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FUTURE CONTINGENTS AND DETERMINISM IN ARISTOTLE'S *DE INTERPRETATIONE* IX: SOME LOGICAL ASPECTS OF THE SO-CALLED SECOND OLDEST INTERPRETATION

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Abstract

Dealing with the famous Chapter IX of Aristotle's *De Interpretatione*, the paper proposes a formal reconstruction of the so-called Second-Oldest Interpretation, which (i) is based on the indeterminist logic DARB of historical necessity [Åqvist & Hoepelman (1981)] and which (ii) is inspired by the seminal work done by the scholars van Eck (1988) and von Kutschera (1986). It must be emphasized that the point of view from which *De Int.* IX is studied here is not so much that of a strict philologist engaged in Aristotelian scholarship as rather that of a modern philosophical logician concerned about systematic combinations of tense and modality. However, both points of view are of course respectable and justified in the case of *De Int.* IX, and, in the opinion of the present author, there ought to be more cross-fertilization between them.

1. *Introduction*

The main purpose of the present paper is to give an analysis / interpretation of the famous Chapter IX of Aristotle's *De Interpretatione*, which is unorthodox in the following two respects: (i) it is based on a Prior-style tense logic supplemented with characteristic operators for the notions of *historical* necessity ["inevitability"] and possibility, where this logic is a fragment of the indeterminist "tree" system DARB originally presented in Åqvist & Hoepelman (1981); and (ii) it tries to reconstruct and represent, within that system, a version of the so-called $\mathsf{Second-Oldest\ Interpretation}$ of *De Int.* IX, which is due to the Dutch scholar van Eck (1988) — see the References *infra*.

As to the first unorthodox feature of our approach, we observe that there is considerable agreement among writers on the logic of historical necessity

that the *semantics* of that notion should be based on *tree-structures* representing 'branching' time[1] with the same past and open to the future. As Burgess (1978, p. 159) nicely puts it:

> If the determinist sees Time as a line, the indeterminist sees it as a system of forking paths...

There is less agreement, however, on the question how the temporal dimension is to be reflected *syntactically* in the formal language of the logic of historical necessity under consideration. There is then a choice between essentially two courses: (*a*) to follow Prior (1967, Appendix A) in using, in addition to the modalities N and M for historical necessity and possibility, special *temporal operators* such as his F, G, P and H as well as the Scott / von Wright operators for the *next* and the *last* moment in discrete time; and (*b*) to follow Rescher & Urquhart (1971, Ch. XVII), van Eck (1981, 1988), and von Wright (1984) in using those historical modalities as *explicitly indexed by temporal names*, in the style of, say

N_tA for	"it is historically necessary at time t that A", and
M_tA for	"it is historically possible at time t that A"; together with the more general notation:
p_t for	"p-at-time t".

In this paper we follow von Kutschera (1986) in adopting course (*a*), mainly because the kind of modal-temporal logic to which it gives rise seems to be better developed, and easier to handle for our present purposes, than its rival according to course (*b*). At least, this appears to be so in today's research situation.[2]

As to the second unorthodox feature of our approach, we must point out, first of all, that we use the Kretzmann (1987) labels for the historical interpretations at issue. On the so-called Oldest Interpretation of *De Int.* IX, Aristotle claims that the Principle of Universal Bivalence ["all statements — including statements about particular future events — are true or false"] implies a Deterministic Conclusion to the effect that every true statement holds by necessity, or, equivalently, that every statement is either necessarily true or necessarily false; then [in 19a7–22] he argues that there are true statements about particular future events which are contingent in the sense of admitting "the possibility of being and of not being", where, then, "both possibilities are open, both being and not being, and, consequently, both

[1] The locution "branching time" is perhaps not entirely unobjectionable: see e.g. Rescher & Urquhart (1971, Ch. VII, sect. 2, p. 72 f.). In spite of this being so, we continue to use the received terminology in this paper.

[2] The situation may now have improved somewhat, due to my recent results in Åqvist (2004). But the present paper is not the right place to report on those results, let alone to apply them to problems of ancient modal logic.

coming to be and not coming to be". Thus, Aristotle explicitly abandons the Deterministic Conclusion and will consequently have to give up the Law of Universal Bivalence, restricting its application to statements about past events, present events, and such future events as are naturally necessitated — eclipses, for instances [see Kretzmann (1987, sect. (i)), when commenting on Łukasiewicz]. This is the distinctive feature of the Oldest Interpretation of Aristotle's *De Int.* IX.

Again, on the so-called Second − Oldest Interpretation, Aristotle is concerned about *preserving* Universal Bivalence and about reconciling it with *in*determinism (particularly with respect to the future), which means that he gives up, not only the Deterministic Conclusion ["all true statements hold by necessity"] just spoken of above, but also, most importantly, the thesis that Universal Bivalence *implies* this Deterministic Conclusion.

In his defence of the Second-Oldest Interpretation van Eck (1988, p. 19) points out that Boethius, in his two commentaries on *De Interpretatione* IX, shows himself a representative of the Second-Oldest Interpretation: his main thesis is that, according to Aristotle, it is necessary for a future contingency proposition and its negation that one is true and the other false, but not *definitely* true, nor *definitely* false.[3] In the context van Eck refers to Kretzmann (1987) as having stressed the influence which this point of view of Boethius has had on the subsequent discussion [see in particular Kretzmann (1987, "Conclusion")].

van Eck also points out that in modern times most commentators reject the Second-Oldest Interpretation on the ground (partly) that the crucial phrase phrase "definitely true" is rather obscure and its Greek analogue [ἀληθὲς ἀφωρισμένως] does not occur in *De Int.* IX at all.[4] In order to counter this objection, then, van Eck (1988, p. 20) suggests that instead we take the phrase "definitely true" in Boethius as an equivalent of the "already true" [ἤδη ἀληθῆ] in 19a38. Such a somewhat special concept of truth can then be naturally connected with a temporally dependent notion of necessity, viz.

[3] We may observe here that the French translator and commentator J. Tricot, when dealing with the difficult sentence 19a39–19b2 in the concluding passage of *De Int.* IX, adds to his translation of that sentence in a footnote: "sous-entendu ἀφωρισμένως *determinate*" (i.e. "tacitly understood: definitely, determinately"). See Tricot (1994, p. 103, n. 3) as well as our comments on 19a39–19b4 at the end of Section 9 *infra*.

[4] Interestingly, Kretzmann (1987, sect. (iii), "Sources of the second-oldest interpretation") observes that in the *Categories* ch. 10, 12b38–40 and 13a2–3, Aristotle uses the adverbial modifier ἀφωρισμένως in a way which appears to provide a warrant for Boethius' emendation.

that of historical necessity.

Without taking a definite stand on the hard issue concerning the historical accuracy of the two interpretations of Aristotle just mentioned (an issue involving *inter alia* a large number of difficult strictly philological questions), I now want to state two main reasons for my being seriously interested in the Second-Oldest Interpretation as reconstructed within the system DARB of Åqvist & Hoepelman (1981). The first main reason derives from Dana Scott in a discussion of the use of three-valued logic in connection with so-called 'improper definite descriptions':

> ...I have yet to see a really workable three-valued logic. I know it can be defined, and at least four times a year someone comes up with the idea anew, but it has *not* really been developed to the point where one could say it is pleasant to work with. Maybe the day will come, but I have yet to be convinced.
> So my advice is to continue with two-valued logic because it is easy to understand and easy to use in applications; then when someone has made the other logic workable a switch should be reasonably painless.
>
> Scott (1970, p. 153)

So *a* reason (not necessarily decisive) for preferring the Second-Oldest Interpretation to its Oldest rival then comes down to the following well-known one: it has the virtue of enabling us stay — along with Aristotle — within two-valued logic, whereas the Oldest Interpretation compels us — along with him — to go into three-valued logic (many-valued logic? intuitionism?). Again, the second main reason for my interest in the Second-Oldest Interpretation is bound up with my choice of logico-analytical framework, the indeterminist "tree" system DARB: it turns out that the central notion in van Eck's reconstruction — the "already true" [$\ddot{\eta}\delta\eta$ $\grave{\alpha}\lambda\eta\theta\hat{\eta}$] in 19a38 — can be explicated and rigorously defined in our framework against the background of the technical result on DARB, which is stated and proved in Section 2 *infra*; furthermore, on the basis of that very same result, we are also able to provide an explanation within DARB of Aristotle's difficult argument for Determinism, on which he spends so much time in *De Int.* IX (see Sections 2–3 and 10 *infra*).

