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# PROBABILITY AND METAPHYSICS

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## ABSTRACT

In this article I explore the relationship between the concepts of probability and metaphysics. I start by presenting first Popper's metaphysical interpretation of probability and then Suppes' probabilistic metaphysics. Their views are examples of two rare modern attempts to explore metaphysical ramifications of probability. Whereas Popper's approach is less analytic and does not invest any effort in analysing the concept of metaphysics itself, Suppes' approach encompasses both of these aspects. As much as a clarification of the concept of probability employed also a clarification of the concept of metaphysics is needed. For this purpose I first give a short account of Hume's and Kant's positions on metaphysics as these are early instances of the impact that probabilistic inductive reasoning made on metaphysical thought with its newly acquired evidential weight. Then I conclude with Suppes' explicated metaphysical position, indicating the main lines along which a probabilistic metaphysics could be developed.

## KEY WORDS

probability, metaphysics, Karl Popper, Patrick Suppes

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## INTRODUCTION

Within modern science, the concept of probability gained substantial importance at the beginning of the 20th century although its reflection is still catching up with some delay. It became central to an independent science of statistics, which evolved from Galton's heredity studies, and to statistical hypothesis testing established by Pearson, Gosset and Fisher[1], which nowadays forms the base of the modern scientific approach to data analysis. In the 1920's, probability further became of central importance with the advent of quantum mechanics, whose predictions are intrinsically probabilistic in nature. The so-called modern evolutionary synthesis, which took place in the 1930's and 1940's and merged Darwin's and Mendeleev's understanding of genetics into evolutionary genetics and was based on Fisher's statistical analysis of heredity, resulted in a probabilistic-statistical concept of gene and thus also employs the concept of probability [1; p.4]. Von Plato in his work on modern concepts of probability even claims that the modernity of what we understand as modern science (and modern physics specifically) consists in its employing (and developing) the concept(s) of probability: "… the shift from classical to modern probability appears as part of a great movement, the very change from classical to modern science itself" [2; p.26].

As far as philosophy is regarded, the concept of probability was introduced into modern philosophical discourse by empiricist philosophers like Berkeley and Hume, about a century after probability theory emerged with the work of Pascal, Huygens and others[2] [3; pp.57-72, 3; pp.92-121]. Especially Hume can be credited as the one who employed the concept of probability as an integral part of his philosophical thought, but his position was understood more as rejecting metaphysics altogether and relying on habits and probability as a kind of best – but insufficient – surrogates.

Probability is often used as a logical concept like in Bayesian confirmation theory, as a broader epistemological concept like in Bayesian statistics, decision theory and statistics in general, or as a purely mathematical concept. This is in accordance with the variants of probability one can find with interpreters of this concept. Interpretations of probability are usually classified into subjective probability, which entails the so-called logical and personalist variant, and objective probability, which entails the so-called frequentist interpretation and an additional variant, which figures under different names: Guttmann writes about physicalist interpretation [4], Lucas writes about axiomatic interpretation [5], von Plato about measure-theoretic interpretation [2]. The peculiarity of this variant is that it can be applied to continuous mathematical spaces that we meet in physics.

Although there are many interpretations of the concept of probability, one rarely encounters an interpretation of this concept that would have explicit metaphysical implications. It seems that some notion of physical probability is a precondition to develop a metaphysical concept of probability, at least in the modern scientific era. This path of development of understanding can be clearly seen with K. Popper (1902-1994) and his propensity interpretation of probability, which not all authors on interpretations of probability find relevant to study. Popper is one of the most noticeable authors that attributed to the concept of probability a metaphysical dimension. Another such author was P. Suppes (1922-2014). It is mainly these two views that I want to present. Interestingly enough, the authors do not mention each other in their main works on probability and metaphysics, despite being one of the few authors to see the need for such step in philosophical-scientific thought.

