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1. Why were you initially drawn to metaphysics (and what keeps you interested)?

My first encounter with metaphysics was triggered by one of my grammar school teachers in Bolton, England, who lent me his copies of Wittgenstein's *Tractatus* and Russell's *Introduction to Mathematical Philosophy* after I had expressed an interest in applying to read for the then newly established joint degree in Mathematics and Philosophy in Oxford. I did not, at that stage, have more than a foggy idea about what studying philosophy might involve, but I was immediately taken by the *Tractatus*, and by what I would later formulate as the goal of finding ways to represent reality in formal, structured ways analogous to those of mathematics. I have remained faithful to this goal ever since, and it provides a unifying thread along a meandering journey from Wittgenstein and Russell, through Frege and Dummett to Ingarden, Husserl and Brentano, and from there to a new terrain of applications of metaphysical ideas in areas outside philosophy.

It was the Polish philosopher Roman Ingarden whose work first made clear to me what 'metaphysics' might mean. I encountered Ingarden by accident after chancing upon a copy of his *Time and Modes of Being* on the Bodleian library shelves. This short book, long since out of print, is a translation of portions of Ingarden's four-volume defense of metaphysical realism entitled *The Problem of the Existence of the World.* The latter is, I believe, one of the few great works of metaphysics to be published in the twentieth century. However – not least due to the fact that it was published originally in Polish and then, in extended form, in German, and to the fact that it is still available in English only through the fragments compiled in *Time and Modes of Being* – it is a work which, outside Poland, has been almost entirely neglected.

Ingarden enjoyed for a time a certain following in the English-speaking world for his *The Literary Work of Art*, a work which was read primarily for theoretical contributions of a sort once of interest to students of literature. But Ingarden's own reasons for writing this book were strictly philosophical. Its subtitle is: *An Investigation on the Borderlines of Ontology, Logic and Theory of Literature*, and its goal was to provide a supplement to the defense of metaphysical realism advanced in *The Problem of the Existence of the World.* Roughly, the latter provides an account of what the real world would have to be like if different forms of realism and idealism were to be true. According to one important sub-family of idealisms the real world would be a configuration of intentional objects, processes and states of affairs of the sort that are represented in a work of literature. In *The Literary Work of Art* Ingarden provides a description of a world of this sort, demonstrating how different such a world would be from the world we know through scientific investigation.

I was immersed in Oxford overwhelmingly in logic and in the philosophy of mathematics (most memorably in lecture courses given in the Mathematics Institute by Michael Dummett on Frege, on axiomatic set theory, and on the intuitionistic differential calculus). The still predominantly linguistically oriented Oxford analytical philosophy of the day I found much less exciting. Against this background, Ingarden's writings provided me with the first glimpse of a tradition of philosophizing that was both friendly to realism and marked by a philosophical rigor at least comparable to that of mathematics. It was also refreshingly free of any overarching concern with niceties of language. I moved in stages from Ingarden to his teacher Husserl and from Husserl to his teacher Brentano. Along the way I learned to appreciate the work of other realist followers of Husserl such as Adolf Reinach (inventor, in 1913, of a remarkably sophisticated version of speech act theory) and to distinguish these realist phenomenologists from Heidegger and other progressively more zany 'Continental' thinkers in the broadly phenomenological tradition initiated by Husserl.

I take metaphysical realism, or any metaphysical realism worth believing in, to be consistent with both scientific and common-sense realism. Hence my interest in the work of Roland Omnès and of other proponents of the 'consistent histories' school in quantum mechanics, for whom the 'quasi-Newtonian' physics governing common sense reality is (after taking account of a negligibly small probability of error) logically inferable from the equations of quantum mechanics. Hence, too, my interest in the so-called 'ecological psychology' of J. J. Gibson and Roger Barker – an approach to empirical psychology based on the direct realist view that we are engaged, in our perceptions and actions, not with sense data or other figments of idealist philosophers' imaginations, but rather with concrete objects in the world of everyday reality.

Against this background, and seeking a formal means to translate Gibsonian ideas into a form which would allow them to be used as the basis of a more adequate semantics for natural language, I discovered the work of the former philosopher Patrick Hayes, and specifically his two papers entitled "Naïve Physics Manifesto" and "Ontology for Liquids" published in a volume on *Formal Theories of the Common-Sense World* which appeared in 1985.

