Future Contingent Logic and aFramework for Understanding Project Risk Assessments

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Abstract: *When risk assessments are conducted by project managers, information technology professionals, or engineers, often efforts are put into calculating a definite conclusion about the likelihood of disruptions that prevent completion of a project. However, some of the factors assessed are calculatable naturalistically determined events, while others are rooted in human decisions, perhaps as part of an agile project development process or another development process that emphasizes an iterative prototyping approach. The sun will rise tomorrow is dependent wholly on the laws of physics. However, some future events seem contingent due to their origin in human deliberation. Aristotle, through a thought experiment of a sea battle, in chapter nine of De Interpretatione, seems to accept the law of the excluded middle, while wanting to express a third truth-value of indeterminateness for future events. In this paper, we map out what a polyvalent system of logic may look like that is consistent with Aristotle's writings and go on to argue that adopting a modal framework with regard to future contingent talk is rationaland discuss implications for understanding project risk assessment. Because of this dichotomy in types of events that are being assessed, managers and executives need to understand the underlying logic of future contingents in order to better appreciate risk assessment conclusions. In this paper, we lay out Aristotle's mapping of what we argue assigns an indeterminacy truth-value to certain future events, which are a robust metaphysical claim and not merely a comment on our epistemic condition with regard to future events.*

Keywords:Philosophy, Logic,Bivalence, Polyvalence, Alternative Possibilities, Future Contingents, Risk Assessment, Security Risk, Modal Logic

I. Introduction

When risk assessments are conducted by project managers, information technology professionals, or engineers, often efforts are put into calculating a definite conclusion about the likelihood of disruptions that prevent completion of a project. However, some of the factors assessed are calculatable naturalistically determined events, while others are rooted in human decisions, perhaps as part of an agile project development process or another development process that emphasizes an iterative prototyping approach. Because of this dichotomy in types of events that are being assessed, managers and executives need to understand the underlying logic of future contingents in order to better appreciate risk assessment conclusions. In this paper, we lay out Aristotle's mapping of what we argue assigns an indeterminacy truth-value to certain future events, which are a robust metaphysical claim and not merely a comment on our epistemic condition with regard to future events. Afterwards, we discuss its implications on legal aspects of business requirements and what would be required to assume a reasonable assumption of risk.

When speaking on future events, some events seem necessary based on laws of nature. The sun will rise tomorrow is dependent wholly on the laws of physics. However, some future events seem contingent due to their origin in human deliberation. Aristotle, through a thought experiment of a sea battle, in chapter nine of *De Interpretatione,* seems to accept the law of the excluded middle, while

wanting to express a third truth-value of indeterminateness for future events. Łukasiewicz in the 1920's developed a three-value logic system that seems to reject bivalence and the law of the excluded middle. Bourne and Tooley, have revised Łukasiewicz's three-valued logic system to preserve the law of excluded middle. Other answers that try to keep open the indeterminateness of future events include Thomason's supervaluationism and MacFarlane's relativism.

First we will examine Aristotle's attack on fatalism and how events that originate from human deliberation adhere to our concept of necessity. Second, we will cover various polyvalent systems of logic concerning future contingents that could be used to describe Aristotle's position.After looking at what Quine's naturalized epistemology may add to the discussion, we will evaluate which system seems most plausible, why future contingents warrant different explanations than those things that have already happened (past tense) or are happening (present tense). After the examination, we propose that the only way to preserve sensible talk of future contingents is to reject bivalence with regards to future events, while trying to preserve the Law of Excluded Middle. To do this one should adopt a three-valued logical structure that preserves sensible talk of possibilities of future events as well as avoid diachronic concerns in event predication by becoming an evidentialist with regard to predicting future probabilistic events.

II. Aristotle's Sea Battle and Future Contingent Predications

"A sea-fight must either take place tomorrow or not, but it is not necessary that it should take place to-morrow. Since propositions corresponding with facts, it is evident that when in future events there is a real alternative, and a potentiality in contrary directions, the corresponding affirmation and denial have the same character" [1;*De Interpretatione*, I, 9, 19a30-34].