## POPPER'S PROPENSITY INTERPRETATION OF PROBABILITY

Karl Popper, best known for his work on scientific theories, first presented his propensity theory in his work *The Propensity Interpretation of Probability* (1959) and further developed

it in his late work *A World of Propensities* (1994). As some other members of the Vienna circle, with which Popper was affiliated at the time, he too was first adherent of the frequentist interpretation of probability, but he gradually developed a critical position towards it. The main problem he saw with frequentism was its inability to endorse a concept of probability of single events. Frequentists like e.g. von Mises held that probability should be understood as a limit of relative frequencies and therefore only be applicable to a series of events or to collectives, as he named them [6; pp.114-115]. Coherent with his definition in *Probability, Statistics and Truth* (1928), von Mises explicitly rejected objective probabilities of single cases. Talk about objective probabilities of single event is nonsensical from the frequentist point of view while it is pretty common with subjective interpretations of probability.

Popper understood this as a drawback, especially when trying to interpret the wave function employed in quantum mechanics. Since Heisenberg's introduction of the principle of uncertainty Popper felt the need to introduce an adequate objective theory of probability instead of the then prevailing epistemic understanding:

> "But starting with Werner Heisenberg in 1927, a great change occurred in quantum physics. It became clear that minute processes made the clockwork imprecise: there were *objective indeterminacies*. Physics had to bring in probabilities. It was here that I had some severe disagreement with Heisenberg and other physicists, even with my hero, Einstein. For most of them adopted the view that the probabilities had to do with our *lack of knowledge* and, therefore, with our state of mind: they adopted a *subjectivist* theory of probability. In opposition to this, I wished to adopt an *objectivist* theory" [7; pp.7-8].

This is also the reason why Popper departed from von Mises' viewpoint at some stage of his development.

Similarly, he started to break up with R. Carnap, with whom he had collaborated. At first, they agreed they would strictly differ between probability as was used in physical theories and especially quantum mechanics and probability of hypotheses as degrees of their confirmation or corroboration. With respect to this he writes: "we agreed *not* to assume, without strong arguments, that the degree of confirmation or corroboration of a hypothesis satisfies the calculus of probabilities, but to regard this question as … open – indeed, as the central problem" [7; p.5]. Popper thus strictly discerned subjective probability as applied to hypotheses and objective probability as used in physics.

## SHIFT FROM COLLECTIVES TO CONDITIONS

It might be beneficial to take a closer look at how Popper introduced his propensity concept. The main shift in his understanding consisted in viewing the outcomes of an experiment as results of repeatable conditions and not of collectives. He illustrates this with throws of two dice, of which one gives equiprobable results and the other does not, i.e. is not a fair die. If by some procedure we always first select among one of the two dice and then throw the selected die, we will collect a long series of results, which von Mises would attribute to a collective or maybe would group them as two collectives. Popper maintains that we can mark such series with a set of generative conditions, in this case the two dice, their properties and properties of the surface on which they land. This is a shift from a multitude to a small set of conditions. A similar proposal was given already by Kolmogorov, but he did not give arguments for this [2; p.220].

In the described sense probabilities are dependent on experimental conditions: "Since the probabilities turn out to depend upon the experimental arrangement, they may be looked upon as *properties of this arrangement*. *They characterize the disposition, or the propensity,* of the experimental arrangement to give rise to certain characteristic frequencies *when the*

*experiment is often repeated*" (from Popper, K.: *The Propensity Interpretation of the Calculus of Probability, and the Quantum Theory*. p.67, 1957, as cited in [6; p.116]). This implies that probabilities are a result of the inner structure of the observed object and of the way the environment that acts upon it. Popper stresses this point very clearly in retrospective: "I had stressed that propensities should not be regarded as properties inherent in an object, such as a die or a penny, but that they should be regarded as inherent in a situation (of which, of course, the object was a part). I asserted that the situational aspect of the propensity theory was important, and decisively important for a realist interpretation of quantum theory" [7; p.14]. Borrowing a popular term from quantum mechanics we can say that probabilities are expressions of the entanglement between experimental conditions and the object.