These papers opened up for me what artificial intelligence researchers were then beginning to refer to as 'formal ontology' – inadvertently employing a term coined by Husserl in his *Logical Investigations.* In 1993 I was invited by Nicola Guarino, one of the leaders in this new field, to work with his formal ontology group in Padua, Italy. Formal ontology in the sense of Hayes and Guarino is a subdiscipline of computer science in which metaphysical ideas and the technology of first-order logic are applied by software engineers, for example in order to provide a basis for programming robots with the rudiments of common-sense. Collaborating with practitioners of this new discipline provided a valuable boost to my interest in ontology, since it gave first indications that it might enjoy a practical utility.

2. What do you consider to be your most important contributions to metaphysics?

2.1 "Truth-Makers"

My work on Brentano, Husserl, Ingarden and their followers led to a more general interest in the philosophy of Central Europe at the turn of the last century, and I collaborated closely in various endeavors relating to the Austrian and Polish schools of philosophy with Kevin Mulligan and Peter Simons. The three of us had already founded the Seminar for Austro-German Philosophy in 1977 upon completing our doctoral studies in Manchester. Kevin, here, played the signal role of convincing Peter and myself of the importance of Husserl's 3rd Logical Investigation, "On the Theory of Wholes and Parts", and of Husserl's application of the term 'formal ontology' to designate a formal discipline analogous to, though in essential ways different from, logic. Peter, in turn, showed us how to meld Husserlian formal ontology with the formal approach to the theory of parts and wholes (or mereology) he had learned from Czesław Lejewski (then Professor of Philosophy in Manchester, and a student of the great Polish logician-ontologist Stanisław Leśniewski).

In 1980 the three of us began to apply Husserl-inspired ideas on formal ontology to the development of a correspondence theory of truth broadly in the spirit of Russell and the *Tractatus*. This led in 1984 to our paper "Truth-Makers," which did much to spark the renaissance of interest in truthmaker-based approaches to the theory of truth which continues to this day. It also led to an alliance with Australian realists such as David Armstrong, also interested in truthmaking, and in the potential for a theory of truthmaking to provide new arguments for a realist theory of universals.

"Truth-Makers" proposes an account of truth which supplements the work of Tarski by asserting, for certain kinds of logically simple true empirical sentences, the existence of a real relation which obtains between the relevant truthbearer and some truthmaking portion of reality.

At the heart of the doctrine is Aristotle's so-called 'ontological square' (Figure 1), and more specifically the idea of what Aristotelians call 'individual accidents'. The "Truth-Makers" paper defends the view that such individual accidents are the principal truthmaking ingredients of reality: they are that, in reality, to which the verbs of simple empirical sentences correspond. Our approach to truthmaking thus has a certain connection to Davidson's theory of events. Unlike Davidson, however, we recognized the need to quantify not only over those individual accidents which correspond to event verbs such as 'runs' or 'swims' or 'eats', but also over those which correspond to state verbs such as 'knows' or 'owns' or 'loves'.

	Not in a Subject ***Substantial***	**In a Subject** ***Accidental***
Said of a Subject ***Universal, General***	*Second Substances* man, ox	*Non-substantial Universals* knowledge, running
Not said of a Subject ***Particular, Individual***	*First Substances* this man, this ox	*Individual Accidents* this knowledge, this run

Figure 1: The Aristotelian Ontological Square

2.2 "Against Fantology"