Under modal symbolization, in the event of evaluating a possible future sea battle (S), we may state that □ (~S ∨ S) • ~□ S • ~ □ ~S. However, □ (~S ∨ S) is different than what the fatalist would assert, which is either □S alone or □ ~S alone, dependent on which actually ends up happening. The fatalist will argue that the sentence is true because of the state of affairs is always the case indefinitely in the past or in the future, and our not knowing what holds for the future is brought about purely by limitations in our epistemic field. For the fatalist, nothing happens by chance, and even our deliberations are not up to us. In other words, everything that will happen will happen by necessity and not by chance happening.

A quick implication:

1. □ (~S ∨ S) (What Aristotle accepts)
2. □ (S ⊃ S) (1, material implication)

This material implication move is fine; however, when the fatalist wants to assume □ S is implied by S, he will run into the problem that "… is it a straightforward modal fallacy to infer p ⊃□ q from □(p ⊃ q)" [4; p. 55]. Also, since the state of affairs is not yet S, one could not infer □ S regardless of the use of a modal fallacy.

But, the sea battle is contingent on matters of fact, not necessary truths. Aristotle does not accept the fatalist position. For Aristotle, what will be in the case of this event has an origin in human actions, which are not necessitated but brought about by our deliberation. In short, the future-events-in-human-origin depends on what we decide, and Aristotle accepts that humans have genuine free will. Aristotle also accepts the Law of the Excluded Middle, and because of this the Law of the Excluded Middle must be maintained under any interpretation of Aristotle's conception of future contingency. "Again, to say that neither the affirmation nor the denial is true, maintaining, let us say, that an event neither will take place nor will not take place, is to take up a position impossible to

defend" [1;*De Interpretatione*, I, 9, 18b17]. This means that ~(P ∨ ~P) is impossible to defend, because P ∨ ~P is a tautologous statement (true under every possible scenario) due to the meaning of the negation and disjunctive symbols. Hence, ~(P ∨ ~P) is self-contradictory, as it would not be true under any possible scenario.

To avoid an instance where ~(P ∨ ~P) could have the truth value of true, logicians have made various attempts at developing polyvalent systems of logic that could be used to accurately represent Aristotle's ideas as well as future contingencies. To do this, one must try to preserve the Law of Excluded Middle and reject bivalence sensibly as it pertains to future predications.

III. Using Different Logical Systems to Represent Future Contingency

Łukasiewicz models a three –valued logic system that seems to have application in the case of Aristotle's sea battle. Under his system; however, we will lose the comfort of having P ∨ ~P as a tautology. "In Łukasiewicz's system, the trouble with excluded middle originates from the semantic treatment of the connectives" [4; p.47]. Nevertheless, it seems that under his evaluation of the three-valued logic system, the law of the excluded middle as shown above may not hold.

Here is an example of his truth table, where 'I' is indeterminate as neither true nor false:

P	~P	P v ~P
T	F	**T**
F	T	**T**
I	I	**I**

The problem with this system in application to an Aristotelian interpretation of future contingents is that P v ~P, which is a tautologous statements, fails to hold true under the condition that P is indeterminate and ~P is also indeterminate, "… hence [under this interpretation] the law of excluded middle does not hold" [4; p. 47]. As stated above in the first section, Aristotle finds this position impossible to defend.

A system we would seemingly want to adopt would then be one in which we would try to defend the law of excluded middle while rejecting a bivalent system with regard to future contingents. In the above example, if P has an indeterminate value and ~P has an indeterminate value, then our intuitions still lean towards saying that P v ~P is still true. How to apply the negation operator to the indeterminate value seems to be the point of contention.

Iacona describes Bourne's revision of the negation operator such that the negation of an indeterminate value can now become true [2;and 4, p. 49].

p	~
T (1)	0 (F)
F (0)	1 (T)
I (1/2)	1 (T)

The Bournian application of the negation operator implies the following truth table:

p (P)	q (~P)	p (P) v q (~P)
T	F	**T**
F	T	**T**
I	I	**T**

::: ~ q(P) ⊃ p(P)
T
T
T

The bolded column shows that the law of the excluded middle may be held even while rejecting bivalence. But, one problem arises. If we grant that the negation of an atomic sentence with an indeterminate value is true, simply to be able to hold the law of the excluded middle, then how would we explain meta-variable q's value in the case where the negation of whatever is held in meta-variable p?