Popper gives the example of throwing a coin on different types of surfaces. When we throw a coin on a perfectly flat surface, the probabilities for both outcomes are 1/2. This implicitly takes into account the properties of the landing surface – this is assumed to be flat, hard, non-reactive, etc. If we design a surface full of vertical slots, in which a coin can land vertically (i.e. on none of the two faces), we get a third possible outcome with its corresponding probability. With coin tossing, probabilities are always also a function of the properties of the surface on which they land, but because we usually throw it so that it lands on a flat and horizontal surface, we abstract the probabilities to represent a property of the coin itself. This is the reason why Popper views the introduction of probability in relation to the set of experimental conditions as legitimate, although the trials are not repeated many times.

Popper thus stresses that even when we have only one trial, there is a propensity for a certain result because of objective experimental conditions entangled with the object of inquiry. It does make sense to talk about the probability of one event as something objective, despite not knowing the outcome in the single case and being able to verify the probabilities only after many trials. The event we are trying to predict inherits the status of objectivity from the objectivity of the circumstances.

In this sense Popper breaks down probabilities of events to objective conditions. Propensities are then weighted possibilities, because they are not equally probable. He tries to conceptually discern the contributions of individual impacting conditions to the overall probability, which he writes in the form of so-called probability of total event, which entails the use of conditional probabilities; for an event $B$ and $n$ conditions $A_i$ we have:

$$P(B) = \sum_{i=1}^{n} P(B|A_i)P(A_i). \quad (1)$$

If I illustrate this using Popper's example, we can imagine tossing a coin on a surface, which is partially flat and partially carved in the sense described above. For each of the two surface sections the probabilities for the three outcomes are different: the conditional probability of the coin landing vertically on the flat part of surface is, for example, close to 0, while this is not true for the carved section of the surface. The two sections of the surface have different propensities of outcomes.

Frequentists and objective probabilists in general do not regard conditional probability as central in any sense. Conditional probabilities in frequentism are an expression of the so-called reference classes, i.e. subclasses of events. To give an example, in statistical analyses we can improve our probability assignment for mortality of an individual if we take into account additional information about him or her like sex, age, social status etc. This is disturbing for frequentists from a foundational point of view as we may introduce an unlimited number of reference classes and we cannot claim that for a certain object or phenomenon a single objective probability assignment exists (for this see e.g. [6; p.113]). What is a foundational problem for the frequentist interpretation is on the other hand a means

of learning and organizing data in statistical inquiry. Recognizing reference classes in a population or data set is a way to discern relevant factors that impact a certain phenomenon.

Bayes' theorem, which introduced conditional probability, is regarded mostly as a pragmatic formula – even Fisher's Maximum likelihood method, which formally employs it, understands it merely as a heuristic tool[3]. Popper's approach is one of the rare ones that offer a proper possible objectivist interpretation of conditional probability as a set of objective conditions intertwined with the object of inquiry. His position is that additional information helps to sharpen our probability assignments for probabilities of single events, which are objectively existent although unclear.

Another author on interpretations of probability, J.R. Lucas, is also of the view that in some cases it makes sense to talk about objective probabilities of individual objects or events, but he stresses that in such cases we view the event as representative of a type of events or objects, not as an individual one. "It is not because we do not know whether an individual has a certain factor present or not, but because we want to consider him not just as an individual, but *qua* member of a population, that we use probabilistic rather than black-and-white, Yes-or-No, true-or-false language" [5; p.188]. We can view the individual event/object as a perfectly determined individual object or as a representative of a wider population. The language of probability is such that it can view the same object as specified to a lesser or greater extent, which is illustrated exactly by the reference classes. From this point of view there is no need to maintain that probabilities of single events do not exist, the question might just be whether they are, strictly speaking, objective. Or alternatively, is objectivity of types of events/objects the same as objectivity of individual events/objects?