Individual accidents in this broad sense were, we argued, neglected by analytic philosophy because they did not fit well with the Fregean function-argument approach to logical grammar. I attempted much later, in my "Against Fantology" (delivered at the Wittgenstein Conference in Kirchberg in 2005), to use this idea as the basis for a new view of the history of analytical metaphysics in terms of the pernicious influence of the doctrine according to which, in Russell's terms, "all form is logical form". According to this view, Frege-inspired metaphysicians from Russell and the early Wittgenstein to David Armstrong have seen the key to the ontological structure of reality as being captured syntactically in the 'Fa' (or, in more sophisticated versions, in the 'Rab') of first-order logic. Because predicate logic has maximally two syntactically different kinds of basic referring expressions—'F', 'G', 'R', etc. on the one hand, and 'a', 'b', 'c', etc. on the other—the fantologist sees himself as being allowed to infer that reality itself must consist of maximally two correspondingly different kinds of entity: the general (properties, concepts, sets) and the particular (individual things or objects). This leaves no room in the fantological ontology for individual accidents (tropes, moments, particularized qualities) such as pains or debts. Such fantological thinking amounts to what Luc Schneider has referred to as the 'ontological diagonal', since it recognizes only two of the four corners of the Aristotelian ontological square. Davidson took one small step away from fantology in recognizing the need for a category of individual occurrents ('events') in addition to the category of individual things. "Against Fantology" argues that we need to go one step further and admit also what I would now call dependent continuants, in addition to the individual things (independent continuants) upon which they depend. Dependent continuants include qualities, roles, capabilities and functions; they include information objects such as the representations of genetic structures we find in sequence databases; and they include debts, ownership and authority relations, and many of the other individual relational entities which form the glue which holds together social reality.

"Against Fantology" contains also a proposal to counteract the effects of fantological thinking by introducing a minimal adjustment to the standard syntax of first-order logic, effectively by reducing substantially the allowed substituends for 'F' in 'Fa' and for 'R' in 'Rab' so that they would be confined only to predicates and relational expressions of the highest possible generality, almost all of them binary relations such as 'is identical to' (or '='), 'is part of', or 'is an instance of', and other relations now incorporated into the RO Relation Ontology (see below). At the same time the range of the constant and variable terms 'a', 'b', 'c', …, 'x', 'y', 'z', … is broadened tremendously to include not only individual things, individual events, and individual qualities, but also the universals or types which such individual entities instantiate. The syntactically reformed predicate logic would then consist of atomic formulae such as:

> =(x, y), for: x is identical to y,
> Part(x, y), for: individual x is part of individual y,
> Inst(x, y), for: individual x instantiates universal y,
> Inhere(x, y), for: individual quality x inheres in individual thing y,
> Is_a(x, y), for: universal x is a subkind of universal y,

and so forth.

The result is comparable to the vocabulary of set theory in the sense that there, too, we have a restricted number (two) of primitive relational predicates: = and $\in$. But while the language we are proposing has a vocabulary structurally very similar to that of set theory, it differs radically in that the formal tie of set-theoretic membership itself emanates from the fantological stable.

2.3 "On Drawing Lines on a Map"

Moving gradually towards applying formal-ontological theories to domains outside philosophy, I began collaborating in the early 1990s with David Mark and his colleagues in the National Center for Geographic Information and Analysis in Buffalo. Drawing not only on formal ontology but also on the work of linguists and other cognitive scientists, Mark and I embarked on an empirical study of the ontologies of geographic space underlying the cognition of human subjects, including comparative studies involving the speakers of multiple languages.

One output of this interaction was a new way of understanding the distinction between what we can loosely think of as the 'natural' boundaries of a lake or an island and the artificial boundaries marking, for example, rectangular states and provinces such as Utah or Saskatchewan. Geographers had until that point been disposed to call the latter 'abstract' or 'conceptual'. To the extent that they reflected on them ontologically at all, they preferred to view them as mere fictions, and thus as not really a part of the furniture of reality. In a paper entitled "On Drawing Lines on a Map" published in 1995, and since much cited by geographers and others, I propounded an alternative, realist view, resting on a distinction between what I called 'fiat' and 'bona fide' boundaries, the former being illustrated by the borders of real estate parcels or postal districts, the latter by entities such as planets and apples, which have borders or boundaries in their own right, independent of any drawing of borders by cognitive beings such as ourselves. Fiat boundaries and the fiat objects which they bound are, I argued, not only full-fledged denizens of reality, but also surprisingly pervasive not just in the geospatial realm but also for example in clock- and calendar-induced partitioning of regions of time. The drawing of fiat boundaries plays an important role, too, in medicine, for example in the anatomy of brain regions and in the definition of terms such as 'elevated blood glucose' or 'hypertension' or 'anemia' or indeed 'leg'.

In 2000 I published with Achille Varzi a paper in which we sought to show that, where bona fide physical discontinuities can be axiomatized in classical topological terms, fiat boundaries require for their understanding a non-classical topology, in which the distinction between open and closed regions can no longer be made – hereby drawing in turn on mereotopological ideas on boundaries developed by Roderick Chisholm, who drew in his turn on Brentano's *Philosophical Investigations on Space, Time and the Continuum*.