Suppose then that we accept, provisionally at least, the Second-Oldest Interpretation. What does it amount to? and what problems do we then face? We recall that both interpretations agree on taking Aristotle to reject what I called the Deterministic Conclusion ["all true statements hold by necessity", "every statement is either necessarily true or necessarily false"], but that the Second-Oldest one differs from its Oldest rival in two respects: (i) in taking

Aristotle to reject the thesis that the Law of Bivalence implies the Deterministic Conclusion, and (ii) in taking him to accept the Law of Bivalence since, by (i), there is no longer any reason for him to give it up. Clearly, then, on the Second-Oldest Interpretation we face two interesting problems that are respectively bound up with the features (i) and (ii):

Ad (i): Explain why Aristotle spends so much time in developing an argument [in 18a34–19a6] for the thesis that Universal Bivalence *implies* the Deterministic Conclusion in spite of the fact that in the end he rejects that argument; and explain the import of the argument itself!

Ad (ii): Although Aristotle is now taken to accept Universal Bivalence in *one* sense of that Law, there are passages [e.g. 19a32–39 and 19a39–19b2] suggesting that he may still want to reject it in *another* sense of that Law: hence, explain those different senses with a view to telling us how this can be so!

In answer to the first problem here, we suggest that on the Second-Oldest Interpretation one should take Aristotle to be engaged in a dispute with an imaginary opponent, "the determinist", whose views and arguments he tries to present as forcefully and convincingly as possible, thus playing the role of an *advocatus diaboli*, as it were. Moreover, as to the import of the determinist argument itself, we suggest that it is based on an *operator shift fallacy* from

FNp ["it will be the case that necessarily (i.e. *then* in the future) p"]
to
NFp ["necessarily (i.e. as of *now*), it will be the case that p"]

which in turn suggests a distinction between a weak and a strong future tense, viz. one between the sentence-forms

Fp [weak future tense] and NFp [strong future tense].

This distinction is already implicit in the Prior (1967, Ch. VII) distinction between the Ockhamist and the Peircean future operators "will"; in Section 10 below we notice that the same distinction is used by van Rijen (1986, 1989). As appears from Section 11 *infra*, however, we strongly feel that our operator-shift-fallacy diagnosis should be supplemented by the von Kutschera (1986) analysis of the Aristotelian arguments for determinism — an analysis based on the interesting distinction between "Aussage *über* Gegenwärtiges / Vergangenes" and "Aussage in Gegenwarts- / Vergangenheits*form*".

Again, in answer to the second of the above problems, we refer the reader to Section 9 *infra*, where we emphasize a distinction between the Principle of

Bivalence *tout court* (i.e. Bivalence as ordinarily understood) and a Principle of Strong Bivalence, which asserts that every statement is either *already* true or *already* false, i.e. that every statement is either true or false *in the way it holds for the past and the present*. As we explicate that strong principle, it captures a sense of Bivalence in which Aristotle would certainly reject it; recall what he says about future contingents like the Sea Battle one at the very end of 19a32–39: *οὐ μέντοι ἤδη ἀληθῆ ἢ ψευδη*.

In very broad outline the plan of the present paper is as follows. We devote Sections 2–7 to certain logical and analytical preliminaries to a commentary on *De Int.* IX, whereas the analysis or commentary itself — carried out using DARB (or better, an extended fragment of DARB) — is to be found in the remaining Sections 8–12.

2. *A result in the logic of historical necessity*

In our analysis of some Aristotelian views and arguments we shall use a *Prior-style tense logic with historical necessity*, the syntax of which contains the following special, characteristic locutions:

MA	for *it is historically possible that* A
NA	for *it is historically necessary that* A
FA	for *it will at some time in the future be the case that* A
eA	for *it will be the case tomorrow that* A
GA	for *it will always be the case that* A
PA	for *it was at some time in the past the case that* A
wA	for *it was the case yesterday that* A
HA	for *it was always the case that* A

In addition to these locutions our formal language contains an at most denumerable set Prop of *propositional variables* as well as the familiar *Boolean sentential connectives* $\neg$, $\wedge$, $\vee$, $\rightarrow$ and $\leftrightarrow$ for, respectively, negation, conjunction, disjunction, material implication and material equivalence. The set of (formal) *sentences*, or (well-formed) *formulas*, is then built up in the usual way.

Again, our present logic of historical necessity, i.e. the logic of the above indicated temporal notions, will essentially be a fragment of the system DARB, which was first presented and studied in Åqvist & Hoepelman (1981) from a semantic as well as an axiomatic point of view. We must note, however, that the notation used here is typographically simpler and more in conformity with current styles of tense logic than the one adopted in Åqvist & Hoepelman (1981); thus, for our crucial tense-logical operators we now use

straightforward letters M, N, F, e, G, P, w and H instead of diamonds, squares and circles with various inscriptions (including the 'empty' inscription). Furthermore, we note that the expressive resources of our DARB-fragment largely coincide with those employed by von Kutschera (1986) in his analyses of Aristotle's argument for determinism in *De Int.* IX and of Diodorus' so called "Master Argument" — a main difference between our formalisms lies in the fact that von Kutschera (1986) uses the Kamp (1971) operator "Jetzt" (*now*), where in the DARB-fragment we use the operators "Tomorrow" (*e*) and "Yesterday" (*w*).

As to the detailed description of the model-theoretical "tree"-semantics for DARB, we must refer the reader to Åqvist & Hoepelman (1981). We recall here that already the title of Åqvist & Hoepelman (1981) indicates that DARB is a system of combined *modal* (and deontic) *tense* logic, the semantics of which is based on certain set-theoretical structures known as *trees* (in the word "DARB", "ARB" suggests the Latin *arbor*, meaning "tree"). See also von Kutschera (1986, p. 216, n. 6), who speaks of *Baumuniversen* in a similar context. Furthermore, my later papers Åqvist (1996, Section 14) and Åqvist (1999) are helpful as far as the closer understanding of this style of semantics for historical modalities is concerned.

Now, an important axiom of DARB, which reappears in our present fragment, is the following:

A28. $A \rightarrow NA$, provided that A is a propositional variable.[5]

In Åqvist & Hoepelman (1981) we were able to generalize this axiom in an interesting way, which gives us the following result in our present logic of historical necessity (or fragment of DARB):

THEOREM. By saying that a formal sentence is *non-future* we mean that it contains no occurrences of the operators F, e or G. Then, any instance of the schema

S. $\quad A \rightarrow NA$

[5] As to the semantical justification of the axiom A28, its validity is due to a condition on so-called *valuations*, referred to in Åqvist & Hoepelman (1981, p. 198) as (C), in Åqvist (1996, p. 96) as (III), and in Åqvist (1999, pp. 352–353) as (ix) or, equivalently, as (C4 $\approx$). See also von Kutschera (1986a, sect. 3, p. 265).

is provable (and valid) in our logic of historical necessity, *provided that* A is non-future.

Proof. By induction on the length of A.

Basis. $A = p$, for some propositional variable p. Clearly, p is non-future in the required sense of containing no occurrences of F, e or G. The desired result is then immediate by virtue of axiom A28.

Induction step. The cases where the main, or principal, operator of A is any of the Boolean connectives $\neg$, $\wedge$, $\vee$, $\rightarrow$ or $\leftrightarrow$ (with their arguments being non-future) are easy and left to the reader. Consider next:

Cases $A = MB$ and $A = NB$, where B is non-future. By virtue of the well known S5-principles

$$MB \rightarrow NMB \text{ and } NB \rightarrow NNB$$

which are valid in our logic for the historical modalities M and N, we immediately obtain the desired result in these two cases without even having to appeal to the inductive hypothesis.

Again, consider:

Case $A = PB$, where B is non-future. We then argue as follows:

1.	$B \rightarrow NB$	provable by the hypothesis of induction
2.	$H(B \rightarrow NB)$	from 1 by a rule of proof in elementary tense logic
3.	$PB \rightarrow PNB$	from 2 by a familiar thesis in tense logic
4.	$PNB \rightarrow NPB$	axiom A30 in Åqvist & Hoepelman (1981)
5.	$PB \rightarrow NPB$	3, 4, transitivity of $\rightarrow$

where 5 is our desired result.

Case $A = wB$, where B is non-future. Then:

1.	$B \rightarrow NB$	provable by the inductive hypothesis
2.	$w(B \rightarrow NB)$	1, the tense logic of w
3.	$wB \rightarrow wNB$	2, the tense logic of w
4.	$wNB \rightarrow NwB$	axiom A31 in Åqvist & Hoepelman (1981)
5.	$wB \rightarrow NwB$	3, 4, transitivity of $\rightarrow$

where 5 = Q.E.D.

Case $A = HB$, where B is non-future. The case is handled as follows:

1.	$B \rightarrow NB$	provable by the inductive hypothesis
2.	$H(B \rightarrow NB)$	1, the tense logic of H
3.	$HB \rightarrow HNB$	2, the tense logic of H
4.	$HNB \rightarrow NHB$	axiom A29 in Åqvist & Hoepelman (1981)
5.	$HB \rightarrow NHB$	3, 4, transitivity of $\rightarrow$

where 5 = Q.E.D.

The induction is complete, and so is the proof of our Theorem.