It is to be mentioned that different variants of the propensity interpretation of probability evolved. D. Gillies, one of the rare authors who pay special attention to propensity interpretations of probability, mentions besides Popper also D.W. Miller and J.H. Fetzer. The first held a similar view as Popper while the latter developed a theory in which the probability is a function of the complete set of relevant conditions and not of the state of the world, which is a position that Popper later adopted. In this sense, both Fetzer's theory and later Popper's theory have metaphysical pretensions, which is exactly the aspect Gillies criticizes about them [6; p.127]. Propensity interpretations of probability have not become a distinct branch of probability very likely because they did not add any technical insight to the corpus of probability theories, their merits are more of philosophical nature.

## THE CONCEPT OF PROPENSITY

The concept of propensity as developed by the late Popper, of which probability is a measure, gets its relevance and strength in conjunction to the concept of causality. Popper was of the view that ordinary causality is a special type of propensity, more precisely, the propensity with probability 1: "Causation is just a special case of propensity: the case of a propensity equal to 1, a *determining* demand, of force, for realization" [7; p.20].

In his book *A World of Propensities*, published during the last year of his life, Popper developed his propensity interpretation to further metaphysical dimensions, of which he was admittedly unaware before: "it was only in the last year that I realized its cosmological significance. I mean the fact that we live in a *world of propensities*" [7; p.9]. In this graduated interpretation Popper does not understand probabilities in an analytical sense anymore, that is, as conditions that generate certain relative frequencies, but as a current state of the world. He ascribes to propensities a fully equivalent status to physical concepts: "Propensities, it is assumed, are not mere possibilities but are physical realities. They are as real as forces, or fields of forces. And vice versa: forces are propensities. … Fields of forces are fields of propensities" [7; p.12].

It might thus be more precise to claim that Popper views propensities as a fundamental concept which underlies also other physical concepts like forces and fields. They are to him what is ultimately ontologically given[4]. Propensities are inherent in situations and in this sense they bridge also the modern gap between subject and object as they mirror the entanglement of a knowing subject with the world. The subject, behaving actively or passively, will always be part of a situation, which he or she can influence with his or her understanding. As Popper puts it:

> "Now, in our real changing world the situation and, with it, the possibilities, and thus the propensities, change all the time. They certainly may change if we, or any other organisms, prefer one possibility to another; or if we discover a possibility where we have not seen one before. Our very understanding of the world changes the conditions of the changing world; and so do our wishes, our preferences, our motivations, our hopes, our dreams, our phantasies, our hypotheses, our theories" [7; p.17].

The picture Popper is painting here is very interactive and also very dynamic. It is not past situations that determine future situations but changing propensities, which influence future situations without uniquely determining them; the future is not objectively determined, but objectively open: "The future is open: objectively open. … The present can be described as the continuing process of the actualization[5] of propensities" [7; p.18].

From this point of view, the present is nothing simple – it becomes a complex entanglement of possibilities which extend into the past and the future. "And in so far as these possibilities can, and partly will, realize themselves in time, the open future is, in some way, already present, with its many competing possibilities, almost as a promise, as a temptation, as a lure. The future is, in this way, actively present in every moment" [7; p.19]. Popper's world of propensities postulates a blurred concept of the present. In such a world, as already mentioned, probabilities are not an expression of human ignorance. "Changing propensities are objective processes, and they have nothing to do with our lack of knowledge" [7; p.18]. Our knowledge itself evolves[6] and probabilities mirror not the impossibility of objective knowledge in general but the impossibility of fully abstract objective knowledge which dismisses conditions and/or the knowing subject, because they are always inherent in the situation.

Last but not least, the concept of propensity introduces also a kind of neutral teleology without any explicit mentioning of this term. Popper rather makes a parallel to Newtonian attractive forces: "It is not the kicks from the back, from the past, that impel us but the attraction, the lure of the future and its competing possibilities, that attract us, that entice us. This is what keeps life – and, indeed, the world – unfolding. (Remember that Newtonian forces too are attractive forces!)" [7; pp.20-21].

