]

Some preliminaries

First, in Latin medieval writings on modal syllogistic, the focus is on propositions which express necessity, possibility and contingency, regardless of whether they are true or false. Logicians such as Ockham and Buridan are concerned with necessity propositions, possibility

[1] '*L*' stands for a necessary proposition, '*Q*' for a contingent proposition, '*X*' for an assertoric proposition. A pair of these letters stands for an ordered pair of syllogistic premises, the major premise being stated first.

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propositions and so on, not with necessary or possible propositions. Gersonides, however, is concerned with propositions that are necessary or possible etc.[2]

Second, when Gersonides talks about possible propositions he means what in modern logic are called contingent propositions, namely propositions that are neither necessary nor impossible. This is clear from his definition, "The possible is that which may or may not be" (Manekin §10).

Third, Gersonides conceives of possibility in relation to the future: what is possible is not so but is capable of being so in the future.[3] Thus, what is necessarily so is what is so and cannot in future not be so, what is impossibly so is what is not so and cannot in future be so, and what is contingently so (what is 'possibly' so) is what can in future be so and can in future not be so.

Is not moving		Is moving	
Cannot in future be moving	Can in future be moving	Can in future not be moving	Cannot in future not be moving
Is necessarily not moving	Is contingently moving		Is necessarily moving

Table 1. What is so, what is necessarily so, what is contingently so

In this conceptual field the notion of what is so is taken as fundamental, but so is the notion of what can in future be so.

Fourth, Gersonides, following Averroes, applies the epithets 'necessary' and 'possible' not only to propositions, but also to subject and predicate terms. Necessary terms are such as *human*, *rational*; these are terms signifying a genus, species or differentia. Possible terms are such as *walking* and *geometer*, accidental terms signifying an accidental feature of a substance. He sometimes uses 'essential' instead of 'necessary' for the first type of term. I will generally use 'essential' and 'accidental' to mark this distinction.

The data

Types of necessary propositions

Gersonides distinguishes the following types of necessary proposition.

L_1. Essentially necessary propositions with two essential terms. He gives the examples *Every human is living* (Manekin §128), and *No horse is rational* (Manekin §311).

L_2. Essentially necessary propositions with essential predicate and accidental subject. He gives the examples *Everything walking is living* (Manekin §133), *Nothing writing is a horse* (Manekin §308).

L_3. Essentially necessary propositions with accidental predicate, such as *No stone is flying* or *Nothing flying is writing* (Manekin §309, §21). Propositions of types L_1, L_2 and L_3 are perpetually necessary. Affirmatives have an essential term as predicate. Negative essential necessities may have one or two accidental terms, provided that if either term is accidental, the terms are subsumed under a pair of incompatible essential terms, as *flying* and *writing* are subsumed under *bird* and *human*.

L_4. Incidentally necessary propositions. *Every walker is moving* (Manekin §22) *No walker is resting* (Manekin §23). Incidental necessity is perpetual: Gersonides says (§302) that incidentally necessary propositions hold because of 'the very nature of the terms themselves'.

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[2] Manekin §25: "(…) a statement is (…) called 'possible' or 'assertoric' or 'necessary' (…) because the relation of the predicate to the subject is in the respective mode".

[3] Manekin §32: "(…) the different modalities belong to a statement because of its link to different tenses; linked to the present it will be incidentally necessary, yet when linked to the future it is possible".

L_{1a}. Non-perpetual essentially necessary propositions whose subject is an essential term restricted to a particular time and place. *Everything living here is a human* (Manekin §128), or (we may add) *Nothing living here is human*. These propositions would be true at any time or place at which all/no living things happened to be humans.

L_{2a}. Non-perpetual essentially necessary proposition whose subject is an accidental term restricted to a particular time and place. *Everything black here is living* supposing for example that everything black in this time and place is a crow (Manekin §133), or *Nothing walking here is rational* supposing that everything walking here is non-human (Manekin §310). Propositions of types L_{1a} and L_{2a} have an essential term as predicate, and a subject term which is restricted to a particular time and place.

L_{3a}. Non-perpetual essential negative necessary propositions with accidental predicate, for example *No animal here is flying* (where only humans are here), or *Nothing moving here is flying* (where only humans are moving here).

It may seem that there ought to be a class of non-perpetual incidental necessities – propositions like *Everything moving here is walking or Nothing resting here is walking.* Gersonides later counts the former as assertoric, the latter as incidental necessary.

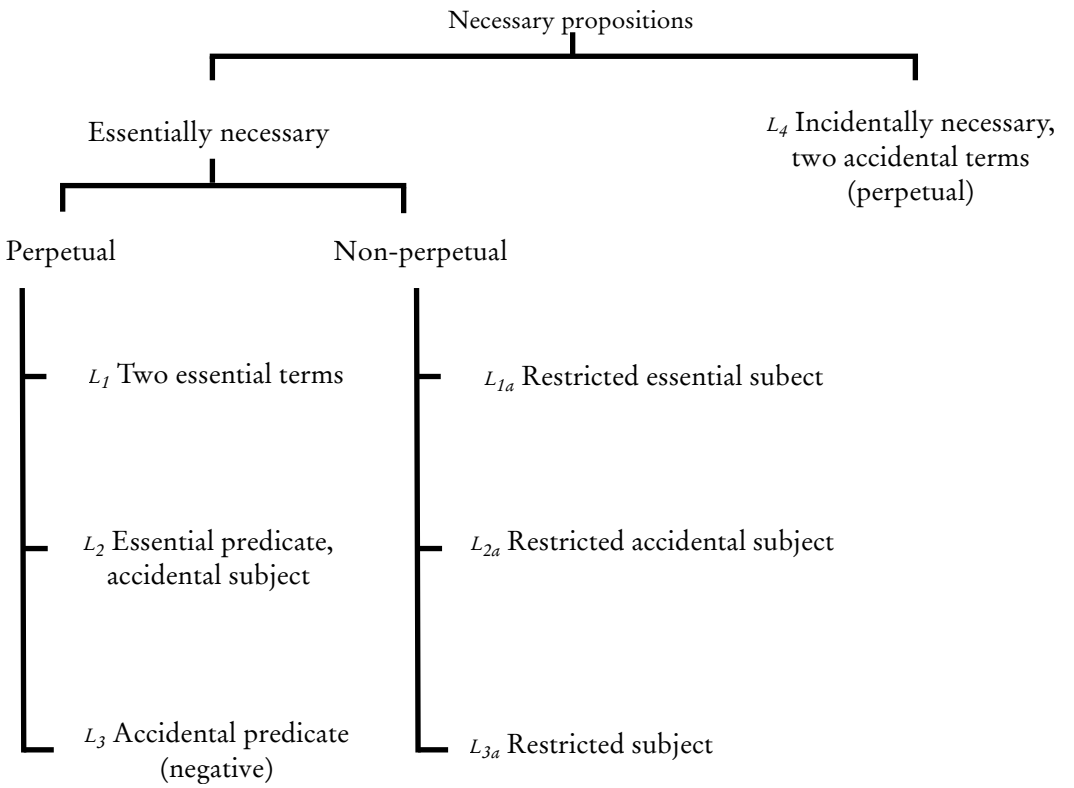

Figure 1. Types of necessary proposition

In perpetual necessary subject-predicate propositions, there is a necessary connection between subject and predicate, such that it's not possible that in future the predicate should fail to be predicated of the subject. This impossibility might be due to the fact that the predicate is an essential term (e.g. *human*) which is predicated of its subject so long as the subject continues to exist; or it might be due to a relation of inseparability that links two denominative terms.