Here is an illustration of the problem. Suppose P has truth-value indeterminate. If the negation of an indeterminate value is always T, then there would

never be a case where P is I and ~P is I. However, in Aristotle's sea battle, both the value of S and ~S have the truth-value I. But if we know that S has the value I, then ~S cannot hold both the truth-value of I and T. "Then it would no longer be clear that ~ expresses negation as we ordinarily understand it… so it is not clear how excluded middle can be preserved" [4; p. 50]. Thompson's supervaluationism is another attempt to reject bivalence, while preserving the Law of Excluded Middle, but it also loses the original meaning of the negation operation because of its changes to the truth table in the cases of comparing indeterminate atomic sentences in a disjunct.

Thompson's supervaluationism indicates that individual atomic sentences are only true or false if they line up with histories (past events). "Truth at *m* is defined as truth on all histories passing through *m*. That is, p is true at *m* if p = 1 on all histories passing through *m*, false is p = 0 on all histories passing through *m*" [4; p. 51]. In this way, bivalence is rejected, since in the case of future events p cannot be true nor can it be false. However, the excluded middle can still be held since p v ~p is still true. Since truth or falsity can be put into predication relative to a given history, perhaps a downside is that all future predictions may have an indeterminate nature, and future predictions will be subject to Hume's power of induction - the future may not represent that past. Because the laws of nature are consistent and unalterable, whatever events do not having origin in human deliberation are necessitated and restricted to what nature provides. Supervaluationism allows for true and false predication only for historically and currently true paths, which makes sense for the correspondent theory of truth epistemologist, where truth or falsity is only warranted by its correlation to events that have happened or the state of things as they are currently.

MacFarlane's relativism claims that "… truth must be relativized both to the context of utterance (referring to the moment of utterance) and to the context of assessment (referring to the moment of assessment)" [4; p. 53]. These contexts are very much like supervaluationism; however, the predication will change with time, since in the future, what is neither true nor false about now will become some history that will then have the definite predicates assessed as true or false. This helps avoid diachronic concerns in event predication

IV. Diachronic Concerns in Event Predications

Taking a step back from the logical analysis of future contingents, one ought to look at what is trying to be expressed when we use the indeterminate truth-value. A good aspect with MacFarlane's relativism is that it takes into account that the possibility of events will also change also over time. An example is that Aristotle could not play in Madison Square Garden, because of temporal restrictions - Madison Square Garden did not exist during Aristotle's lifetime. Possibilities are thought of as a set of members that increase or decrease over time depending on the changing status of the world. A modern paradox can highlight how important temporal considerations in predication become.

In the example of the lottery paradox, a problem is recognized when truth is not relevant to a specific time in the thought experiment. In the lottery paradox, let us say that there are one billion lottery tickets. We are warranted in saying that any single ticket has such a low probabilistic chance of winning that we are warranted in predicating "not a winning ticket" to any individual ticket, while we are also warranted in also holding the believe that one ticket in the set of tickets will in fact be a winner. Although holding both of these beliefs seem contradictory, most of the confusion comes from temporal concerns in predication.

Let us make the assumption that lottery ticket #3 will be the winner. Yet in this possible circumstance, a probabilistic account of the lottery ticket being a winner can also be given. At time t1 (before the lottery drawing) lottery ticket #3 is in

fact not the winning lottery ticket; however, at time t2 (after the drawing), lottery ticket #3 is declared the winner. In fact, the lottery ticket at time t1 has 1/1,000,000,000 chance of being declared a winner (assuming one-billion participants), while at time t2, the lottery ticket #3 is the winner or would have a 1/1 chance of being the winner. Truth-values about probabilistic events (just like truth-values in events that have origin in human deliberation) cannot be deterministic. Basically, the difference in describing a coin flip being Heads or Tails is different than claiming that a single coin flip event is Heads. Although it might be determined after a person in fact flips the coin, all events leading up to the flip are contingent.

When relating this to the sea battle passage in Aristotle, we must first ask ourselves the definition of a sea fight. If all of the ships from opposing groups lined themselves across from one another and nobody fired any shots, then a sea fight would not have taken place. However, after the human deliberation has taken place and the first cannon is lit, then we may say that beyond human control a sea fight necessarily must take place (assuming a single shot is necessary for a fight).