3. *Putative laws of commutation in the* DARB*-fragment*

In the proof of the result on historical necessity just presented we met with three interesting DARB-valid principles telling us how the operator N commutes with the past tense operators P, w and H, viz., in the nomenclature of Åqvist & Hoepelman (1981):

A30. $PNB \rightarrow NPB$
A31. $wNB \rightarrow NwB$
A29. $HNB \rightarrow NHB$

A crucially important feature of our logic of historical necessity is now that the corresponding principles all fail to be valid for the future tense operators F, e and G. Thus, *none* of the "putative" laws of commutation

$FNB \rightarrow NFB$
$eNB \rightarrow NeB$
$GNB \rightarrow NGB$

are valid or provable in DARB. (The converses of the second and the third law, at least, are provable and valid in DARB, however.) These facts will be seen to be of considerable interest when we turn to a closer examination of Aristotle's reasoning in *De Interpretatione* IX. Again, we should observe here that DARB shares those features with some indeterminist tense logics discussed in the literature, e.g. the so-called 'Actualist' or 'Ockhamist' system A considered by Burgess (1978) as well as the so-called 'T $\times$ W logic' dealt with by von Kutschera (1997).

4. *On the notions* already true *and* already false *within an extension of the* DARB*-fragment*

In the present section we add to our Prior-style tense logic with historical necessity (= the fragment of DARB presented in Section 2 *supra*) certain fresh one-place operators that form sentences when applied to sentences,

viz. *True*, *False*, *Pres-or-Past*, *AlreadyTrue* and *AlreadyFalse*. The intended reading of the characteristic locutions to which our new operators give rise is as follows (where A is any sentence of our DARB-fragment):

TrueA	for *it is true that* A
FalseA	for *it is false that* A
Pres-or-PastA	for *it is a present or past* possible fact *that* A
AlreadyTrueA	for *it is already true that* A
AlreadyFalseA	for *it is already false that* A

As to the interpretation in a technical sense of these new locutions, we adopt the following 'definitional' axiom schemata:

AxTrue.	*TrueA* $\leftrightarrow A$
AxFalse.	*FalseA* $\leftrightarrow \neg A$
AxPres-or-Past.	*Pres-or-PastA* iff (if and only if) A contains no occurrences of F, e or G; i.e., A is *non-future* in the sense of Section 2 above.
AxAlreadyTrue.	*AlreadyTrueA* $\leftrightarrow$ (*Pres-or-PastA* $\wedge$ *TrueA*)
AxAlreadyFalse.	*AlreadyFalseA* $\leftrightarrow$ (*Pres-or-Past*$\neg A \wedge$ *True*$\neg A$) [$\leftrightarrow$ *AlreadyTrue*$\neg A$].

Caveat. We must observe here that only the first two and the last two equivalences are full-blown axiom schemata in the object-language, whereas the characterization offered by the third equivalence, AxPres-or-Past, cannot be formulated in the object-language but has to be relegated to the meta-language (of our extended DARB-fragment); this explains why we use "iff" instead of $\leftrightarrow$ in that characterization. Another way of putting the matter is to say that, in the extended DARB-fragment, we treat *Pres-or-Past* as a primitive logical operator which, unlike the remaining four ones, is not explicitly definable in the object-language of that fragment.

On the basis of the interpretation just provided we obtain the following straightforward result:

Corollary. All instances of the following schemata are provable and valid in the extended DARB-fragment:

(i) $A \vee \neg A$, $N(A \vee \neg A)$ [Law of Excluded Middle, two versions]

(ii) *TrueA* $\vee$ *FalseA*, N(*TrueA* $\vee$ *FalseA*) [Principle of Bivalence, two versions]

(iii) *Pres-or-Past*$\neg A \leftrightarrow$ *Pres-or-PastA*

and similarly for NA, MA, PA, wA and HA replacing $\neg A$ in the left member of (iii).

(iv) *Pres-or-Past*$(A \vee B) \leftrightarrow$ (*Pres-or-PastA* $\wedge$ *Pres-or-PastB*)
and similarly for $(A \wedge B)$, $(A \rightarrow B)$ and $(A \leftrightarrow B)$ replacing $(A \vee B)$ in the left member of (iv).
(v) *AlreadyTrueA* $\rightarrow N A[\leftrightarrow$ *NTrueA*$]$
(vi) *AlreadyFalseA* $\rightarrow N\neg A[\leftrightarrow$ *NFalseA* $\leftrightarrow \neg M A]$
On the other hand, in spite of the validity of (i) and (ii), the following schema fails in the extended DARB-fragment:
(vii) *AlreadyTrueA* $\vee$ *AlreadyFalseA*.

Proof. Immediate by the meaning of the relevant notions. As to the principles (v) and (vi), their validity in the extended DARB-fragment readily follows from our Theorem in Section 2 — note that, due to the presence of *Pres-or-Past* as a new primitive in the object-language of this extended fragment, they simply amount to a re-formulation of that Theorem in this new object-language. As to the non-validity of schema (vii), just take A to be any sentence containing occurrences of the future-tense operators F, e or G, in which case both disjuncts in (vii) are seen to be false.[6]

5. *Different versions of determinism explicable in the extended* DARB*-fragment*

In the present section we speak loosely of 'determinism' in the sense of a deterministic *claim* or *thesis*. We then make two distinctions with respect to determinism in this sense, viz. (*a*) between *strong* and *weak* deterministic theses, and (*b*) between what I call *plain* and *disjunctive* deterministic theses. Cross-classifying in the obvious way, we then arrive at four forms of determinism, which are made precise as follows:

Strong Plain Determinism. This thesis asserts that all instances of the schema
TrueA $\rightarrow N A$
are provable and valid in the extended DARB-fragment.

Weak Plain Determinism. This thesis only asserts that all instances of the weaker schema

[6] We ought to observe here that, although our characterization of the new primitive *Pres-or-Past* looks like a fairly uncomplicated syntactical one, that characterization in effect amounts to quite a powerful *truth condition* in the model-theoretic *semantics* for the extended DARB-fragment, which has far-reaching consequences as far as the *validity* of various schemata is concerned. In the present Corollary, this fact is nicely illustrated e.g. by the validity of schemata (v) and (vi) and the non-validity of (vii).

AlreadyTrueA $\rightarrow NA$
are provable and valid in the extended DARB-fragment. Since that thesis is equivalent to
Pres-or-PastA $\rightarrow$ (*TrueA* $\rightarrow NA$)
it might be viewed as a form of determinism about the present or past, but not necessarily about the future.

Strong Disjunctive Determinism. This is the thesis according to which all instances of the schema
(*TrueA* $\vee$ *FalseA*) $\rightarrow (NA \vee N\neg A)$
are provable and valid in the extended DARB-fragment. A *prima facie* weaker version of the thesis amounts to the provability / validity of the schema
N(*TrueA* $\vee$ *FalseA*) $\rightarrow (NA \vee N\neg A)$.

Weak Disjunctive Determinism. According to this view we only have that all instances of the definitely weaker schema
(*AlreadyTrueA* $\vee$ *AlreadyFalseA*) $\rightarrow (NA \vee N\neg A)$
are provable and valid in the extended DARB-fragment. Again, this thesis is clearly a form of determinism about the present or the past, but not necessarily about the future; the schema defining it is equivalent to the schema
Pres-or-PastA $\rightarrow$ ((*TrueA* $\vee$ *FalseA*) $\rightarrow (NA \vee N\neg A)$).

Remarks.
(I) The two disjunctive versions of determinism respectively follow from, and are in fact equivalent to, the plain ones.[7]

[7] They can indeed be seen also to entail, and thus to be equivalent to the plain versions. As this fact is perhaps not immediately obvious, let us quickly show how Strong Disjunctive Determinism entails Strong Plain Determinism in our extended DARB-fragment:

1.	(*TrueA* $\vee$ *FalseA*) $\rightarrow (NA \vee N\neg A)$, for all A	assumption (= Strong Disjunctive Determinism)
2.	(*TrueA* $\rightarrow (NA \vee N\neg A)$) $\wedge$(*FalseA* $\rightarrow (NA \vee N\neg A)$)	1, propositional logic
3.	*TrueB* $\wedge \neg NB$, for some B	counterassumption, equivalent to the negation of Strong Plain Determinism
4.	$N\neg B$	2 (setting $A = B$); then use 3 together with elementary DARB-laws
5.	$\neg$*TrueB*	4, elementary DARB-laws, AxTrue

where 5 contradicts the first conjunct in 3. Hence, the counterassumption 3 is reduced *ad absurdum*. Q.E.D.

(II) The schemata defining the two strong versions are clearly invalid in the extended DARB-fragment, but we are free to consider the results of adding them to the latter, for sure. On the other hand, the schemata defining the two weak versions are indeed valid in the extended DARB-fragment.

(III) Strong Disjunctive Determinism, on both versions, asserts that for all sentences A, the Principle of Bivalence, on both versions, implies the conclusion $(NA \vee N\neg A)$. By AxTrue and AxFalse it may equivalently be taken to assert that the Law of Excluded Middle, on both versions, implies that conclusion.