Whether the necessity is essential or incidental, the predicate may be conceptually inseparable from the subject, or else it may just happen that the predicate is true of everything the subject is true of. This is the distinction between perpetual and non-perpetual necessities. In a non-perpetual necessity the subject term is restricted to a specific place and time. A perpetual essential necessity may have as subject either an essential term or an accidental term (types L_1 and L_2); or, if the proposition is negative and its terms are subsumed under a pair of incompatible essential terms, both terms may be accidental (type L_3). (Negative necessities with essential predicate are of type L_1 or L_2). Similarly, a non-perpetual essential necessity may have as subject either a restricted essential term or a restricted accidental term (types L_{1a} and L_{2a}).

In his explanation of the sense in which affirmative essential necessities are necessary, Gersonides says:

> (…) the writer, i.e., the man, must be rational under any attribute by which he is described. For if you describe him qua 'man' or 'risible' or 'philosopher' or 'geometer' it is necessary for each one of these that it be rational.

This is not quite right. It is not true that *every* true description of a man is such that it is necessary for a being so described to be rational; for example, a man *qua* animal or qua walking is not necessarily rational. What is true is that whenever an essential term is inseparable from a given subject, then that term is truly predicated of the subject in an essential necessity. *Rational* is inseparable from *man*, from *risible*, from *philosopher*, and from *geometer*; and all geometers, philosophers, beings capable of laughter, and men, are necessarily rational, with an essential necessity. But *rational* is not inseparable from *animal*, and so *All animals are rational* is not an essential necessity.

Of course, it may happen to be the case that all the animals in a particular place and time are rational; and this possibility gives rise to a non-perpetual essential necessity. The necessity in this case arises, not from the fact that an essential term is inseparable from the subject, but from the fact that an essential term at this time and place determines a class that includes the class determined at this time and place by the subject term – as in types L_{1a}, L_{2a} and L_{3a}.

Given that an incidental necessity has an accidental term as predicate, it appears that there should be two types here, depending on whether the subject term is an essential or an accidental term. However, Gersonides seems to hold that no necessity has an essential subject and accidental predicate. He says (Manekin §134), 'Subject necessary, predicate possible. When this statement is affirmative, it will be either incidentally possible or assertoric'. He appears to hold that whenever an accidental term is truly predicated of an essential subject, the proposition can only state a fact holding for a specific place and time, or a contingency – never a necessity.

1. The LLL system

Aristotle accepts all the standard *LLL* syllogisms, reducing them to the perfect *LLL* syllogisms of the first figure: Barbara *LLL*, Celarent *LLL*, Darii *LLL* and Ferio *LLL*.

Since Gersonides distinguishes different types of necessary proposition, the question arises, which types of necessity can be combined to yield a syllogistic conclusion? There cannot be a syllogism unless the premises share a term, i.e., unless there is a middle term. In the first figure, the predicate of the first-stated premise (Gersonides states the minor premise, i.e., the premise containing the subject of the conclusion, first) is the same as the subject of the second (the major) premise. Obviously, this condition can be met only if the predicate of the minor premise is *of the same type* as the subject of the major.

Leaving aside for the moment L_3 propositions and propositions with restricted subjects (types L_{1a}, L_{2a} and L_{3a}), there are 9 combinations, of which only 4 satisfy the condition that

in the first figure the predicate of the first proposition is of the same type as the subject of the second. These are L_1L_1, L_1L_2, L_2L_4, L_4L_4. Gersonides recognises that each of these premise-pairs yields a syllogistic conclusion. He states that if the major premise is essentially necessary then an essentially necessary conclusion follows (Manekin §301); this covers syllogisms of the types $L_1L_1L_1$, $L_1L_2L_2$ and $L_2L_4L_2$. He adds (*ibid*.) that if the major term is 'possible' (i.e., accidental) then the conclusion will be incidentally necessary; this covers syllogisms of the type $L_4L_4L_4$.

An L_3 necessity may have an essential subject and an accidental predicate, or both subject and predicate may be accidental. Accordingly, there are syllogisms of types $L_3L_1L_3$, $L_3L_2L_3$ and $L_3L_4L_3$. Examples:

(1) All humans are rational(L_1) — Nothing rational is flying (L_3)
No humans are flying (L_3)

(2) All poets are humans (L_2) — No humans are flying (L_3)
No poets are flying (L_3)

(3) All poets are writers (L_4) — No writers are flying (L_3)
No poets are flying (L_3)

In addition to syllogisms made up of perpetual necessities, Gersonides notes that the subject of a premise may be restricted to a particular time and place, but that when this happens the subject of the conclusion must be restricted in the same way (Manekin §302).

We have seen that Gersonides accepts first figure syllogisms of seven types of perpetual necessities: $L_1L_1L_1$, $L_1L_2L_2$, $L_2L_4L_2$, $L_3L_1L_3$, $L_3L_2L_3$, $L_3L_4L_3$, $L_4L_4L_4$. We have focused on the form of syllogism that deduces a universal affirmative from two universal affirmatives (*Barbara*); in fact, Gersonides accepts all four perfect *LLL* syllogisms of the above nine types. Gersonides himself says that his claims regarding first figure *LLL* syllogisms 'suffice' for all first figure syllogisms that 'yield the *quaesitum*' (Manekin §307), i.e., those that have a direct conclusion; and these are Aristotle's perfect syllogisms. Thus, Gersonides agrees with Aristotle in accepting all four of the perfect *LLL* syllogisms, and he goes beyond the Philosopher in identifying seven different specific forms those syllogisms can take.

What Gersonides does not do is to agree with Aristotle on the list of syllogisms that can be reduced to this perfect base. The reduction of the imperfect syllogisms depends in part on the laws of conversion for necessary propositions. Now, Gersonides maintains that partial conversion of the universal affirmative to the particular affirmative holds for necessities of type L_1 (Manekin §138). However, necessities of other types do not behave in such an orderly manner. L_{1a} propositions do not always convert to propositions of the same type: *No walker in such-and-such a place now is rational* (type L_{1a}) converts to *Nothing rational in this place and time is walking*, which is not necessary at all (Manekin §141). Further, Gersonides holds that propositions of type L_4 do not always convert to necessities of the same type: *Every writer is movin*g (type L_4) does not imply *Something moving is writing* (Manekin §139).