In this sense, the best approach to understanding how correct predications happen according to a correspondent theory of truth is that before the sea fight has taken place, we must ask ourselves whether the necessary and sufficient conditions have been met for a sea fight. As long as the elements of a sea fight have not been met, and there is a chance that it will or will not occur wholly dependent on human deliberation, then to predicate necessarily S or ~S would be to ignore that something must be the case if it corresponds to what is the case with respect to the world. The question should not be whether something that has origin in human deliberation is necessarily the case or not the case, but rather, how are we able to accurately predict those future contingent events. Becoming an evidentialist with regard to probabilistic outcomes would insure degrees of likelihood, which ought to be adopted when deliberating rational action in light of those contingencies.

"All probability, then, supposes an opposition of experiments and observations, where the one side is found to overbalance the other and to produce a degree of evidence proportioned to the superiority" [3;*Inquiry*, Section X, Part I, p. 371]. That is a sort of evidentialist claim that we ought to accept what we have the best degree of evidence to support – perhaps only in situations where, as Hume puts it, there is an 'overbalance' when the likelihood of one alternative is severely more probable than another alternative.

Returning to the lottery paradox, when asking the question of whether we *should* buy a lottery ticket or not, the question is not whether we are right or wrong in knowing the ticket #3 will eventually be the winning ticket; instead, if the lottery is fair, all we need to know is that there is in fact a one in a one-billion chance in winning. We may eventually make a Bayesian inference, when we jump from a one in one-billion chance to a zero percent chance, but the only reason we would make that assumption is because of prudential concerns rather than concerns for truth in accurately reporting what is the case. Next, we will explore possible insight that naturalized epistemology can grant in our understanding of cognition affecting sentence meanings and truth.

V. A Comment on Epistemology, Psychology, and Truth-functional Sentences About Future Contingents

Quine offers some insight on naturalizing epistemology and how it could play a role in the evaluation of truth predications to future events. Exploring cognitive science may clear up the confusion between knowing what a sentence means vs. knowing if the sentence is true or not. "Studies in the foundations of mathematics divide symmetrically into two sorts, conceptual and doctrinal. The conceptual studies are concerned with meaning, the doctrinal with truth" [5; p. 528]. If we rely on psychology completely for understanding in epistemology, then that will mean we will be "…

justifying our knowledge of truths of nature in sensory terms…" and "… so much the worse for common sense; the notion of its being the same apple on one occasion and another is a vulgar confusion" [5; p. 529]. Quine does not view us as any further today than in Hume's time when dealing with the doctrinal side of epistemological investigation.

What adopting MacFarlane's framework would allow us to do is describe whether the physical event is true relative to only past and current factors. For Quine, the truth or falsity of sentences is dependent on the holistic theory. "Sometimes also an experience implied by a theory fails to come off; and then, ideally, we declare the theory false" [5; p. 532]. If the sentences rely on the theory for their truth or falsity, then any number of theories can be a good translation. The problem with allowing for multiple correct translations is that some translations might be good but for the wrong reason. An example of how a 'correct' translation may not be reflecting the truth of a situation is the understanding of how a car is turned on.

An example: Person X recognizes that their car is turned on every time they turn the correct key in the ignition keyhole. Person X is not an auto mechanic and has never had a dead battery or had the car fail to start when the produces turning the correct key in the ignition keyhole. Person X then builds the following theory:

T1: The reason the car starts is that the user turns the correct key in the ignition keyhole.

However, the truth of the matter is that the turning of the key does not necessarily mean that the car will start. Instead, T2 is more accurately describing the true situation.

T2: The reason the car starts is that the user turns the correct key in the ignition keyhole, which if the car is in proper working order starts a spark that allows combustion inside cylinders in the ignition system.

While both of the following are correct translations of actual events in the world, T2 tracks truth of the situations more so than T1, because of how the second theory actually describing everything in the process going from T (turning key) → S (spark) → C (combustion in cylinders) → car starting. So, although T1 is a correct translation, it is false in that the turning of a key does not in fact necessitate the car starting: So T (turning key) → car starting = false. People other than Person X can validate the process described in T2, and the description of T1 as a good translation is purely due to Person X's experience, which does not track or relate to the truth or falsity of the translation. This is the problem with allowing for multiple correct translations. Some of those translations will be correct based on evidence, yet wrong for reasons beyond the subject's beliefs, thoughts, and experiences.