Popper's late concept of propensity is not analytical and overshadows the concept of probability, which is basically a measure. In this sense his account is not an interpretation of probability anymore, but a metaphysics of propensities, which has an analytical correlative in the concept of probability and is coherent with it. If we now try to sum up the main postulates of Popper's ontology, we can say that propensities:

- are the ultimate ontological reality,
- are the basis of the entanglement between subject and object,
- are intertwined among them and constitute a blurred present,
- do not determine future states uniquely, but openly,
- are temporally stretched entities that entail a kind of neutral teleology,
- can generate empirically observed relative frequencies and can be measured by a frequentist concept of probability,

- are inherent in situations and preclude the possibility of traditional abstract objective knowledge.

## SUPPES' PROBABILISTIC METAPHYSICS

Patrick Suppes' main motivation in his *Probabilistic Metaphysics* (1984) is his dissatisfaction with how probability is incorporated into the western thought in general, not only into science in particular. This state of inadequate accommodation is what has brought by confusion in understanding the concept of probability, which has been subject to the split between subjective and objective interpretations. The classical concept of probability advocated for example by Laplace was compatible with determinism because it entailed the so-called epistemic understanding of probability, i.e. that probability is merely an expression of our ignorance. Suppes sees the need for a probabilistic metaphysics, by which he means a paradigm that would relax the tensions associated with the understanding of the concept of probability.

Suppes criticizes the postulates of what he calls neotraditional metaphysics, which can be found in much of post-Kantian philosophy, in much of contemporary analytic philosophy and in contemporary versions of logical empiricism or logical positivism. He summarizes them as follows [8; p.2]:

**N1.** The future is determined by the past.
**N2.** Every event has a sufficient determinant cause.
**N3.** Knowledge must be grounded in certainty.
**N4.** Scientific knowledge can in principle be made complete.
**N5.** Scientific knowledge and method can in principle be unified.

Instead of logical empiricism Suppes advocates something which he calls probabilistic empiricism. In his words:

> "I use concepts of probability to deal with metaphysical and epistemological matters, and I argue for replacing the concept of logical empiricism by that of probabilistic empiricism. But probabilistic empiricism is not meant to have a reductive bias as I conceive it. I shall claim that it is probabilistic rather than merely logical concepts that provide a rich enough framework to justify both our ordinary ways of thinking about the world and our scientific methods of investigation"[7] [8; p.2].

In the introduction, Suppes puts forward a set of metaphysical propositions which form the core of his probabilistic metaphysics [8; p.10]:

**P1.** The fundamental laws of natural phenomena are essentially probabilistic rather than deterministic in character.
**P2.** Our conception of matter must contain an intrinsic probabilistic element.
**P3.** Causality is probabilistic, not deterministic, in character. Consequently, no inconsistency exists between randomness in nature and the existence of valid causal laws.
**P4.** Certainty of knowledge – either in the sense of psychological immediacy, in the sense of logical truth, or in the sense of complete precision of measurements – is unachievable.
**P5.** The collection of past, present, and future scientific theories is not converging to some bounded fixed result that will in the limit give us complete knowledge of the universe.
**P6.** The sciences are characteristically pluralistic, rather than unified, in language, subject matter, and method.
**P7.** Language learning and performance in their phonological, grammatical, semantical and prosodic aspects are intrinsically probabilistic in character.
**P8.** The theory of rationality is intrinsically probabilistic in character.

Tenets P4 and P5 stand in explicit opposition to the tenets N3 and N4, respectively, they represent their negation. The rest of the neoclassical tenets are criticized and the main concepts are modified and put into a different context during the various chapters of the book.

It is not my aim to go into details of all the points above, at this point I would rather acknowledge that common traits with Popper's understanding are evident, both in rejecting N1-N5 and in accepting the majority of Ps, certainly P1, P3, P4 and P5. What stands out as a major addition and is of central importance for Suppes is P2. He demands that the concept of matter be changed in a way to contain an intrinsic probabilistic element. He points out that in modern atomism it was recognized that, contrary to ancient ideas about atoms, matter is not indestructible, it can turn into energy. Moreover, particle physics introduced a myriad of particles, that have very short lifetimes and, so to speak, constantly come in and out of existence. Conceptually speaking, the fundamental importance of fields has become more and more prominent, physics is done in terms of continuous properties of fields rather than singular properties of individual particles. Matter is thus continually changing, there is no reason to think that one form, that is, one set of particles is necessarily more fundamental or ultimate than another.