Types of contingent propositions

Gersonides distinguishes essential from incidental, and perpetual from non-perpetual contingencies on the basis of the status – essential or accidental – of the subject and predicate, and the presence or absence of spatio-temporal restrictions on the subject term, thus generating eight types of contingent proposition.

Q_1. Essentially contingent propositions with two essential terms. He gives the examples *All copper may be verdigris* (i.e., copper carbonate $Cu_2CO_3(OH)_2$) (Manekin §130) and *Every man may be dead* (Manekin §336). Following Aristotle, Gersonides holds that there are no negative contingent propositions that are not equivalent to affirmatives.

Q_2. Essentially contingent propositions with essential predicate and accidental subject. An example: *All the walking may be dead* (Manekin §386). Propositions of types Q_1 and Q_2 are perpetually contingent. Type Q_2 are generated from type Q_1 by taking an accidental term under the subject, as *walking* is taken under *footed animal*, generating *All the walking may be dead* from *All footed animals may be dead*.

Q_3. Gersonides distinguishes those incidental contingencies that have an essential subject from those having an incidental subject. He illustrates incidentally contingent propositions with an essential subject with the proposition *Every man may be writing* (Manekin §151).

Q_4. Incidentally contingent propositions with an accidental subject are exemplified by the proposition *Every writer may be a geometer* (Manekin §229). These last two types are perpetual incidental contingencies. Gersonides does not give examples of non-perpetual incidental contingencies; but we can do so, as follows.

Q_{1a}. Non-perpetual essentially contingent propositions whose subject is an essential term restricted to a particular time and place. *All metal in this time and place may be verdigris* (supposing that copper is the only metal here) (Manekin §130).

Q_{2a}. Non-perpetual essentially contingent propositions whose subject is an accidental term restricted to a particular time and place, e.g., *Everything red here may be verdigris* (supposing that all the red things here are copper) (Manekin §392).

Q_{3a}. Non-perpetual incidentally contingent propositions with an essential subject. *Every animal here may be writing* (supposing that every animal here is human).

Q_{4a}. Non-perpetual incidentally contingent propositions with an accidental subject. *Everything moving here may be writing* (supposing everything moving here is human).

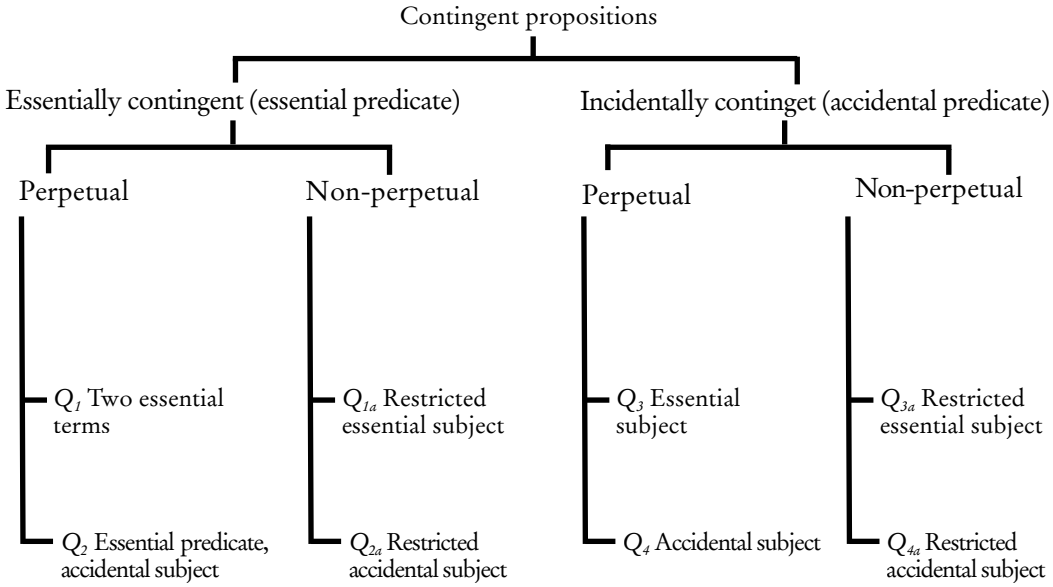

Figure 2. Types of contingency

2. The QQQ system

Aristotle's system of pure contingency syllogisms is based on the perfect syllogisms Barbara and Darii *QQQ*. The remaining valid *QQQ* moods accepted by him reduce to these by partial conversion of universal affirmative contingencies (converting *All A may be B* to *Some B may be A*), simple conversion of particular affirmative contingencies (converting *Some A may be B* to *Some B may be A*), or qualitative conversion of contingencies ('complementary conversion').[4]

Which combinations of two contingency propositions of the above types have a middle term? Leaving aside contingencies with restricted subjects, there are 8 such combinations having a middle term: Q_1Q_1, Q_1Q_2, Q_2Q_3, Q_2Q_4, Q_3Q_1, Q_3Q_2, Q_4Q_3, Q_4Q_4. Of these, Q_1Q_1, Q_1Q_2, Q_3Q_1, Q_3Q_2 have an essential term for middle, while Q_2Q_3, Q_2Q_4, Q_4Q_3, Q_4Q_4 have an accidental middle. Gersonides' doctrine is that when the middle is essential no contingent conclusion follows, but when the middle is accidental a contingent conclusion does follow – a contingency that will be essential if the major is an essential contingency and will be incidental if the major premise is an incidental contingency (Manekin §331-332). The conclusion's predicate must be the same as the predicate of the major premise, and its subject must be the same as the subject of the minor premise. Thus, Gersonides accepts the perfect syllogisms in the configurations $Q_2Q_3Q_1$, $Q_2Q_4Q_2$, $Q_4Q_3Q_3$, $Q_4Q_4Q_4$. To these we can add syllogisms where a subject term is restricted to a particular time and place.

Gersonides says that partial contingency conversion is self-evident when both terms are accidental, i.e., for contingencies of type Q_4, but that it is invalid for essential contingencies, and that contingencies of type Q_3 (where the subject is an essential term) convert not to a contingency but to a necessity (Manekin §151). He accepts complementary conversion (Manekin §333). So, he holds that all the Aristotelian *QQQ* syllogisms are valid in the configuration $Q_4Q_4Q_4$ but may not be so in other configurations.