2.4"Searle and de Soto: The New Ontology of the Social World"

The ontology of geography led to work on the ontology of social objects, and to a series of debates with John Searle concerning his *Construction of Social Reality.* These debates turned on Searle's naturalistic view of social objects as being, like presidents and cathedrals and parcels of real estate, physical objects which *count as* entities with special social attributes in certain special kinds of contexts. Social objects such as debts, claims, ownership rights, and collateralized debt obligations do not admit of such an analysis, since there is typically no physical object which *counts as* (for example) a debt. Such objects thereby fall outside the limits of Searle's naturalism, and their absence leaves a problematic hole in his social ontology.

While engaging with Searle I began to read the work of the Peruvian economist Hernando de Soto, whose *The Mystery of Capital* contains a treatment of the ontology of the social world that is in interesting ways complementary to that of

Searle. For de Soto it is entities such as title deeds, stocks, shares and insurance policies which play the central role in structuring the ontology of social reality. The full title of de Soto's book is *The Mystery of Capital: Why Capitalism Triumphs in the West and Fails Everywhere Else,* and it presents the formula for what Bill Clinton has called 'the most promising anti-poverty initiative in the world'. De Soto's idea begins with the fact that we in the West have in almost all areas reliable and systematic ways of keeping track of ownership rights; it is this, de Soto argues, which explains why we have been able to harvest and augment the world's resources to a more successful degree than elsewhere when measured, for example, in terms of prosperity, longevity, and security.

This is because in the Western world property rights are recorded in *documents*, and these documents, where publicly registered and reliably maintained, allow the same piece of land or house or factory to serve simultaneously a double purpose – of providing food or shelter or productive services, and of providing collateral for further investment. In even the poorest countries, vast numbers of people have parcels of land which they farm, houses in which they live, and even factories in which people are employed in manufacturing goods. But their claims to land and buildings are tenuous at best because there is no framework of property title. De Soto's strategy, accordingly, a strategy that has been successfully applied in many third-world countries, is to develop very simple forms of legal title in order to allow the poor to enjoy the same benefits of collateral (and a variety of other benefits such as insurance and legal electricity supply) which are enjoyed in the developed nations of the West as a matter of course.

De Soto hereby awards to *documents* a crucial role in the social order, analogous to the role awarded by Searle to speech acts. Speech acts, we might say, suffice as a basis for claims and obligations in small, village-based societies in which everyone knows (and so knows how much he can trust) everyone else, and in which memories are long. As societies grow, and as markets become extended, verbal promising and the swearing of oaths give way to complex edifices of documents and document systems – encompassing bank statements, passports, driving and marriage licenses, bills and receipts, degree certificates and tax forms, as well as stocks and shares – all of which form part of the fabric of developed societies at every level, but which are still lacking in the undeveloped world.

In 2003 I organized with my Buffalo colleagues a conference entitled The Mystery of Capital and the Construction of Social Reality in which de Soto and Searle presented their views on social reality, and since then I have worked with de Soto on applying ideas pertaining to the ontology of documents in support of his work in developing countries sponsored by the United Nations-sponsored Commission on the Legal Empowerment of the Poor and by other bodies.

Interestingly, the document-based social reality of Western societies is becoming even more complex and sophisticated with the growth in importance of new kinds of digital documents and of new ways of handling the digital social objects which such documents bring in their wake, above all in the domain of banking and finance. At the same time, as we know, this new kind of sophistication brings also new kinds of hazards, where the value for example of collateralized debt obligations can no longer reliably be determined because, as de Soto shows (2009), there is no adequate documentary basis for determining which securities form their ultimate collateral.

3 What do you think is the proper role of metaphysics in relation to other areas of philosophy and other academic disciplines, including the natural sciences?

Metaphysics, I can well imagine, will continue in its present role within the discipline of philosophy. As concerns relations to the natural sciences, however, I envisage a new role for the sub-dicipline of ontology, including a gradual spinning off of ontology from its philosophical home – in a way roughly analogous to the way in which other sciences have spun off from philosophy in earlier epochs – and it is with the fate of the new science of ontology so conceived that I shall concern myself in what follows.