6. *What are we to mean by a 'future contingent'?*

When dealing with such a difficult and controversial text as Aristotle's *De Interpretatione* IX, it is clearly quite important to get straight about the terminology used in commenting on it; the question raised in the title of this section then has to be answered in a reasonably precise way.
Well, consider any sentence A of our logic of historical necessity [= the extended DARB-fragment as presented in Section 4 *supra*]. First of all, then, we say that

> A is a *statement about some particular future event* iff
> $A = FB$ or $A = eB$ or $A = GB$ for some sentence B such that
> B is a propositional variable or a truth-functional compound
> of propositional variables, which is interpreted as referring to
> some particular event.

Hence, if A is a statement about some particular future event, A will begin with one of the future tense operators F, e or G, but the sentence governed by that operator will be non-future in our familiar sense of containing no occurrences of those three operators. Instead of the locution just defined we could as well speak here of statements about '*particulars that are going to be*', which phrase is used by Aristotle himself in the opening paragraph of *De Int.* IX [18a28–34]. Or, with Ackrill (1963, p. 132), we might speak of '*future singulars*' in the very same sense.
Secondly, we can now say that

> A is a contingent *statement about some particular future event*
> — or A is a future contingent, for short — iff
> A is a statement about some particular future event, and,
> according as A is of the form FB, eB, or GB, A satisfies the condition

$MFB \wedge M\neg FB$, or
$MeB \wedge M\neg eB$, or
$MGB \wedge M\neg GB$,

as the case may be.[8]

7. *How does the existence of future contingents, if there are any, affect the validity of such laws as those of Bivalence and Excluded Middle?*

In the present section we make an attempt to answer the question raised in its title. So consider any future contingent A, e.g. of the form FB, which, as we recall, then satisfies the condition

$MFB \wedge M\neg FB$

asserting that "the two future possibilities are both open", as it were. With respect to A, we argue as follows, with a view to providing counterexamples to the Principle of Bivalence (on both versions, the 'necessitated' as well as the 'unnecessitated' ones):

0.	$N(\textit{TrueFB} \vee \textit{FalseFB})$	assumption, instance of 'necessitated' Bivalence
1.	$\textit{TrueFB} \vee \textit{FalseFB}$	from 0 by the logic of N (= an extension of S5)
2.	*TrueFB*	hypothesis (= first disjunct in 1)
3.	NFB	from 2 by Strong Plain Determinism
4.	$NFB \vee N\neg FB$	from 3 by disjunction introduction
5.	*FalseFB*	hypothesis (= second disjunct in 1)
6.	$N\neg FB$	from 5 by Strong Plain Determinism together with AxFalse and AxTrue
7.	$NFB \vee N\neg FB$	from 6 by disjunction introduction
8.	$NFB \vee N\neg FB$	from the deductions 2–4 and 5–7 by disjunction elimination, discharging the two hypotheses 2 and 5
9.	$N(\textit{TrueFB} \vee \textit{FalseFB}) \rightarrow (NFB \vee N\neg FB)$	from the deduction 0–8 by the Deduction Theorem, discharging the initial assumption 0.

On the other hand, we know that

10.	$MFB \wedge M\neg FB$	since FB is a future contingent

But line 10 is equivalent to the negation of the consequent of line 9. Hence:

[8] We note that our notion of a future contingent comes close to the one used by Ackrill (1963, p. 139): 'future singulars in cases where both possibilities are open'.

11. $\neg N(\mathit{TrueFB} \vee \mathit{FalseFB})$ 9, 10, *modus tollens*

where the result 11 provides a counterexample to the 'necessitated' form of the Principle of Bivalence. In order to obtain the desired counterexample to the 'unnecessitated' form thereof, we just start from line 1 as our initial assumption and, after having arrived at line 8, we obtain instead of line 9:

9′. $(\mathit{TrueFB} \vee \mathit{FalseFB}) \rightarrow (NFB \vee N\neg FB)$ from the deduction 1–8 by the Deduction Theorem, discharging the initial assumption 1.

Hence:

11′ $\neg(\mathit{TrueFB} \vee \mathit{FalseFB})$ 9′, 10, *modus tollens*

and we are done.

Remarks.

(I) Our argument is considerably simplified, if we use Strong *Disjunctive* Determinism in the place of the "plain" version. We then obtain line 8 directly from line 1 by Strong Disjunctive Determinism, and, since the remainder of the proof goes through unproblematically as above, we are done.

(II) As the Laws of Excluded Middle and Bivalence are clearly equivalent[9] in the extended DARB-fragment, the above argument can easily be re-written in a way so as to provide counterexamples to Excluded Middle as well. Again, this goes for both versions of that law.

(III) We observe that the above argument also goes through for future contingents $A = eB$ and $A = GB$, as is easily verified.

It is now crucially important to realize that these counterexamples (to Bivalence/Excluded Middle) and their proofs rely heavily on the principle of Strong Plain/Disjunctive Determinism, to which we appealed in the arguments *supra*. If we reject those strong deterministic theses while accepting just the their weak versions (given in Section 5 above), those arguments fail,

[9] On the issue whether the two laws are equivalent also for Aristotle, see e.g. von Kutschera (1986, p. 216, n. 9), and Hintikka (1973, p. 148, n. 2). I agree both with Hintikka's assertion: "Whatever the merits of the distinction are in the abstract, I cannot find it in Aristotle's text", and with that of von Kutschera: "Bei der normalen Deutung der Operatoren $\vee$ und $\neg$, ..., gilt jedoch das *tertium non datur* dann und nur dann, wenn das Prinzip der Bivalenz gilt. Der Unterschied ist für das folgende jedoch unerheblich, da Aristoteles "nicht" und "oder" im normalen Sinn deutet." A difference (noteworthy, but of subordinate importance in our opinion) between von Kutschera and myself concerns the status of the Principle of Bivalence: von Kutschera (*op.cit.*, *loc.cit*) takes it to be, unlike the *tertium non datur*, a metalinguistic principle, whereas I take them both to be capable of being formulated in the object-language (see Section 4 above: Corollary, schemata (i)–(ii)).

of course.
At best, we know from the Corollary in Section 4 *supra* that the schema

(vii) *AlreadyTrueA* $\vee$ *AlreadyFalseA*

fails to be valid or provable in the extended DARB-fragment. More precisely, (vii) fails whenever A contains occurrences of the future-tense operators F, e, or G. Expressing this result in the object-language of our extended DARB-fragment, we obtain that the following schema
(viii) $\neg$*Pres-or-PastA* $\rightarrow$ ($\neg$*AlreadyTrueA* $\wedge$ $\neg$*AlreadyFalseA*)
is provable and valid in that fragment by the definitions of the notions involved. So, in particular, then, we have for any future contingent $FB \mid eB, GB \mid$ that

(ix) $\neg$(*AlreadyTrueFB* $\mid eB, GB \mid \vee$ *AlreadyFalseFB* $\mid eB, GB \mid$)

is provable and valid in the present logic of historical necessity.

To summarize our findings in this section. Suppose that there are future contingents of any of the three forms considered in our definition of the notion. Then, (*i*) given Strong Plain Determinism or Strong Disjunctive Determinism, the existence of future contingents certainly affords counterexamples to the laws of Bivalence and Excluded Middle, as shown by the proof of lines 11 and 11′ *supra* (or of its eB- and GB-cognates). This holds regardless of whether we deal with the necessitated or unnecessitated versions of these laws. On the other hand, (*ii*) rejecting these strong forms of determinism in favour of the weak ones considered in Section 5, the existence of future contingents does not provide any counterexamples to those laws any longer. Moreover, (*iii*) these laws and weak forms of determinism are all provable and valid in our extended DARB-fragment. Finally, (*iv*) according to this logic of historical necessity there *are* true future contingents in the precise sense of there being sets of sentences

$$\{FB, MFB \wedge M\neg FB\}, \{eB, MeB \wedge M\neg eB\},$$
$$\{GB, MGB \wedge M\neg GB\}$$

with B a propositional variable or a truth-functional compound of propositional variables referring to some particular event, which sets are *consistent* and *satisfiable* in the extended DARB-fragment. In fact, this is an obvious and important feature of that logic of ours.

8. *Structure of* De Int. *IX: a four-fold division and a preliminary account*

Here, we suggest dividing Chapter IX of *De Interpretatione* into four main parts.[10]

Part I consists of 18a28–34, Part II of 18a34–19a6, Part III of 19a7–22 and Part IV consists of 19a23–19b4. This division differs from those of Ackrill (1963) and van Eck (1988) just in the following respect: we make a separate Part III of 19a7–22, while Ackrill takes his Part III to start with 19a7 and to continue down to the very end 19b4; van Eck, on the other hand, squeezes 19a7–22 into his Part II which then encompasses 18a34–19a22. So I agree with Ackrill on the extension of Parts I and II, and with van Eck that 19a23–19b4 should be taken to form a separate Part (*his* Part III, *my* Part IV).