3. The QLQ system

Aristotle's system of mixed modal syllogisms reducible to the first figure *QLQ* syllogisms is structured by the following rules of reduction: affirmative necessity partial conversion (*All A are B* to *Some B are A*), affirmative necessity simple conversion (*Some A are B* to *Some B are A*), contingency simple conversion (*Some A may be B* to *Some B may be A*), and contingency complementary conversion (*All A may be B* to *No A may be B*).[5] The fundamental syllogisms are Barbara *QLQ* and Darii *QLQ*.

Relative to Gersonides' account, it is clear that when a contingent major is combined with a necessary minor, there is a middle term in the following combinations: Q_1L_1, Q_1L_2, Q_2L_4, Q_3L_1, Q_3L_2, Q_4L_4. Leaving aside propositions with restricted subjects, if the major is essentially contingent, the syllogisms will be $Q_1L_1Q_1$, $Q_1L_2Q_2$, $Q_2L_4Q_2$. If the major is incidentally contingent, the syllogisms will be $Q_3L_1Q_3$, $Q_3L_2Q_4$, $Q_4L_4Q_4$. These results are consistent with Gersonides' findings, viz. that

- an essentially contingent major premise combined with a necessary minor yields an essentially contingent conclusion;
- an incidentally contingent major combined with a necessary minor yields an incidentally contingent conclusion (Manekin §381).

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[4] P. Thom, *The Logic of Essentialism: An Interpretation of Aristotle's Modal Syllogistic*, Kluwer, Dordrecht 1996, pp. 63-7.

[5] Thom, *The Logic of Essentialism* (above, n. 4), pp. 62-3.

Syllogisms in each of the perfect Aristotelian *QLQ* moods are accepted by Gersonides in the configurations $Q_1L_1Q_1$, $Q_1L_2Q_2$, $Q_2L_4Q_2$, $Q_3L_1Q_3$, $Q_3L_2Q_4$, $Q_4L_4Q_4$.

But not all the syllogisms that Aristotle reduces to the perfect *QLQ* moods are accepted by Gersonides. The only contingent propositions that convert to the same type are type Q_4. These are paired with type L_4 necessities, which according to Gersonides do not convert if they are affirmative. So, no configuration accepted by Gersonides obeys the requisite laws of conversion, and according to his analyses there is no uniform reading of contingencies that generates the full set of Aristotle's *QLQ* syllogisms.

Types of assertorics

Assertoric propositions have an accidental predicate which determines a class that non-perpetually includes the class determined by a restricted subject. There are two main types, e.g., *Every man here is walking* (Manekin §168), *Nothing rational here is white* (Manekin §172) (type X_{1a}), or *Every writer here is a geometer* (Manekin §131), *Everything moving here is walking*, *No writer here is a geometer* (Manekin §172) (type X_{2a}). A third type is the 'rhetorical assertoric', which is true for most of the time but is posited as if it were true at all times, e.g., *He who honors his father will be honored by his children* (Manekin §18) (type 16). My discussion will be confined to the first two types.

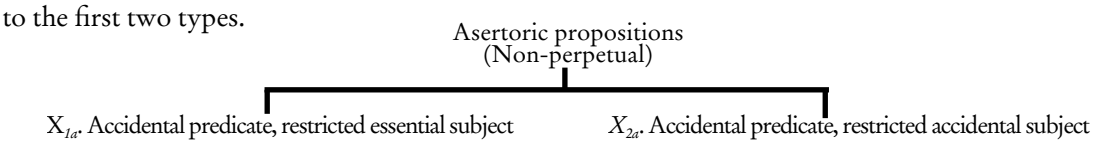

Figure 3. Types of assertoric proposition

4. The LXL system

Aristotle's system of *LXL* syllogisms is based on the perfect first figure syllogisms. Imperfect syllogisms in the other figures are reducible to these by conversion of affirmative and negative necessities, simple conversion of affirmative assertorics, and the partial conversion of affirmative assertorics in the reductions of Darapti *LXL* and *XLL* and Felapton *LXL*.[6]

An *LX* pair in the first figure has a middle term in the following configurations: L_2X_{1a}, L_2X_{2a}, L_3X_{1a}, L_3X_{2a},L_4X_{1a}, L_4X_{2a}. Gersonides states that (i) if the major term is essential the conclusion will be essentially necessary (Manekin §358), (ii) if the major term is accidental and the minor essential, in affirmative moods the conclusion will be assertoric (Manekin §358), (iii) in negative moods, the conclusion is essentially necessary in some cases and assertoric in others (Manekin §359), (iv) in affirmative moods, if the minor term is accidental the conclusion may be either incidentally necessary or assertoric (Manekin §360), (v) in negative moods, the conclusion may be either essentially or incidentally necessary or assertoric (Manekin §361).

These encompass the following cases:

(i) $L_2X_{1a}L_{1a}$, $L_2X_{2a}L_{2a}$;

(ii) $L_4X_{1a}X_{1a}$;

(iii) $L_3X_{1a}L_{3a}$ (Gersonides' example in §359 is 'Every raven here is flying, nothing flying is writing, so no raven here is writing'), $L_3X_{1a}X_{1a}$ (Gersonides' example in §359 is 'Everything rational here is resting, nothing resting is moving, so nothing rational here is moving');[7]

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[6] Thom, *The Logic of Essentialism* (above, n. 4), pp. 51-3.

[7] Gersonides says 'at times' the conclusion is essentially necessary, 'at times' assertoric. So, no conclusion follows necessarily.

(iv) $L_4X_{2a}X_{2a}$ (Gersonides' example in §360 is 'Every geometer here is walking, everything walking is in a place unequal to itself, so every geometer here is in a place unequal to itself'), $L_4X_{2a}L_4$ (Gersonides' example in §360 is 'Everything moving here is walking, everything walking is in a place unequal to itself, so everything moving here is in a place unequal to itself'),[8]

(v) $L_3X_{2a}L_3$ (Gersonides' examples in §361 is 'Every geometer here is writing, nothing writing is flying, so no geometer is flying').[9] $L_3X_{2a}L_4$ ('Everything moving here is walking, nothing walking is resting, so nothing moving here is resting'). $L_3X_{2a}X_{2a}$ ('Every geometer here is walking, nothing walking is resting, so no geometer here is resting').

Thus, Gersonides is committed to the validity of Barbara (and Darii) in the configurations $L_2X_{1a}L_{1a}$, $L_2X_{2a}L_{2a}$, $L_4X_{1a}X_{1a}$. And he is committed to the validity of Celarent (and Ferio) in the configurations $L_2X_{1a}L_{1a}$, $L_2X_{2a}L_{2a}$, $L_3X_{1a}L_{3a}$.