There was a time, familiarly, when all university scientists working in the field of what we now call 'psychology' were employed as professors in departments of philosophy. Psychology made its first step towards its current status as an independent, scientific discipline when Wilhelm Wundt established the world's first psychological laboratory at the University of Leipzig in 1879. My present view is that ontology is currently taking similar steps towards establishing itself as a discipline in its own right.

The rationale for this development turns on the astonishing success of ontology in the extra-philosophical world, where it now forms a central part of a strategy for coping with the problems which arise when bodies of data developed independently for different purposes need to be harmonized, aligned or integrated, as when large financial companies or hospital systems merge, or military forces or disaster relief agencies from different countries need to coordinate their plans, or public health organizations need to aggregate data pertaining to epidemic outbreaks spanning multiple geographic areas.

To serve this strategy, multiple ontological research laboratories have been established in scientific institutions throughout the world, and many industrial and government organizations are developing and using ontologies for the representation and integration of their data and information. There are multiple ontology journals, and multiple national and international conferences in ontology, including an annual Ontology Summit held in the US National Institute of Standards and Technology. There is an International Association for Ontology and Its Applications, and a (US) National Center for Ontological Research (based in Buffalo) and National Center for Biomedical Ontology (based in Stanford, Buffalo and the Mayo Clinic). Progress towards the establishment of ontology as an academic discipline, on the other hand, has been slow, in part because many of the philosopher-ontologists who would help to form its core are reluctant to leave what they see as the safe confines of traditional metaphysics. There is, in consequence, an acute shortage of trained ontologists relative to the large number of programs seeking to hire persons with ontology expertise.

It is especially in data-intensive areas of the life sciences such as biochemistry and computational genomics that the new ontology has yielded its most impressive results. Here ontologies are being used in hundreds of projects throughout the world to describe biological and clinical data in algorithmically useful ways that are designed to help biologists and clinical scientists address the increasingly urgent challenges they face in finding ways to make sense of each other's data. In 2002 I established in Leipzig the Institute for Formal Ontology and Medical Information Science (IFOMIS), the world's first institute of bio-ontology, with the goal of applying formal-ontological methods in addressing these challenges.

There is a long-standing tendency for each biological research group to use its own guidelines for terminology and categorization. Their data is thereby siloed, and opportunities for harvesting valuable information from cross-organism comparisons are thereby lost. To address this problem a group of biologists studying different so-called 'model organisms' – which is to say organisms, such as mouse or fly, studied for purposes of understanding human health and disease – joined together in 1999 to create what they called the 'Gene Ontology' (GO), a 'controlled structured vocabulary' designed to create a common terminological framework to be used by all model organism databases.

The GO consists of a hierarchically organized set of some 30,000 biological terms – such as 'induction of cell death' or 'cardiac muscle development' – together with semi-formal definitions. The GO is used in multiple ways. Most prominently it serves the manual annotation of experimental results reported in the scientific literature, whereby teams of professional biocurators tag data about, say, gene and protein sequences to terms from the GO. This strategy makes the data that is presented in scientific publications not only more easily searchable by both humans and machines but also – because data pertaining to different species, including *home sapiens*, are annotated using the same terms – more easily comparable and integratable for purposes of research.

The GO was very quickly able to establish itself as a valuable tool of biomedical research, and the ontology is today, when measured in terms of both numbers of users and of reach across species, the world's most successful ontology. There exist over 11 million annotations relating gene products described in major databases of molecular biology to terms in the GO, and data related to some 180,000 genes have been manually annotated in this way.

Unfortunately, initial versions of the GO were logically poorly structured, and its definitions were often circular ('hemolysis' was defined as 'the causes of hemolysis') or worse (the 'part-of' relation used in defining the hierarchical organization of the GO was provided simultaneously with four distinct and logically incompatible definitions). Responding to these problems I organized in Leipzig in May 2004 a workshop on the topic of "The Formal Architecture of the Gene Ontology" in which the leading figures of the GO community participated, above all Michael Ashburner, Professor of Genetics in Cambridge and Suzanne Lewis of Berkeley National Labs. My own talk at the meeting was entitled 'STOP!' (short for: 'Smart Terminologies through Ontological Principles'), and it consisted primarily in the recital of a long list of logical and ontological errors in the GO, together with simple recipes for fixing these errors using methods familiar to students of logic and philosophy.