A problem with allowing for multiple correct translations could be a negative aspect of adopting a polyvalent system of logic to describe Aristotle, as we would not want to make assumptions beyond the text to justify a theory that Aristotle himself may not accept. Although MacFarlane's relativism is very similar to supervaluationism, the question then becomes whether it is accurate in reflecting the way future contingents operate in the world works as opposed to the way Aristotle viewed the world and future contingents. After all, the fatalist could object by simply rejecting the notion that predications change. The fatalist would say that things are necessitated and our failures to recognize those necessitations arise merely from our epistemic limits. With the rejection of probability, the fatalist may still claim that □ p or □ ~p, and we simply do not have access to the facts yet, even though they still exist (even if in our current time period they do not yet). Unfortunately, neither of these theories are falsifiable, and so their debate remains wholly dependent on the assumptions we are willing to

grant. Perhaps in the future, developments in cognitive science will connect some of the missing elements in our understanding of belief formation, which may impact how we view contingencies in future events that have origin in human deliberation.

VI. Implications on Project Risk Assessment

The Federal Information Security Management Act (FISMA) of 2002 ensure Information Technology standards through agencies, such as the National Institute of Standards and Technology (NIST). The result is that FISMA requires agencies to have an information systems inventory in place, categorize that information according to risk, have security controls in place, and have a foundational level of risk assessment that informs a system security plan. Afterwards, the organization can gain security accreditation that ensure a form is quality control and then there can be monitoring put in place – as is with all accreditation systems.

Concerning FISMA and NIST the "level of acceptable risk" concept employed by security professionals should be understood to include degrees of variability, which cannot be assessed, such as decisions made throughout the course of a project that rely on human deliberation.

Similarly, concerning green computing, "The Electronic Industry Citizenship Coalition (EICC) was established to promote a common code of conduct for the electronics and ICT (information and communications technology) industry. The EICC focuses on the areas of worker safety and fairness, environmental responsibility, and business efficiency. ICT (information and communications technology) organizations, electronics manufacturers, software firms, and manufacturing service providers may voluntarily join the coalition" [7]. The following are the five areas of social responsibility and guiding principles covered by the code: [7].

- Labor
- Health and Safety
- Environmental
- Management System
- Ethics

Within the past several years, the Electronic Industry Citizenship Coalition (EICC) has changed and is now the Responsible Business Alliance (RBA). The RBA's Readiness Risk Assessment (RRA), which is a self-assessment tool that aims to promote a common understanding of best practices and can be used to assess the risk of supply chain.Version 6.0 of the RBA Code of Conduct went into effect Jan. 1, 2018.Overall, the RBA Code of Conduct is a recommended set of standards on social, environmental and ethical issues in the electronics industry supply chain [6].

As an IT manager, one of the tensions between using benchmark norms and being flexible for a natural disaster is that future contingents are indeterminate, and how we reason about reasonable standards of risk will be affected by the logical model adopted.

VII. Conclusion

Adopting a modal framework is rational for understanding future contingency and when assuming a reasonable standard of risk, because when we use language, there are varying implications with future tenses that would not work under the same framework used for past tense. In predication of persons and events, there are contingencies that exist not merely from our epistemic limitations but also from our deliberations, which seem to generate genuine choice brought about by a multitude of factors (perhaps some which could be explained through cognitive science). We should adopt a three-valued logical structure that will preserve sensible talk of possibilities of future events as well as avoid diachronic concerns in event predication by both becoming evidentialists with regard to probabilistic prediction making and adopting MacFarlane's relativist stance with histories playing a vital role in accurately reflecting future event predication.

VIII. Acknowledgements

Brendan Moore is a philosopher and instructional designer currently working on a leadership development program at Ochsner Health Systems in New Orleans, Louisiana. His background includes 7+ years of university medical ethics teaching at Ohio University and several years of work in the area of information technology, instructional technology, and applied computing systems.

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