I have omitted the configurations $L_4X_{2a}X_{2a}$, $L_4X_{2a}L_4$. Consider Barbara $L_4X_{2a}X_{2a}$ and Barbara $L_4X_{2a}L_4$. Suppose that *A* and *B* are accidental terms, where the Bs include the As. And suppose that *C* is accidental where *C* is inseparable from B. Then *A* and *C* are accidental terms, but *C* may or may not be inseparable from *A*. If *C* is inseparable from *A* then we have a $L_4X_{2a}L_4$ configuration; if not, then we have $L_4X_{2a}X_{2a}$. Thus there is no universal rule for what follows from the premises L_4X_{2a}.

If we assume that the truth of particular assertorics is a function of the truth-condition of universals, then the standard laws of conversion will hold for X_{2a} assertorics but not for those of type X_{1a}.

5. The QXQ system

The inferences in Aristotle's *QXQ* system all reduce to *QXQ* syllogisms in the first syllogistic figure by a-conversion, i-conversion of Qi-conversion.

Gersonides states that in the first figure inferences, if the major premise is essentially contingent and the minor assertoric, then the conclusion will be essentially contingent (Manekin §390). The only such *QX* combinations that have a middle term are Q_2X_{1a}, Q_2X_{2a}; thus Gersonides is claiming that an essentially contingent conclusion follows from these premises. The syllogisms will be $Q_2X_{1a}Q_{1a}$ (where the conclusion's subject is a restricted essential term) and $Q_2X_{2a}Q_{2a}$ (where the conclusion's subject is a restricted accidental term). In both cases the conclusion's predicate will be an essential term, and thus the contingency will be essential. Here are examples:[10]

(4) $\dfrac{\textit{Every human here is walking } (X_{1a}) \qquad \textit{Everything walking may be dead } (Q_2)}{\textit{Every human here may be dead } (Q_{1a})}$

(5) $\dfrac{\textit{Every geometer here is walking } (X_{2a}) \qquad \textit{Everything walking may be dead } (Q_2)}{\textit{Every geometer here may be dead } (Q_{2a})}$

If the major is incidentally contingent, then the combinations having a middle term are Q_4X_{1a} and Q_4X_{2a}. Thus we would expect the syllogisms to be $Q_4X_{1a}Q_{3a}$ (where the conclusion's subject is a restricted essential term) and $Q_4X_{2a}Q_{4a}$ (where the conclusion's subject is a restricted accidental term). In both cases the conclusion's predicate will be an accidental term, and thus the contingency will be incidental. Examples of these two types are

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[8] Gersonides says the conclusion is 'at times'incidentally necessary, 'at times' assertoric; i.e., no conclusion follows necessarily.

[9] Gersonides says the conclusion can be essentially or incidentally necessary or assertoric, i.e., no conclusion follows necessarily.

[10] Thom, *The Logic of Essentialism* (above, n. 4), pp. 55-6.

(6) $\dfrac{\textit{Every human here is moving } (X_{1a}) \qquad \textit{Everything walking may be at rest } (Q_4)}{\textit{Every human here may be at rest } (Q_{3a})}$

(7) $\dfrac{\textit{Every geometer here is moving } (X_{2a}) \qquad \textit{Everything walking may be at rest } (Q_4)}{\textit{Every geometer here may be at rest } (Q_{4a})}$

However, Gersonides does not draw attention to these configurations. Instead, here is what he says:

> However, when the possibility in the major is not essential then we may reduce it to actually existing, and the syllogism will be assertoric. The mode of its conclusion has already been shown from what was stated before, except that what yielded there essentially necessary when the major extreme was a possible term yields here essentially necessary, whereas what yielded there incidentally necessary or assertoric yields <here> possible for the reason we mentioned in what preceded (Manekin §390).

I believe that the reference here is to §323, where Gersonides is discussing the indirect conclusions that follow from a pair of first figure assertoric premises, and that consequently in §390 he is talking about QX pairs that yield an indirect conclusion. If I am right about that, I do not need to discuss §390 in the present paper, given that my focus here is on the perfect syllogisms, which all have direct conclusions.

As we have seen, Gersonides accepts the perfect syllogisms in the configurations $Q_2X_{1a}Q_{1a}$, $Q_2X_{2a}Q_{2a}$, $Q_4X_{1a}Q_{3a}$ and $Q_4X_{2a}Q_{4a}$. But he does not accept all the Aristotelian rules for contingency-conversion; so, we cannot attribute to him all of the QX syllogisms that Aristotle endorses.

An interpretation

In this second half of the paper, I sketch an interpretation of Gersonides's modal syllogistic as outlined in the first half. In interpreting Gersonides' account of necessary propositions, I assume a notion of perpetuity; I take as primitive the relations of inseparability and incompatibility between terms; and I postulate a class of essential terms as an undefined subclass of terms, with a class of accidental terms as the complementary subclass. In addition, I assume standard set-theoretic notions that are standardly used in stating truth-conditions for non-modal propositions.

Conditions for necessity

Perpetual essential necessities *Every A is B* or *No A is B* are true by virtue of a relation of inseparability or incompatibility between the terms *A* and *B*. The primary case is where both subject and predicate are essential terms. *Human* and *living* are essential terms, where *living* is inseparable from *human*. *Horse* and *rational* are essential terms, *horse* being incompatible with *rational*.

Secondary cases are generated in different ways for affirmatives and negatives. For affirmatives, a perpetual essential necessity is generated by taking as subject an accidental term from which the subject of a primary perpetual essential necessity is inseparable. For example, given that *Every human is living* is a primary perpetual essential necessity, and that human is inseparable from the accidental term *geometer*, *Every geometer is living* counts as a perpetual essential necessity.

For negatives, secondary cases are generated by taking accidental terms from which either subject or predicate is inseparable. For example, given that *No horse is rational* is a primary perpetual essential necessity, and that *horse* is inseparable from the accidental term *white horse*, and that rational is inseparable from the accidental term *writer*, *No white horse is a writer* counts as a perpetual essential necessity. The truth-conditions are:

- *Every A is B* is a perpetual essential necessity iff *B* is inseparable from A, where *B* is an essential term (type L_1 has *A* essential, type L_2 has A accidental)
- *No A is B* is a perpetual essential necessity iff two incompatible essential terms are respectively inseparable from *A* and *B* (type L_1 has both terms essential, type L_2 has an essential predicate and an accidental subject, type and L_3 has an essential subject and an accidental predicate or has both terms accidental.
- *Every A here is B* is a non-perpetual essential necessity iff the Bs include the As, where *B* is an essential term (type L_{1a} has *A* essential, type L_{2a} has *A* accidental).
- *No A here is B* is a non-perpetual essential necessity iff two incompatible essential terms *M*, *N* are such that the Ms include the As and the Ns include the Bs (type L_{1a} has both terms essential, type L_{2a} has an essential predicate and accidental subject, type L_{3a} has accidental predicate).
- *Every A is B* is an incidental necessity iff *B* is inseparable from *A*, where *B* and *A* are accidental terms.
- *No A is B* is an incidental necessity iff *B* is incompatible with *A*, where no two incompatible essential terms are respectively inseparable from *A* and *B*.