Let me now, without getting entangled in too many controversial details, briefly state what I take to be the main content of each part in my suggested division. In Part I [18a28–34] Aristotle asserts that the necessitated version of the Principle of Bivalence holds for statements about "what is and what has been", but that it does not hold in the same way [οὐχ ὁμοίως] for statements about "particulars that are going to be". Next, in Part II [18a34–19a6] Aristotle develops an argument that purports to show that if every affirmation or negation is true or false, then "nothing either is or is happening, or will be or will not be, by chance or as chance has it, but everything of necessity and not as chance has it...". Elsewhere in Part II, Aristotle formulates this '*deterministic*' conclusion using such locutions as "everything that happens happens of necessity", "everything that will be happens necessarily", and the like. Again, in Part III [19a7–22] Aristotle rejects the deterministic conclusion, claiming that "not everything is or happens of necessity", because "what will be has an origin both in deliberation and in action" so that, sometimes, "there is the possibility of being and of not being". Finally, in Part IV [19a23–19b4], Aristotle states his own view about the notion of necessity in relation to statements about particular future events (such as the famous sea-battle tomorrow), whereupon, in a concluding paragraph beginning with 19a39, he closes Chapter IX by connecting his findings in Part IV with the opening Part I.

[10] In the present paper I mainly use Ackrill's translation in Ackrill (1963). I will indicate in footnotes where I deviate from it. My deviations are mostly due to van Eck (1988), who prefers variants closer to the Greek text which often result in more distorted English but, on the other hand, in a better understanding as well. The Greek text I use is that of the edition by L. Minio-Paluello (1949).

9. *The gist of the van Eck (1988) version of the Second-Oldest Interpretation represented in the extended* DARB*-fragment*

The best way of approaching van Eck's interpretation of *De Int.* IX from our standpoint is, I suggest, to turn to the original Aristotelian text itself, just as van Eck himself does, and check his comments on it. We may then usefully start with Parts I and IV in our suggested division.

The chapter, i.e. *De Int.* IX, opens as follows:

> With regard to what is and what has been it is necessary for the affirmation or the negation to be true or false. And with universals taken universally it is always the case[11] that one is true and the other false, and with particulars too, as we have said; but with universals not spoken of universally it is not necessary. But with particulars that are going to be not in the same way [οὐχ ὁμοίως].
>
> Part I [18a28–34]

Ad 18a28–34. Here we read that with regard to the present and the past it is necessary (*a*) that the affirmation or the negation is true or false; and that with universal and particular sentences it is always the case (*b*) that one is true and the other false. Now, van Eck (1988, p. 34) points out that it is most significant how the denial of this is phrased in the concluding sentence. Aristotle *does not say*, for example, that for future contingencies this *does not hold*, or, this *is not necessary* (as he in fact says with regard to "universals not spoken of universally"). No, he says:

> "But with particulars that are going to be *not in the same way*". [van Eck's italics].

van Eck then suggests that we read this concluding sentence as follows: for statements about particular future events, it is not in the same way necessary that (*a*), nor that (*b*); it is a denial not of the Principle of Bivalence *tout court*, but of that principle *in the way it holds for the past and the present*.
For short, let us call the principle thus conceived the Principle of Strong Bivalence. And it turns out that, on our representation of the van Eck (1988) interpretation, this principle amounts precisely to the schema (vii) met with in the Corollary in Section 4 above, viz.:

(vii) $\mathit{AlreadyTrueA} \vee \mathit{AlreadyFalseA}$ [Principle of Strong Bivalence]

which is known to fail of validity in the extended DARB-fragment (because it does not hold for any sentences containing occurrences of the future-tense

[11] ἀεὶ; Ackrill and van Eck: "it is always necessary...". There is no ἀνάγκη in the Greek text at this spot, however, although there is certainly one in the preceding sentence.

operators F, e, or G). On the other hand, the Principle of Strong Bivalence is clearly valid for statements about the present or the past, viz., in the sense that the following schema

(x) $\mathit{Pres\text{-}or\text{-}PastA} \rightarrow (\mathit{AlreadyTrueA} \vee \mathit{AlreadyFalseA})$

is provable and valid in our logic of historical necessity.

How does van Eck arrive at his way of making precise the words "not in the same way" [οὐχ ὁμοίως] in Part I? In order to understand this crucial feature of his interpretation we must skip Parts II and III for the time being, and go on directly to our Part IV [19a23–19b4] which reads as follows:

> What is, necessarily is, when it is; and what is not, necessarily is not, when it is not. But not everything that is, necessarily is; and not everything that is not, necessarily is not. For to say that everything that is, is of necessity, when it is, is not the same as saying simply[12] [ἁπλῶς] that it is of necessity. Similarly with what is not.
>
> [19a23–27]
>
> And the same account holds for contradictories: everything necessarily is or is not, and *will* be or not[13]; but one cannot divide [διελόντα] and say that one or the other is necessary. I mean, for example: it is necessary for there to be or not to be a sea-battle tomorrow; but it is not necessary for a sea-battle to take place tomorrow, nor for one not to take place — though it is necessary for one to take place or not to take place.
>
> [19a27–32]
>
> So, since statements are true in the same way the states of affairs are[14], it is clear that wherever these are such as to allow of contraries as chance has it, the same necessarily holds for the contradictories also. This happens with things that are not always so or are not always not so. With these it is necessary for one or the other of the

[12] ἁπλῶς; Ackrill: "unconditionally". We follow van Eck here in sticking to the more literal translation: "simply".

[13] καὶ ἔσεσθαί γε ἢ μή; Ackrill: "and will be or will not be". We follow van Eck here in using italics to render the emphasis that γε imparts to ἔσεσθαί.

[14] van Eck's translation, slightly deviating from Ackrill's.

> contradictories to be true or false — not, however, this or that[15], but as chance has it; or for one to be true *rather* than the other, yet not *already* [ἤδη] true or false.
>
> [19a32–39]
>
> Clearly, then, it is not necessary that of every affirmation and opposite negation one should be true and the other false. For the way it is with the things that are, so it is not also with the things that are not, but may possibly be or not be; but as is said.[16]
>
> [19a39–19b4]

Let us now consider in turn the four passages *supra*, which make up Part IV in our suggested division of *De Int.* IX, with a view to capturing the gist of the van Eck (1988) interpretation as seen from the standpoint of our extended DARB-fragment.

Ad 19a23–27. This passage is truly fascinating: Aristotle is saying that everything that is, necessarily is, when it is; but that this does not mean that it is simply [ἁπλῶς] necessary. Now, van Eck makes the following observation:

> 'Thus something is necessary under the condition that it is already the case, i.e. past or present. If so, it is historically necessary.
> So "if p then necessarily p" holds when p satisfies the condition, but not if it does not, if p is about the future.'
>
> [van Eck (1988, p. 37 f.)]

Note that two important notions appear in this comment by van Eck, viz. that of something being *already* the case (or being *present or past*), and that of *historical* necessity. And he connects the two notions by suggesting that they satisfy what I called the principle of Weak Plain Determinism in Section 5 *supra*, viz.

> *AlreadyTrueA* $\rightarrow NA$, or more explicitly:
> *Pres-or-PastA* $\rightarrow$ (*TrueA* $\rightarrow NA$)

In my opinion, the importance of van Eck's present suggestions can hardly be overrated. Again, as to Aristotle's second, unspecified notion of necessity, which also figures in 19a23–27 and is called by him 'simple' necessity

[15] τόδε ἢ τόδε; Ackrill: "this one or that one (*sc.* of the contradictories)". We follow van Eck in reading the phrase as referring to "true or false", but the difference is probably of subordinate importance.

[16] We follow van Eck's translation here as being more literal, but admittedly less elegant than the one adopted by Ackrill.

(necessity *simpliciter* or necessity *tout court*, if you are a fan of Latin or French), let us denote it by the symbol $\Box$ and just observe for the time being that such schemata as

$A \rightarrow \Box A$
$\neg A \rightarrow \Box \neg A$

are not to be accepted as valid according to Aristotle in the passage under consideration. We do not, however, exclude the possibility that the unspecified modality $\Box$ be identical to the modality N of historical necessity in our extended DARB-fragment. In that case, i.e. if $\Box = N$, the distinction emphasized by Aristotle here would be the straightforward one used in Section 5 above to distinguish Weak Plain Determinism from Strong Plain Determinism, viz. *AlreadyTrueA* $\rightarrow NA$ vs. *TrueA* $\rightarrow NA$ (or $A \rightarrow NA$) without any restriction on A.