For the mentioned reasons Suppes proposes to introduce Aristotle's concept of matter as pure potentiality without qualification and attributes, as introduced in his *Physics* and *Metaphysics*. As we observe change, there must be an underlying substratum that does not change, but it has no definite shape. In other words, there is no principle of individuation for matter *qua* matter. Viewing matter as pure potentiality, Suppes holds, is not a guidance on the laws of physical phenomena, rather it is a valuable alternative to the atomistic conceptual view. For Suppes this tenet is of central conceptual concern: "my conception of probabilistic metaphysics should be thought of as an extension of the Aristotelian metaphysics of matter and substance" [8; p.7].

Suppes does not view his metaphysical tenets as an exhaustive and exclusive list, he just wants to stress "general propositions that depend on probabilistic concepts, but this is because of their neglect or, in many cases, rejection, as metaphysical assertions by many philosophers just because of their probabilistic character" [8; pp.10-11]. He can accept other metaphysical propositions as sound and important which do not involve probability in any way. Traditional metaphysics has focused on the nature of being, substance, space and time and similar concepts. One way of formulating Suppes' claim is "that the probabilistic character of phenomena is almost as ubiquitous as their spatial or temporal character" [8; p.11].

Suppes is aware that it is uncommon to claim that probability should be regarded as a fundamental metaphysical concept and that he is running counter many philosophical and scientific thinkers. He sees his main predecessor in C.S. Peirce, who put explicit stress on chance phenomena in nature.

## WHAT KIND OF METAPHYSICS?

I have reviewed two metaphysical expositions of probability. Perhaps it can be sensed already from what has been explicated so far that the authors have a different conception of what metaphysics is, although there are many common traits. Before discussing this point I will give a short account of the two earliest views on metaphysics impacted by an emerging concept of probability – Hume's and Kant's.

It was already mentioned that the concept of probability became an integral part of philosophy with Hume. Probability is for him the central epistemological concept. When we want to apply our knowledge, due to our imperfect faculties "all knowledge degenerates into probability" [9; p.121]. Probability with Hume does not have any metaphysical dimensions, it

is rather an epistemological concept. By his time the concept of probability had gained a reputation of evidential impact compared to its previous role of mere opinion as opposed to knowledge, that is, *doxa versus episteme*, respectively. In thomistic philosophy, knowledge was the domain of demonstrative proof and was applied to questions about eternity and ontology, while probability had a quite different object – opinion; this line could never be crossed [3; pp.21-22]. In Hume's philosophy demonstration applies only to mathematics, the other evidential impact comes from facts, to which we apply probability. Probability thus has evidential impact, but does not have ontological dimensions yet.

Because of his rejection of the notion of substance, Hume is sometimes labelled as anti-metaphysician. It is recognized that his attitude towards metaphysics *via* his rejection of the concept of substance is more disproving in his earlier *A treatise on human nature* (1739) than in his later *Enquiry concerning human understanding* (1748). While at the end of the former he expresses his despair about the possibilities to build a solid foundation for human understanding in the latter he explicitly expresses that it is necessary to cultivate metaphysics and get rid of the old one, which is full of superstition and prejudice: "And must cultivate true metaphysics with some care, in order to destroy the false and adulterate" [10; p.8]. This is strong indication that Hume was at least in search of some kind of metaphysics. He stands at the dawn of the introduction of a new evidential tool and what metaphysics can rely on it is an open question.

An indirect attempt to answer this question was given by Kant with his critical philosophy. He defends the position of transcendental metaphysics as the science of the *a priori* conditions of possible experience and refrains from making judgements about the nature of things *per se*. His aim is still to build an ultimate scientifically grounded epistemological system and with this goal in mind he explicitly rejects the use of probability in metaphysics: "Nothing can be more absurd, than in metaphysics, a philosophy from pure reason to think of grounding our judgements upon probability and conjecture" [11; p.144].