Gersonides says that the two terms in an incidental necessity are related as species to genus) (Manekin §21-22). I think this means that two concrete terms are denominated from two abstract terms in a non-substance category which are related as species and genus. If I am right, then it may be that some aspects of the logic of incidental necessities depend on the logic of the species-genus relation. In negative necessities of types L_2, L_{1a} and L_{2a}, the stated terms are mediated by one or more unstated terms. In *Nothing writing is a horse* the mediating term could be *human* or *biped*; in *Nothing living here is human* the mediating term could be *bird* or *horse* and so on, depending on the facts of the case. To say that the mediating term is unstated in the initial proposition is not to say that the essential necessity of a sentence depends on what we intend the subject to refer to;[11] it depends on whether there exists a term that happens to mediate between the subject and predicate in the appropriate way.

LLL syllogisms

On the above interpretation, all the perfect Aristotelian *LLL* syllogisms are valid in the configurations $L_1L_1L_1$, $L_1L_2L_2$, $L_2L_4L_2$, $L_3L_1L_3$, $L_3L_2L_3$, $L_3L_4L_3$, $L_4L_4L_4$. I show this for the $L_1L_1L_1$ configuration.

*B*arbara $L_1L_1L_1$ is valid. Suppose *Every A is B* and *Every B is C* are type L_1 necessities, i.e., *A*, *B*, *C* are essential terms, such that *B* is inseparable from *A*, and *C* from *B*; then *A*, *C* are essential terms, and *C* is inseparable from *A*, i.e. *Every A is C* is a type L_1 necessity. It can be shown in a similar way that Celarent $L_1L_1L_1$ is valid – making use of the principle that if *C* is incompatible with *B*, and *B* is inseparable from *A*, then *C* is incompatible with *A*.

In order to show that Darii is valid, we need to show how particular necessary propositions are related to universals. *A* plausible truth condition is that *Some A is B* is necessary iff for some *D All D is A* and *All D is B* are both necessary. Given this assumption, the premises *Some A is necessarily B*, *All B is necessarily C* can be expanded into *All D is necessarily A*, *All D is necessarily B*, *All B is necessarily C*. The last two imply *All D is necessarily C* by *B*arbara *LLL*. Now, *All D is necessarily A*, *All D is necessarily C* can be contracted to *Some A is necessarily C* by our truth condition for particular necessities. So Darii $L_1L_1L_1$ is valid. The validity of Ferio L_1L_1

[11] Manekin p. 197: "Thus 'Some white thing is rational' is essentially necessary if we intend 'Some white thing' to refer to man".

L_1 can be shown in a similar way to follow from the truth condition that *Some A is not possibly B* is true iff for some *D All D is necessarily A* and *No D is possibly B* are both true. So, all the perfect first figure *LLL* syllogisms are valid when read as type L_1 necessities.

Given these readings of type L_1 necessities, the partial conversion of the universal affirmative to a particular affirmative with terms reversed is valid. Suppose that *A* and *B* are essential terms, and *B* is inseparable from *A*. Then there is a *D* such that *D*, *A* and *B* are essential terms, and both *A* and *B* are inseparable from *D*; let *D* be *A*. *B*ut since there is such a *D*, Some *B* is *A* is a type L_1 necessity.

The simple conversion of the particular affirmative is also valid, since its truth-condition is symmetrical in *A* and *B*.

The universal negative necessity is also convertible. If *No A is B* is a type L_1 necessity, then two incompatible essential terms are respectively inseparable from essential terms *A* and *B*. In that case, two incompatible essential terms are inseparable from essential terms *B* and *A*.

Baroco and Bocardo *LLL* do not reduce to the first figure by conversion. They are reducible to the first figure by ecthesis – a process that depends on the truth-condition for the particular negative: some *A* is necessarily not *B* iff for some *D* all *D* is necessarily *A* and no *D* is possibly *B*. I have not seen any treatment of ecthesis by Gersonides; but this principle is a natural one to assume. If we do assume it, then the validity of Baroco and Bocardo *LLL* is derivative on that of Celarent and Barbara *LLL*:

1.	Some B is not possibly A	Assumption
2.	Every C is necessarily A	Assumption
3.	For some M, every M is necessarily B and no M is possibly A	1, definition
4.	Every D is necessarily B and no D is possibly A	3, Instantiation
5.	No A is possibly D	4, Conversion
6.	No C is possibly D	2,5, Celarent *LLL*
7.	Every D is necessarily B and no D is possibly C	4, 5, Conversion
8.	For some M, every M is necessarily B and no M is possibly A	6, Generalisation
9.	Some B is not possibly C	7, definition

1.	Every C is necessarily B	Assumption
2.	Some C is not possibly A	Assumption
3.	For some M, every M is necessarily C and no M is possibly A	2, definition
4.	Every D is necessarily C no D is possibly A	3, Instantiation
5.	Every D is necessarily B	1, 4, Barbara *LLL*
6.	Every D is necessarily B and no D is possibly A	4, 5
7.	For some M, every M is necessarily B and no M is possibly A	6, Generalisation
8.	Some B is not possibly A	7, definition

Figure 4. Reduction of Baroco and Bocardo *LLL* to the first figure

All the syllogisms that Aristotle reduces to the perfect first figure *LLL* moods are therefore valid if propositions in them are read as type L_1 necessities.

We noted earlier that on Gersonides' account not only the perfect $L_1L_1L_1$ syllogisms but also the $L_1L_2L_2$, $L_3L_1L_3$, $L_3L_2L_3$, $L_3L_4L_3$, $L_4L_4L_4$ perfect syllogisms are valid. Our truth-conditions for L_{1a}, L_2, L_{2a}, L_3 and L_4 propositions verify that the perfect syllogisms of the above eight types are indeed valid. We show this for Barbara $L_1L_2L_2$. Suppose *Every A is B* is an L_2 necessity, and *Every B is C* is an L_1 necessity. The truth of these premises requires that *A* is accidental and *B*, *C* are essential, that *B* is inseparable from *A*, and that *C* is inseparable from *B*.

It follows that *the Cs include the As*, and thus that Barbara $L_1L_{1a}L_{1a}$ is valid. Similar reasoning shows the validity of Barbara in the remaining configurations.

We also noted earlier that the laws of conversion do not hold in all cases for necessities not of type L_1, and that as a consequence there may be Aristotelian syllogisms in configurations other than $L_1L_1L_1$ which are not valid on Gersonides' account.