Fatefully, the meeting resulted in a productive collaboration between Ashburner and Lewis and myself which continues to this day. It led to an ambitious program of ontology reform, which in 2005 became institutionalized as the 'OBO Foundry' (http://obofoundry.org), whose goal is to establish a suite of interoperable, high-quality, logically well-formulated Open Biomedical Ontologies to be used in the annotation of biological and biomedical data and to provide effective guidance to biologists and others engaged in ontology creation.

Because this goal has been embraced by some thousands of biologists and bioinformaticians, its realization is allowing a kind of virtual experimentation, in which representations of complex biological systems are able to live side by side with representations of disease processes in individual humans in such a way that the two are brought together within a single, logically well-articulated ontological framework, which will incrementally allowbiological hypotheses generated on the one side to be tested by reference to the clinical data that is being collected about patients on the other.

This goal of a logically formalized biological ontology was anticipated by the clinician/logical positivist J. H. Woodger in 1937. And it was anticipated, too, by Ingarden, with his theory of organisms as structures built out of relatively isolated causal systems on multiple levels of granularity in *The Problem of the Existence of the World.* Its coherent realization today draws on first-order logic and its contemporary offspring, as well as on a number of recognizably philosophical ideas pertaining to continuants and occurrents, universals and particulars, dependent and independent entities, dispositions and functions. But the work involved in contemporary biological and biomedical ontology is in various ways distinct from the work of the philosopher. First, it involves an obvious focus on practical applications; second, it involves a large component of human interaction between ontologists and biologist users, who must be taught to understand each other's needs, and who must be taught to overcome the manifold difficulties involved in large-scale cross-disciplinary ontology coordination; third, the support which ontologies provide to scientists rests upon their being incorporated into the computational artifacts used by scientists to reason with their data; traditional philosophical concerns must therefore be tempered by concerns relating to computational tractability.

The establishment of the OBO Foundry has already led to the creation of several new ontologies, including the OBO Relation Ontology (RO) already mentioned above and the Ontology for Biomedical Investigations (OBI). OBI is in large part a translation in ontological terms of those areas of the philosophy of science which relate to the design, execution and interpretation of experiments. It addresses an increasingly urgent need on the part of experimental biologists for a common controlled structured vocabulary which can be used to describe how given experimental results were achieved – for example in order to satisfy regulations governing approval of new drugs. The Relation Ontology was first presented in a paper published in the journal *Genome Biology* in 2005, on which I served as co-author with seven biologists, a logician, and a database scientist. This paper has since been cited in more than 450 publications and continues to be downloaded some 1,000 times each month. The Relation Ontology forms one component of the Basic Formal Ontology (BFO) upper level ontology framework which I and my colleagues have been developing since 2003, and which is being used in some 100 life science ontology projects, and also in ontology research sponsored by the US Army relating to the Universal Core data integration initiative of the US Federal Government (http://ucore.gov).

4 What do you consider to be the proper method for metaphysics?

I prefer to answer this question as it relates to the proper method of *ontology* in the sense outlined in the above, a discipline which will increasingly involve an empirical component. To see what this means, let us suppose (to take a very simple example) that we need to create an ontology that can serve as an effective framework for data integration in the field of infectious disease. Given two patients, both suffering from Dengue Fever, do we create an ontology which would bring it about that our database would recognize two instances of disease – two dependent entities – corresponding to the two human beings who are their bearers and to the one disease *type*? And if so, are these disease instances dependent *continuants*, which would endure through time, or dependent *processes*, which would unfold in time? Decisions on such questions determine how a principled ontology framework should be constructed that would enable the integration of the corresponding data. By comparing the success or failure of integration resulting from alternative ontology frameworks we can provide an empirical measure of the quality of the underlying ontology. Disputes formerly resolved (or not resolved) through philosophical argument can be tackled in a way which involves, at least in part, a variety of empirical testing. BFO has been subjected to such empirical testing since its inception, and it has been refined over time in light of the utility of specific ontological choices to its biologist users.

5 What do you consider to be the most neglected topics in contemporary metaphysics, and what direction would you like metaphysics to take in the future?

I hope that my answer to this question is by now clear. The most interesting future direction for metaphysics is to transform itself into a discipline which can support the new, empirical science of ontology.

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