Kant's critical turn, influenced by Hume, changed the way he had tried to incorporate natural sciences into his philosophy. The main work presenting his view on natural sciences within his critical philosophy is his *Metaphysical Foundations of Natural Science* (1786). Before the turn, natural sciences, at the time called natural philosophy, formed the basis of his ontology, while after the turn his metaphysics is based on principles of pure reason, which themselves determine the requirements of natural science proper. These are: scientific cognition must (i) be systematically ordered (ii) according to rational principles and (iii) be known a priori with apodictic certainty, i.e., with "consciousness of their necessity" [12; p.4]. Because properly scientific cognition must satisfy these strict conditions, it requires "a pure part on which the apodictic certainty that reason seeks can be based" [12; p.4]. Since Kant identifies pure rational cognition that is generated from concepts with metaphysics, it follows that science proper requires a metaphysics of nature, i.e. a special metaphysics.

He then specifies that such a metaphysics of nature could consist in either a transcendental part, which discusses the laws that make possible the concept of a nature in general, "even without relation to any determinate object of experience" [12; p.4], or a "special metaphysical" part, which concerns a "particular nature of this or that kind of things" for which an empirical concept is given [12; p.4]. Opting for the latter, his special metaphysics is thus part of his larger system of metaphysics, adopts its main principles but has a special subject matter: it focuses on a few main ideas of pure reason – space, time, force and matter. In this aspect it is aligned with the main ontological concepts that form the backbone of natural sciences.

Kant's exposition of the concepts of space and time is known from his *Critique of Pure Reason*, while his *Metaphysical Foundations of Natural Science* is the main source for understanding his concept of force and matter. Kant had developed a dynamical theory of

matter in which properties of matter like solidity and impenetrability are not taken as primitive and self-explanatory, but as derived from the dynamics of particles and attractive and repulsive forces between them. For this purpose he devised in his *Physical Monadology* (1756) pointlike atoms acting in a continuous space, much like Boscovich did just two years later in his very influential *Theory of Natural Philosophy* (1758).

In his *Metaphysical Foundations* Kant incorporated his theory of matter as part of his special metaphysics. The shift that he makes is that matter, in contrast to his *Physical Monadology*, is no longer viewed as simple and indivisible, but as a genuine continuum occupying all geometrical points of the space it fills. The problem of infinite divisibility is solved by explicitly invoking the transcendental idealism of the *Critique*, more precisely the Second Antinomy. Matter is infinitely divisible, but in experience never actually divided. It is only by viewing matter as a thing in itself that we obtain a genuine contradiction. The concept of matter, like the other three, is subject to his conceptual apparatus of the pure concepts of understanding – the categories of quantity, quality, relation and modality. In this sense, the conceptualization of his particular metaphysics is explicitly aligned with his *Critique of Pure Reason*.

Despite its effort to keep up with natural science, Kant's position is not a metaphysics many natural scientists would adhere to nowadays. In fact, it triggered a line of philosophical thought that claimed to have overcome classical metaphysics, attributing to the latter a somehow negative connotation. Also analytic philosophers from the first half of the 20th century, especially the logical empiricists, understood metaphysics as a negative term without real ground and turned rather to a linguistic analysis as basis for ontology. In this perspective, it is not trivial to maintain a relevant modern conception of metaphysics. Indeed, there have been many authors since Hume who maintained either a strong or weak form of the thesis, that metaphysics is not possible[8] [13].

Popper and Suppes are examples of authors who think some form of metaphysics, of course aligned with modern science, is possible. But while Popper limits himself to presenting us a vision of his ontology without reflecting upon it, Suppes explicitly comments on his concept of metaphysics. He understands his attempt as establishing a kind of descriptive metaphysics, which depends upon contemporary science, as opposed to speculative metaphysics.