Conditions for contingency

Gersonides' division of contingent propositions presupposes a background of theory in the Aristotelian tradition concerning what can in future be so or not so. According to this body of theory, certain pairs of terms stand to one another perpetually in a relation of potentiality such that, for example, it is perpetually the case that a body may in future be moving and that what is sentient may in future be dead. This is not the same as saying that the predicate of a contingent proposition may or may not be truly predicable of the proposition's subject.

It's contingent for what is in motion to be at rest, but this is not because *at rest* may be truly predicable of *moving*. Rather, *at rest* may be truly predicable of what is the subject of the movement, namely the body that is moving (Manekin §11). The underlying subject is designated by an essential term – in this case, the term *body*. So, in speaking of contingencies we have to distinguish the stated subject from the underlying subject; what may or may not be so in a contingency is that the predicate comes to belong to the underlying subject. At least, this is how it is for incidental contingencies.

In an essential contingency, there is indeed an underlying subject. The sentient may come to be dead, in virtue of the fact that the sentient are animate and what is animate may die. But whereas the underlying subject persists in an incidental contingency, it is (as Gersonides says) 'eliminated' in an essential contingency. When a body that was at rest starts moving, it is then both moving and a body; but when an animal dies it is not both an animal and dead. What may have *dead* predicated of it is not what is sentient but what is no longer sentient (Manekin §12).

The underlying subject, in both essential and incidental contingencies, is that in virtue of which the contingency holds. It is an essential term that includes the contingency's stated subject; if it is conceptually inseparable from the contingency's stated subject, I shall call it an inseparable underlying subject. What is at rest may come to be moving in virtue of the fact that all and only bodies are potentially per se in movement; what is sentient may come to be dead in virtue of the fact that all and only beings that have formerly been sentient are potentially per se dead. *Body* and *sentient* in these examples are inseparable underlying subjects. As an example of an underlying subject that is not inseparable, all animals at this time and place may contingently be writing, in virtue of the fact that, as it happens, the only animals existing at this time and place are humans.

I assume that every contingency holds by virtue of a per se contingency belonging to a subject which underlies the contingency's stated subject. I also assume that in a per se contingency the underlying subject is equivalent to the potential for the contingency to be actualized. To be a body is equivalent to having the potentiality, of itself, to move; to be animate is equivalent to having the potentiality, of itself, to die. Thus, humans may move by virtue of the contingency that all and only bodies, per se, have for moving; and humans may die by virtue of the contingency that all and only animate things have for dying.

Incidental and essential contingencies differ from one another in the ways their end-state (the state of affairs that contingently comes to be so) relates to the underlying subject. The end-state of an incidental contingency includes not only the state designated by the contingency's predicate, but also the underlying subject: when a body moves, the end-state is not only that there

is movement, but also that there is a body in movement. In an essential contingency, by contrast, the end-state does not include the underlying subject: the contingency that comes to be so is not that there is something that is animate and is dead, but that something which used to be animate is dead.

In the case of non-perpetual contingencies, the underlying subject is predicable of the stated subject non-perpetually (as *human* might be predicable universally of *animal* for some limited time and place), even though the underlying subject stands in a relation of perpetual potentiality to the predicate of the contingency. When it is the case non-perpetually that every animal here may be writing (because only human animals are present), the contingency still holds by virtue of a perpetual relation of potentiality between *human* and *writing*.

Assuming these explanations of 'underlying subject', 'in virtue of' and 'per se', I suggest the following truth conditions.

- *All A may be B* is a perpetual essential contingency iff *A* has an inseparable underlying subject *M* that is incompatible with *B*, where *M* per se is potentially *B*, and having been *M* is inseparable from *B*. Type Q_1 has both terms essential, type Q_2 has *A* accidental and *B* essential.
- *All A here may be B* is a non-perpetual essential contingency iff an essential term *M* is such that the Ms include the As, and *M* is incompatible with *B*, where what is *M* per se is potentially *B* and having been *M* is inseparable from *B*. Type Q_{1a} has both terms essential, type Q_{2a} has *A* accidental and *B* essential.
- *All A may be B* is a perpetual incidental contingency iff *A* has an inseparable underlying subject *M*, where *M* per se is potentially *B* (*B* being an accidental term). Type Q_3 has *A* essential, type Q_4 has *A* accidental.
- *All A here may be B* is a non-perpetual incidental contingency iff some essential term *M* is such that the Ms include the As, and *M* per se is potentially *B* (*B* being an accidental term). Type Q_{3a} has *A* essential, type Q_{4a} has A accidental.

Particular contingencies of any type can be explained as a conjunction of universals of the same type. Some *A may be B* is true iff for some *D All D may be A* and *All D may be B* are both true. Gersonides seems to have this condition in mind, at least as a sufficient condition, when he says: "I say that when 'Something that may be a may be c' is true, it follows that 'Some a may be c' will be true when a is a possible attribute" (Manekin §337).

QQQ syllogisms

Our truth-conditions confirm the validity of the perfect syllogisms in the configurations $Q_2Q_3Q_1$, $Q_2Q_4Q_2$, $Q_4Q_3Q_3$, $Q_4Q_4Q_4$. Consider $Q_4Q_4Q_4$ syllogisms.

The minor premise of *B*arbara $Q_4Q_4Q_4$ requires that *A* and *B* are accidental terms, where *A* has an inseparable underlying subject *M*, and *M* per se is potentially *B*. The major premise requires that *B* and *C* are accidental terms, where *B* has an inseparable underlying subject *N*, and *N* per se is potentially *C*. In order to link the information from the first premise with that from the second, we need an extra principle concerning the actualization of potentialities. I shall assume that, if an essence is inseparable from the actualization of a given potentiality, then that essence is inseparable from the given potentiality. In other words, if the actualization of a potentiality is restricted to things having a given essence, then the potentiality itself is subject to the same restriction.

Now, in the present case, *M* is equivalent to the potentiality for *B*; so, *B* is the actualization of *M*. Moreover, the essential term *N* is inseparable from *B*. So, applying our principle: since *N* is inseparable from *B*, *N* is inseparable from *M*. Consequently, since *M* is inseparable from *A*, *N* is inseparable from *A*. And since *N* per se is potentially *C*, we have the truth condition for *Every A may be C* in the sense of a Q_4 proposition. This shows that Barbara $Q_4Q_4Q_4$ is valid.

Darii QQQ is also valid for type Q_4 contingencies. Suppose some A may be B (type Q_4). Then for some *D All D may be A* and *All D may be B* are type Q_4 contingencies. Now suppose *All B may be C* is type Q_4 contingency. Then, since *All D may be B* and *All B may be C* are type Q_4 propositions, so is *All D may be C* (by Barbara QQQ). But now we have both *All D may be A* and *All D may be C* as type Q_4 propositions. So, by the truth condition for particular contingencies, we have *Some A may be C* as a type Q_4. So, all the perfect QQQ syllogisms are valid in the configuration $Q_4 Q_4 Q_4$.