Ad 19a27–32. This passage contains the famous sea-battle-tomorrow example. So here Aristotle is saying that, according to the same account [ὁ αὐτὸς λόγος], everything necessarily is or is not, and *will* be or not, but also that one cannot divide (i.e. distribute the necessity over disjunction) and say that one or the other is necessary. And the sea-battle-tomorrow example tells us precisely how and why this is so. Again, van Eck comments on the passage as follows:

> 'It is the same logos because "necessarily(p or not-p)" may be read distributively "necessarily p or necessarily not-p" if p satisfies the above condition, i.e. is about the present or past — in that case the distributive and the non-distributive readings are equivalent —, but not if it is about the future.'
>
> [van Eck(1988, p. 38)]

All this is perfectly sound and can be intelligibly expressed in our formal framework as follows. The schema

$N(A \vee \neg A)$

as well as its substitution instances involving future-tense operators

$N(FB \vee \neg FB)$
$N(eB \vee \neg eB)$
$N(GB \vee \neg GB)$

are all valid and provable in the extended DARB-fragment.
On the other hand, since the schema

$N(A \vee \neg A) \rightarrow (NA \vee N\neg A)$ [*cf.* Strong Disjunctive Determinism, Section 5 *supra*]

fails to be valid in that fragment due to the existence of future contingents, we are not entitled to infer from the above substitution instances such schemata as

$NFB \vee N\neg FB$,
$NeB \vee N\neg eB$, or
$NGB \vee N\neg GB$
all of which are clearly invalid in our logic of historical necessity. But, as observed by van Eck in his comment above, Disjunctive Determinism turns out to be acceptable if restricted to the present and the past; just note that the schema

Pres-or-PastA $\rightarrow (N(A \vee \neg A) \leftrightarrow (NA \vee N\neg A))$ [*cf.* Weak Disjunctive Determinism *supra*]

is valid and provable in our logic. Note also that this fact verifies van Eck's remark about the equivalence of distributive and non-distributive readings when p is about the present or past.

Ad 19a32–39. This passage is of course extremely important from a philological point of view, because it is the only one in Chapter IX where Aristotle explicitly uses the word *already* [ἤδη] in connection with those for truth and falsehood. We recall that the main point in van Eck's defence of the Second-Oldest Interpretation of *De Int.* IX consists precisely in taking the phrase "definitely true" in Boethius as an equivalent of the "already true" in the present passage, where this notion of truth is naturally connected with a temporal notion of necessity, viz. that of historical necessity [van Eck (1988, p. 20)].

What, then, is Aristotle's message in this passage? Briefly, it is that, with respect to statements about "things that are not always so or are not always not so" — including future contingents of the 'sea-battle-tomorrow' type just spoken of in 19a27–32 —, the Principle of Bivalence is valid, whereas the so-called Principle of Strong Bivalence, viz.

AlreadyTrueA $\vee$ *AlreadyFalseA*

is not [οὐ μέντοι ἤδη ἀληθῆ ἢ ψευδῆ]; at best, the latter holds for statements about the present or the past — *cf.* schemata (vii) and (x) discussed earlier in this section. Also, Aristotle repeats his warning not to divide here: although, with respect to statements of the type at issue, it is necessary for one or the other of the contradictories to be true or false, he emphasizes: "not, however, this or that, but as chance has it" [οὐ μέντοι τόδε ἢ τόδε ἀλλ' ὁπότερ' ἔτυχε].

Ad 19a39–19b4. According to the van Eck (1988) interpretation, what is denied by Aristotle in 19a39 ff. is precisely the Principle of Strong Bivalence, *not* the Principle of Bivalence as ordinarily understood.[17] He (van Eck) says:

[17] According to the Oldest Interpretation, it is precisely the Principle of Bivalence as ordinarily understood that is denied by Aristotle in the admittedly somewhat surprising sentence 19a39–19b2. True, the present passage as a whole indeed lends a good deal of *prima facie* support to this kind of interpretation. On the other hand, we may note here that van Rijen

> 'And it is in this sense that we must interpret the conclusion that now immediately follows [19a39–19b2]. "Clearly, then, it is not necessary that of every affirmation and opposite negation one should be true and the other false;" It is the denial of the necessity that of every pair of contradictories one is definitely true and the other definitely false in the sense of already true and false respectively. That is to say, the historical necessity of "this one true and that one false" is denied, i.e. it is not necessary that this one is true and that one false *in the way it is necessary for accomplished facts*; "for the way it is (*hôsper*) with the things that are, so (*houtôs*) it is not also with the things that are not, but may possibly be or not be; but as is said." (19b2–4).'
>
> [van Eck (1988, p. 33 f.), his italics]

Thus, in the context of 19a39–19b2, the van Eck interpretation instructs us to read "true" as "*already* true" and "false" as "*already* false". If this was Aristotle's meaning, it is a pity that he did not make it perfectly clear by again putting in ἤδη in front of ἀληθῆ and ψευδῆ in that context. But, anyway, we have now seen in what sense we must take the words "not in the same way" [οὐχ ὁμοίως] in Part I of the chapter.

So far, we have only considered Parts I and IV in our suggested division of the chapter together with the van Eck (1988) commentary on those parts. However, it turns out that this is enough to enable us to grasp the gist of his interpretation which, as we have seen, is readily and naturally representable in the extended DARB-fragment. Nevertheless, we still have to say something about the remaining Parts II and III.

(1986, p. 134; 1989, p. 128) suggests the following translation of the surprising sentence 19a39–19b2:

> Consequently, it is obvious that it is not necessary that of every affirmation and negation it is a *particular* member of the contradictory pair that is the true one and the other that is the false one. [The underlining of "particular" is just in van Rijen (1986), not in van Rijen (1989).]

This translation differs from the one favoured by Ackrill and van Eck mainly in that it invites us more strongly to read ἀνάγκη *distributively* in the context [i.e., formally, as $N(\mathit{TrueA} \wedge \mathit{False}\neg A) \vee N(\mathit{True}\neg A \wedge \mathit{FalseA})$, where the *False*-clauses are clearly redundant]. We should then also observe that the matching formulation in the opening passage 18a28–34 just had ἀεὶ ["always"], but no ἀνάγκη (see note 11 *supra*); this fact could be taken to suggest that Aristotle did not want to complicate his discussion of necessity with the distributive vs. non-distributive distinction already in the opening passage, but preferred to relegate that discussion to the end of the chapter.

10. *On the argument for determinism in* De Int. *IX; a distinction between two future tenses*

The least problematic section in the chapter is Part III [19a7–22] in our division, where Aristotle formulates his indeterminism with respect to the future and his belief in the existence of future contingents. And the most difficult one is the large Part II [18a34–19a6], where he seems to maintain a strong deterministic thesis according to which universal bivalence implies a deterministic conclusion of the form $NA \vee N\neg A$, which applies in particular to the future — and not only to the past and the present. Again, since in Part III he rejects that deterministic conclusion (but not the strong deterministic thesis or implication itself), Aristotle would then, by *modus tollens*, be forced to give up universal bivalence — this is known as the Oldest Interpretation. See also our discussion in Section 7 *supra*.

The most important of Aristotle's arguments for the deterministic thesis in the strong sense at issue is likely to be found in the following passage in Part II:

> Again, if it (*sc.* something) is white now it was true to say earlier that it would be white; so that it was always true to say of anything that has happened that it [was so, or][18] would be so. But if it was always true to say that it was so, or would be so, it could not not be so, or not be going to be so. But if something cannot not happen it is impossible for it not to happen; and if it is impossible for something not to happen it is necessary for it to happen. Everything that will be, therefore, happens necessarily. So nothing will come about as chance has it or by chance; for if by chance, not of necessity.
>
> [18b9–16]

Let us try to formalize this argument in the DARB-fragment. Consider a propositional variable B, which is then non-future in our sense of containing no occurrences of the operators F, e or G; where B represents the statement "it is white now", or else, refers to any particular event. The desired result, indicated in the next to last sentence in the quoted passage, is then:
Q.E.D. $FB \rightarrow NFB$

[18] The bracketed words are missing in the translations of Ackrill and van Eck. And the words ἔστιν ἢ are missing in the Minio-Paluello (1949) edition of *De Interpretatione*. According to Tricot (1994, p. 97, n. 5), those words were deleted already in the Waitz edition from 1844–1846. They remain, however, in the Cooke (1938) edition in the *Loeb Classical Library*.

where, for simplicity, we disregard the universal quantifier "everything" [ἅπαντα].

Here, then, is a possibly Aristotelian proof of Q.E.D.:

1.	FB	truly said by one of Aristotle's speakers in 18a35 at any time earlier than the one to which "now" in 18b9 refers; assumption
2.	FNB	from 1 by theorem-schema S in Section 2 (B being non-future) together with the elementary tense-logic for F in DARB
3.	NFB	from 2 by the putative law of commutation $FNB \rightarrow NFB$ in Section 3
4.	$FB \rightarrow NFB$	from the deduction 1–3 by the Deduction Theorem, discharging 1

where 4 = Q.E.D.

Remarks.