> "It is sometimes said that Aristotle's *Metaphysics* is a model of descriptive metaphysics, an attempt to organize the most general and at the same time most significant aspects of experience. Such descriptive metaphysics is contrasted with the kind of speculative metaphysics that Kant was so concerned to criticize and eliminate from philosophy. The kind of probabilistic metaphysics I try to develop in these pages is meant to be descriptive rather than speculative. The conclusions I want to reach depend upon the science of the day …" [8; p.3].

Suppes criticizes Kant's opinion, expressed in an open letter on Fichte's *Wissenschaftslehre*, that his system of critical metaphysics rests on a fully secured foundation, established forever. In this respect he is in line with R.J. Collingwood, whose view of metaphysics he presents as one of the most influential 20th century expositions of metaphysics. They are both sceptical that an adequate metaphysics can be developed once and for all and they both hold that what is a metaphysical presupposition changes as science changes. Kant, although he somehow opened a backdoor for empirical concepts via a special metaphysics of natural science, still remained faithful to his ideal of science.

Suppes also does not share the view that metaphysics has its own subject matter and its own methodology. In this respect he differs from both Kant and Collingwood, who understood metaphysics as a kind of science of absolute presuppositions that cannot be regarded as either true or false. Suppes holds no special status for metaphysical statements: "Collingwood

represents a retreat from Kant's position by recognizing the absurdity of trying to establish the metaphysical foundations of science once and for all. … But he retains the Kantian view of metaphysics as having a special subject matter and a special methodology. … My position is that there is no sharp delineation of the class of metaphysical assertions" [8; p.9].

It is not within the scope of this article to search for an adequate conception of metaphysics that would encompass the concept of probability. Rather, my aim was to point at some of the important problems that will likely emerge when one attempts to do so. For this purpose I drew on expositions of metaphysics which were influenced by an emerging concept of probability and expositions that rely on a modern physical interpretation of probability, which has been vital for modern scientific development. Moreover, my aim was to investigate approaches that incorporate the views of quantum theory into a scientifically aligned metaphysics.

## REMARKS

[1]For an account of the transformation of statistics into an independent science see e.g. Stigler, J.: *History of Statistics: The Measurement of Uncertainty before 1900*. Belknap Press of Harvard University Press, Cambridge & London, 1986.

[2]For an account of the emergence of the concept of probability and its philosophical extensions see e.g. [3].

[3]For this see e.g. Bolstad, W.: 'Comparing the Bayesian and Likelihood approaches to inference: a graphical approach.' In: Reading, C., ed.: *Data and context in statistics education: Towards an evidence-based society*. Proceedings of the Eighth International Conference on Teaching Statistics ICOTS8. The Netherlands: International Statistical Institute, Voorburg.

[4]In this sense, Popper's concept of propensity is very similar to the concept of *vis* employed by the 18th century natural philosopher Roger Boscovich, best known for his 'curve of forces' and for his influence on physicists and the genealogy of the concept of field. Boscovich did not employ a Newtonian concept of force, but understands it more in the sense of tendency or propensity. For this see the article Lukan, P.: *Roger Boscovich and the quantum mechanical combination of mechanical and statistical laws*. Almagest **6**(1), 65-78, 2015.

[5]This formulation is again very similar to Boscovich's understanding of the *vis*, which acts as potential guidance to the actualization of material points with concrete positions.

[6]This is very well in accordance also with the Bayesian probabilistic point of view, which is permanently open to updating belief.

[7]We encounter this commitment to pursue a common basis of ordinary and scientific knowledge also with geophysicist and philosopher of science H. Jeffreys, who was responsible for the revival of Bayesianism in science.

[8]"Let us call the thesis that all metaphysical statements are meaningless 'the strong form' of the thesis that metaphysics is impossible. (At one time, an enemy of metaphysics might have been content to say that all metaphysical statements were false. But this is obviously not a possible thesis if the denial of a metaphysical statement must itself be a metaphysical statement) And let us call the following statement the 'weak form' of the thesis that metaphysics is impossible: metaphysical statements are meaningful, but human beings can never discover whether any metaphysical statement is true or false (or probable or improbable or warranted or unwarranted)" [13].

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