The validity of Qi-conversion for type Q_4 contingencies is evident from the fact that the truth condition for particular contingencies is symmetrical in subject and predicate. Gersonides says that Qa-conversion is self-evident when the subject term is accidental. Presumably, his thinking is that we can suppose the contingency *All A may be B* to be realised in such a way that at some future time *all A*s *are actually B*s – in which case, at that time some *B*s *will be A*s, and as a consequence *Some B*s *are A* is now true as a type Q_4 contingency. Given these conversions, and given the validity of complementary conversion (which can be stipulated), it follows that all of Aristotle's QQQ syllogisms are valid in the configuration $Q_4 Q_4 Q_4$.

$Q_4 Q_3 Q_3$ differ from $Q_4 Q_4 Q_4$ syllogisms in having an essential rather than an accidental term as subject of the minor premise. This difference does not affect the validity of the perfect syllogisms. However, Q_3 propositions do not convert to contingencies but to essential necessities, because their essential subject becomes an essential predicate on conversion, as in the conversion of *All humans may be writers* to *All writers are human* (Manekin §151). So, the Aristotelian reductions of imperfect syllogisms do not work, and therefore not all of Aristotle's QQQ syllogisms are valid in the configuration $Q_4 Q_3 Q_3$.

$Q_2Q_3Q_1$ and $Q_2Q_4Q_2$ syllogisms, because they have an essential term as predicate of the major premise, have essential contingencies as major premise and conclusion. The premises of Barbara $Q_2Q_3Q_1$ require (i) that A (an essential term) has an inseparable underlying subject M, where M per se is potentially B (an accidental term), and (ii) that B has an inseparable underlying subject N, where N per se is potentially C, and what is N is potentially C (an essential term). We argue in the same way as we did for the $Q_4 Q_4 Q_4$ syllogism.

Our principle concerning the actualization of potentialities shows that N is an inseparable underlying subject of A, and that consequently *Every A may be C* is true – this time as a Q_1 proposition, since it has two essential terms. So, Barbara $Q_2Q_3Q_1$ is valid. It can be shown likewise that Darii $Q_2Q_3Q_1$ is valid, and that the perfect QQQ syllogisms in the configuration $Q_2Q_4Q_2$ are valid; but not all Aristotelian syllogisms in this configuration will be reducible to the perfect syllogisms, because of the failure of some of the conversion rules.

QLQ syllogisms

Gersonides is committed to the validity of the perfect QLQ syllogisms in the following 6 configurations: $Q_1L_1Q_1$, $Q_1L_2Q_2$, $Q_2L_4Q_2$, $Q_3L_1Q_3$, $Q_3L_2Q_4$, $Q_4L_4Q_4$. These syllogisms are valid on our truth-conditions. Consider *B*arbara $Q_1L_1Q_1$. The truth of the premises requires that (i) B is inseparable from A, and (ii) B has an inseparable underlying subject N that is incompatible with C but is potentially C, where A, B, C are essential terms. It follows that A has an inseparable underlying subject N that is incompatible with C but is potentially C, where A, C are essential terms, i.e., we have the truth-condition for *All A may be C* as a Q_1 contingency. The validity of the remaining 5 configurations can be shown in the same way, as can the validity of Darii in all 6 configurations. So all the perfect QLQ syllogisms are accepted by Gersonides.

Given Gersonides' rejection of conversion for L_4 propositions, not all of the Aristotelian QLQ syllogisms can be reduced to the perfect syllogisms in Aristotelian fashion.

Truth conditions for assertoric propositions

It seems that there are no perpetual assertorics:

> A true assertoric sentence cannot truly be a universal statement except incidentally, I mean at a certain time or place as well. For if it existed perpetually in every part of the subject, then it would be necessary (Manekin §13)

Among non-perpetual assertorics, two types can be recognised: those with restricted essential subject, e.g., *Every man here is walking* (Manekin §168), *Nothing rational here is white* (Manekin §172) (type X_{1a});[12] and those with restricted accidental subject, e.g., *Every writer here is a geometer* (Manekin §131), *Everything moving here is walking*, *No writer here is a geometer* (Manekin §172) (type X_{2a}).

The truth conditions for these two types are as follows.

- *All A here is B* is true as a type X_{1a} proposition iff *A* is essential and *B* accidental, and the *B*s include the As that are in this time and place.
- *All A here is B* is true as a type X_{2a} proposition iff *A* and *B* are both accidental, and the *B*s include the As that are in this time and place.

LXL syllogisms

Barbara and Darii are valid in the configurations $L_2X_{1a}L_{1a}$, $L_2X_{2a}L_{2a}$, as are Celarent (and Ferio in the configurations $L_2X_{1a}L_{1a}$, $L_2X_{2a}L_{2a}$, $L_3X_{1a}L_{3a}$. Consider Barbara $L_2X_{1a}L_{1a}$. Suppose that the *B*s include the *A*s, where *A* is an essential term and *B* is accidental. Suppose *C* is inseparable from *B*, where *C* is an essential term. Then the *C*s include the *A*s, *C* and *A* being essential, i.e., *Every C is A* is an L_{1a} necessity. The remaining perfect *LXL* syllogisms can also be shown to be valid in the above configurations. But, since the standard laws of conversion are rejected by Gersonides for L_4 and propositions, not all of Aristotle's reductions of imperfect syllogisms to perfect *LXL* syllogisms can be replicated in processes that Gersonides accepts.

QXQ syllogisms

The syllogisms are $Q_2X_{1a}Q_{1a}$, $Q_2X_{2a}Q_{2a}$, $Q_4X_{1a}Q_{3a}$ and $Q_4X_{2a}Q_{4a}$. The validity of $Q_2X_{1a}Q_{1a}$ can be shown as follows. Suppose *A* is an essential term and *B* accidental, where the *B*s include the *A*s. Suppose that *C* and *N* are incompatible essential terms such that what is *N* is potentially *C* and the *N*s include the *B*s. Then *A*, *N* and *C* are essential terms, the last two incompatible, where the *N*s include the *A*s. Similarly for the other perfect *QXQ* syllogisms. But Gersonides cannot replicate Aristotle's reductions of imperfect to perfect *QXQ* syllogisms in all cases, because he does not accept all of Aristotle's conversion principles for contingencies.

Conclusion

All of the Aristotelian perfect modal syllogisms turn out to be valid if read as modal propositions of Gersonides' types. This result casts no doubt on the extent to which Gersonides modal logic departs from Aristotelian principles. What the result does is to demonstrate the power of Gersonides's modal logic: it is so comprehensive that it includes, as a number of special cases, the basis of Aristotle's system. This is an indication of the extraordinary breadth of Gersonides' theory.

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[12] The letter 'X' indicates an assertoric proposition.