(I) We must observe here that our formulation of the initial assumption FB involves a shift of speech point and speaker, as explained in the comment on line 1. We need this shift in order to have Aristotle's argument start with a *true* prediction FB supposedly made in the past by one of his speakers in 18a35. Note that the opening sentence in the passage gives a 'tricky' impression: it looks as if Aristotle starts the argument with an instance of the tense-logical law $B \rightarrow HFB$; how is that instance linked, and relevant, to the desired conclusion Q.E.D.? However, a careful reading of the text reveals that this might be a pseudo-problem, since it overlooks the role played by the important words "was true to *say earlier*" [ἀληθὲς ἦν εἰπεῖν πρότερον]. The presence of this inserted *saying*-at-any-*earlier*-time by a supposed speaker justifies us in avoiding the complications of the tense-logical law altogether, and in adopting instead an explanation in terms of a shift of speech point and speaker — Aristotle *now*, his supposed speaker *then* in the past. Nevertheless, his appeal to the tense-logical law certainly deserves further discussion; see Section 11 below, where we pay some attention to the interesting account of the Aristotelian deterministic arguments given by von Kutschera (1986).

(II) As we observed in Section 3 above, the putative law of commutation $FNB \rightarrow NFB$ is neither valid, nor provable in DARB. So the step from 2 to 3 in the reconstructed Aristotelian argument is faulty, or at least cannot be justified in our logic of historical necessity. Nor can, of course, the strongly deterministic implication Q.E.D. itself be justified in that logic.

(III) Nevertheless, the fact that $FNB \rightarrow NFB$ fails, whereas the principle A30 :
$PNB \rightarrow NPB$ is valid in our logic is of considerable interest as follows: it shows that statements about the future, notably future contingents, differ from those about the present and the past also in other respects than those emphasized by van Eck *supra*. For they don't obey the same laws of commutation. The same remark obviously applies to such principles as
$eNB \rightarrow NeB$ vs. A31 :$wNB \rightarrow NwB$, and
$GNB \rightarrow NGB$ vs. A29 :$HNB \rightarrow NHB$
as we pointed out already in Section 3 above. Thus, with respect to these putative laws of commutation, we can still say with Aristotle: *οὐχ ὁμοίως*!

At this juncture we are happy to register an important distinction made by van Rijen (1986, p. 122; 1989, p. 116f.), which goes back to the Prior (1967, Ch. VII) distinction between the Ockhamist and the Peircean future operators "will". van Rijen observes that there are two kinds of future tense expressed in English by such phrases as "it will be case that ...", viz. (i) a *weak* future tense in the sense of

> "in the course of future events as they will *actually* take place, it will be case that ...",

and (ii) a *strong* future tense in the sense of

> "whatever may be the course of future events, it will be the case that...".

Clearly, the distinction here intended by van Rijen can be represented in our DARB-fragment as the one between the sentence-forms

(i) FB [weak future tense] and (ii) NFB [strong future tense].

He observes, for instance, that the strong future tense implies the weak one, but not *vice versa*. By paraphrase of this observation into DARB, he is then saying that the schema

$$NFB \rightarrow FB$$

is valid, whereas

$$FB \rightarrow NFB,$$ i.e., our Aristotelian Q.E.D *supra*

fails to be valid; which assertions are perfectly correct on our view. As a matter of fact, in van Rijen (1986, p. 130; 1989, p. 124), he levels a criticism similar to ours against the deterministic argument (although the failure-of-commutativity aspect, on which I insist, seems to be missing), and takes the ambiguity of the future tense to generate the problems with which *De Int.* IX deals. I fully agree with him on this diagnosis.

11. *On the von Kutschera (1986) account of the Aristotelian arguments for determinism*

In his paper von Kutschera draws an important distinction between these notions:

(i) statement about the past [G. "Aussage über Vergangenes"], and

(ii) statement in past-tense form [G. "Aussage in Vergangenheitsform"]

and observes that the distinction may be concealed, or blurred, by our using ambiguously the word

(iii) past-time statement [G. "Vergangenheitsaussage"]

to cover both meanings (i) and (ii). A crucial principle, accepted both by Diodorus Cronus and Aristotle, could then be formulated as follows:

(I) Every true past-time statement is necessary
[G. "jede wahre Vergangenheitsaussage ist notwendig"].

von Kutschera then makes (I) formally precise by translating it as

(I′) For each true past-time statement A it holds that $A \rightarrow NA$.

He then suggests rendering the argument for determinism that we discussed in the last section (Section 10) in the following ingenious way which, unlike ours, has the virtue of doing justice to Aristotle's explicit appeal to the tense-logical law $A \rightarrow HFA$:

(a)	A	hypothesis, assumed to be true
(b)	$A \rightarrow HFA$	valid already in weak tense-logics, like Lemmon's K_t
(c)	HFA	from (a), (b) by *modus ponens*

(d)	$NHFA$	from (c) by principle (I′), (c) being past-time
(e)	$HFA \rightarrow (A \vee FA)$	valid in *discrete-time* tense-logics, like DARB
(f)	$NHFA \rightarrow N(A \vee FA)$	from (e) by standard modal logic
(g)	$N(A \vee FA)$	from (d), (f) by *modus ponens*
(h)	$A \rightarrow N(A \vee FA)$	from the deduction (a)–(g) by the Deduction Theorem
(i)	$FA \rightarrow N(FA \vee FFA)$	substitution of FA for A in (h), which is provable / valid
(j)	$FFA \rightarrow FA$	valid in standard extensions of Lemmon's K_t
(k)	$FA \rightarrow NFA$	from (i), (j) using standard modal logic

Remark
von Kutschera (1986) points out that the step from (c) to (d) in the above argument is justified only if we interpret the locution *past-time statement* ("Vergangenheitsaussage") in principle (I′) as *statement in past-tense form* ("Aussage in Vergangenheitsform", "Aussage im Präteritum"), but not, however, as *statement about the past* ("Aussage über Vergangenes"). He then points out that it is not the case that every statement in past-tense form [in the sense of beginning with a past tense operator like H, P or w] is a statement about the past. For instance, the statement (c), HFA, is certainly a statement in past-tense form since it begins with H, but from this it does not automatically follow that it is a statement *about* the past in the semantical sense that its truth-value only depends on what has happened in the past; the inserted future tense operator F in (c) may make all the difference in this respect.

von Kutschera (1986) refers to the argument just reconstructed as Aristotle's *second argument* for determinism. He also gives an analysis of Aristotle's *first argument* for determinism in the form of a commentary on 18a34–b9, which is interesting in that it utilizes similar ideas and distinctions as his analysis of 18b9–16 (just discussed). Here, I shall quickly paraphrase von Kutschera's account of the argument in 18a34–b9 as follows:

We must carefully distinguish between these notions:

(i) statement about the present [G. "Aussage über Gegenwärtiges"], and

(ii) statement in present-tense form [G. "Aussage in Gegenwartsform"]

and again we should observe that the distinction may be concealed, or blurred, by our using ambiguously the locution

(iii) present-time statement [G. "Gegenwartsaussage"]

to cover both meanings (i) and (ii). A principle analogous to (I) would then be:

(II) Every true present-time statement is is necessary.

which could be formally translated as

(II′) For each present-time statement *TrueA* it holds that *TrueA* $\rightarrow NA$.

Consider then an argument formulated in our extended DARB-fragment:

(a)	*TrueA* $\vee$ *True*$\neg A$,	for all statements A assumption [Law of Universal Bivalence]
(b)	*TrueFA* $\vee$ *True*$\neg FA$	by substitution of FA for A in (a),which is valid *ex hypothesi*
(c)	*TrueFA* $\rightarrow NFA$	by (II′), since *TrueFA* is present-time
(d)	*True*$\neg FA \rightarrow N\neg FA$	by (II′), since *True*$\neg FA$ is present-time
(e)	$NFA \vee N\neg FA$	from (b),(c),(d) by propositional logic
(f)	$(FA \rightarrow NFA)$ $\wedge(\neg FA \rightarrow N\neg FA)$	from (e) by modal logic, using $A \rightarrow MA$ and re-writing (e) twice as an implication

Remark

With respect to such an argument, von Kutschera observes that the principle (II′) is acceptable only if we interpret the locution *present-time statement* ("Gegenwartsaussage") in it as *statement in present-tense form* ("Aussage in Gegenwartsform", "Aussage im Präsens"), though not as *statement about the present* ("Aussage über Gegenwärtiges"). He then points out that statements in present-tense form [in the sense of beginning with a locution in the present tense, like *True*, "it *is* true (to say) that"] are not always statements *about* the present. This means e.g. that the instances (c) and (d) of (II′), in spite of their being in present-tense form, do not have to be statements about the present in the semantical sense that their truth-value only depends on what presently happens, i.e. independently of future developments of the world. But in the present example this is precisely not the case — the inserted future tense operators F in (c) and $\neg F$ in (d) again make all the difference in the relevant respects.

To sum up quickly: the von Kutschera (1986) analysis of the Aristotelian arguments for determinism strikes me as being quite illuminating and ingenious indeed, and I think my own account in the foregoing section certainly needs to be supplemented by this analysis.

12. *The Ackrill (1963) arguments against the Second-Oldest Interpretation*

According to Ackrill's version of the Second-Oldest Interpretation[19] [Ackrill (1963, pp. 139–140)], Aristotle holds that with some future singulars, viz. those where both possibilities are open, though it is necessary that either p is true or not-p is true, it is neither necessary that p is true nor necessary that not-p is true. On this interpretation of *De Int.* IX, Ackrill also says, future singulars in cases where both possibilities are open *are* neither necessary nor impossible, but they will become necessary or impossible in due course, at the latest when the predicted event occurs or fails to occur.

Remark. Let us quickly observe here that these formulations in Ackrill (1963) agree almost exactly with our explanations given above of the concepts of (i) future contingents, (ii) the necessitated version of the Principle of Bivalence, and (iii) the [negation of the] Deterministic Conclusion to the effect that $NA \vee N\neg A$ ["every statement is either necessarily true or necessarily false"]. Furthermore, his last assertion seems to suggest such DARB-valid principles as

$$FB \rightarrow FNB \text{ and } \neg FB \rightarrow G\neg MB \text{ (where } B \text{ is non-future).}$$

Now, Ackrill admits that the just stated view has some plausibility as an interpretation of the chapter, and that much of what Aristotle says in its last part [*sc.* 19a7–19b4] lends colour to the suggested interpretation.[20] But, Ackrill continues:

1st Objection.

> 'On the other hand: (*a*) on this account Aristotle does not end by establishing the denial with which (it was argued above) he starts. He starts by denying that every affirmation and every negation has a truth-value, but he ends by asserting this, though denying that every affirmation and negation has a necessity-value.'

[19] As emphasized in the Introduction *supra*, we suggest that, on the Second-Oldest Interpretation, one should take Aristotle to be engaged in a dispute with an imaginary opponent, "the determinist", whose theses and arguments he attempts to present as compellingly and convincingly as possible, thus playing the role of an *advocatus diaboli*. See our discussion of Ackrill's second objection to the Second-Oldest Interpretation in Section 12 *infra*.

[20] In view of our criticism *infra* of Ackrill's second objection to the Second-Oldest Interpretation, we take this judgment to be an understatement of the most colourful kind.

Remark. Well, it appears from our discussion of 18a28–34 in Section 9 *supra* that it is not at all clear that Aristotle is really *denying in the strict sense* that every affirmation and [matching] negation has a truth-value, i.e. is true or false. For, if van Eck (1988, p. 34) is right in his comments on that initial passage — as I think he is —, Aristotle does not deny the Principle of Bivalence *tout court*, but only the Principle of Strong Bivalence.[21] Again, remember his crucial locution: *οὐχ ὁμοίως*! If so, the present objection to the Second-Oldest Interpretation can be disposed of.

Ackrill's next objection [still Ackrill (1963) pp. 139–140] is more intriguing and challenging:

2nd Objection.

> '(*b*) So far from defeating the determinist's plausible argument from a statement's being true to an event's being necessary, the solution suggested says nothing whatsoever to meet it. The determinist in Part II [*sc.* 18a34–19a6] does not argue from 'necessarily p or necessarily not-p'. He argues *to* this strong thesis, and hence to determinism, from the weak thesis 'necessarily: either p is true or not-p is true', claiming that if p is true the p-event cannot fail to occur. On the first (*sc.* Second-Oldest) interpretation Aristotle's answer does not meet the determinist's argument; it simply denies an implication he claims to prove.'

Remark. The gist of this objection appears to be the following. On the Second-Oldest Interpretation, Aristotle denies determinism, i.e. the deterministic *implication*, both in the sense of Strong Plain Determinism and in that of Strong Disjunctive Determinism according to the explications given

[21] We observe here that this distinction of van Eck's opens up the possibility of a new reading of the initial passage 18a28–34, which complies better with the condition on adequate interpretations advocated by Ackrill in his present objection: in the opening sentence, read "true" as "*already* true" and "false" as "*already* false" (just as we suggested in Section 9 for the case of 19a39–19b2)! An immediate consequence of such a reading is that Aristotle will end Chapter IX by establishing the denial with which he starts: he starts by denying that, necessarily, every affirmation and matching negation is already true or already false (*sc.* counterexamples being afforded by 'particulars that are going to be' — see the concluding sentence in 18a28–34) and he ends by *still* denying this in 19a39–19b2 (and still having in mind the same counterexamples). In other words, he both starts and ends by denying — correctly, on our view — the validity of the Principle of Strong Bivalence, i.e. the validity of schema (vii) and its equivalent necessitated version. Regardless of the problem as to whether this "new" reading of 18a28–34 is defensible or not, it certainly provides an elegant escape from Ackrill's present objection. Furthermore, as far as the traditional issues about the Principle of Bivalence (or Excluded Middle) as ordinarily understood are concerned, they simply fail to arise on the new reading.

in Section 5 *supra*. However, he says nothing whatsoever to meet the determinist's *argument* for those implications. In particular, for instance, with respect to the deterministic *implication* $FB \rightarrow NFB$ (see Section 10 above), Aristotle does not tell us what is wrong about the *argument* from FB [weak future tense] to NFB [strong future tense], on which he spends so much time in Part II. This is contrary to what one would expect him to do on the Second-Oldest Interpretation. So the objection comes down to this: if that account were correct, Aristotle would have told us what is wrong about the argument from FB to NFB; but he has not done so; therefore, the Second-Oldest Interpretation is incorrect.

However striking and ingenious this objection might appear, I take it to be fundamentally mistaken in that it overlooks a subtle but important point in modern mathematical logic, having to do with the nowadays current distinction between model-theoretical semantics and proof theory. In short, one uses semantics to establish the non-validity of arguments and sentences (by providing counterexamples, or countermodels, to them), and one may use proof theory to establish the validity of arguments and sentences (by means of deductions and proofs in a sound[22] deductive system). The Second-Oldest Interpretation could now take Aristotle to have argued as follows against the background of his discussion in Part IV [19a23–19b4]:
'Admittedly, for all future contingents FB (I have reminded you of their existence in Part III), such principles as

$$\textit{TrueFB} \rightarrow NFB$$

and $N(FB \vee \neg FB) \rightarrow (NFB \vee N\neg FB)$
fail to be valid since their antecedents may be, or are, true without their consequents being so. (The modern logician may add: the concepts of validity and truth here appealed to are *semantical* notions in the sense of current so-called model theory.) Therefore, in any *sound*, or correct, *proof theory* for the logic of historical necessity which is here at issue, every alleged proof to the effect that the conclusion NFB always follows from the premiss FB [that $(NFB \vee N\neg FB)$ always follows from $N(FB \vee \neg FB)$] is bound to be fallacious and to contain some error — in some way or other. Knowing this to be the case by virtue of the existence of future contingents, I don't have to worry about which precise error is committed by the determinist in his putative proof of those false and invalid principles, a proof which I have tried to present in such a way as to make it look as plausible and convincing

[22] To say that a deductive system is sound (relative to an associated semantics) means (i) that any sentence *deducible* in the system *from* a given set of sentences is also a *semantic* (or 'logical') *consequence of* that set of sentences, and (ii) that any sentence *provable* in the system is also *valid* in it. Note that provability can be equated to deducibility from the *empty* set of sentences, and validity to being a semantic consequence of the *empty* set of sentences.

as possible — I am satisfied with having shown that it must contain *some* error or other.'

On our view, this potentially Aristotelian assistance to the Second-Oldest Interpretation is on the whole quite successful. To sum up our criticism of Ackrill's second objection: Aristotle *does* meet the determinist's argument[23] — in a somewhat roundabout, but still devastating way; hence, we are not entitled to claim with Ackrill that Aristotle, on the Second-Oldest Interpretation, says nothing whatsoever to meet that argument, or to use this alleged fact as an argument against the Second-Oldest Interpretation.

3rd Objection. In his third and last objection to the Second-Oldest Interpretation [Ackrill (1963, p. 140)] Ackrill discusses the suggestion that the opening thesis about future singulars in Part I [18a28–34] is ambiguous between a non-distributive and a distributive reading of "necessary". He then argues that this suggestion is not helpful in enabling us to cope with the difficulties pointed out in his two preceding objections (called (*a*) and (*b*) above), because (i) the opening thesis is not ambiguous, and (ii) the development of the deterministic argument in Part II [18a34–19a6] does not exploit the strong (and false) version of the thesis.

Remark. We may well grant Ackrill the points (i) and (ii) without thereby agreeing with him that they in any way threaten the Second-Oldest Interpretation. This should by now be obvious in view of (I) our initial formulation of the Second-Oldest Interpretation given in the Introduction *supra* and (II) the criticisms just levelled against his two objections (*a*) and (*b*).

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[23] van Eck (1988, p. 36) certainly agrees with me on this point: he claims that, in the passage 19a32–39, Aristotle meets the deterministic argument, and hits its core, when observing in that passage that every statement is true or false, but not *already* true or false. However, van Eck's reason for this claim is probably not quite the same as mine, due to the fact that our logics of historical necessity differ from each other in the way explained in the Introduction *supra* (see the discussion of the so-called first unorthodox feature of our approach in this paper).

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