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The Networker

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Interview: Maximilian G. Burkhart and Thomas Morawetz

Photo: Jan Greune

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Let's start at the beginning, with the Old Testament. In the Book of Genesis, God reveals to Abraham, who is already past his 100th birthday, that he will soon father a son. Why should Abraham believe that?

Hartmann: When we receive new information and consider whether or not to incorporate it into our basic belief system, we first use various criteria to analyze it. Three of these are particularly important: the a priori plausibility of the new information, its level of coherence and the trustworthiness of the source of the information. These factors often point in the same direction, but sometimes they clash with each other – as in this case. Here, we are dealing with a highly reliable source, with God, who always speaks the truth. However, the information itself is very implausible – centenarians do not sire children. Moreover, it is highly incoherent. The idea of a 100-year-old fathering a child conflicts with our normal belief system. So we must weigh up the results of these tests, and then decide whether or not to take the new information into our belief system. When God speaks, we have no choice but to accept the information. But if anyone else had come along with this information, we would probably reject it, because its lack of coherence and plausibility would tip the scales. The epistemological problem lies in the weighting of the three factors.

How can one combine these factors into a practicable philosophical system?

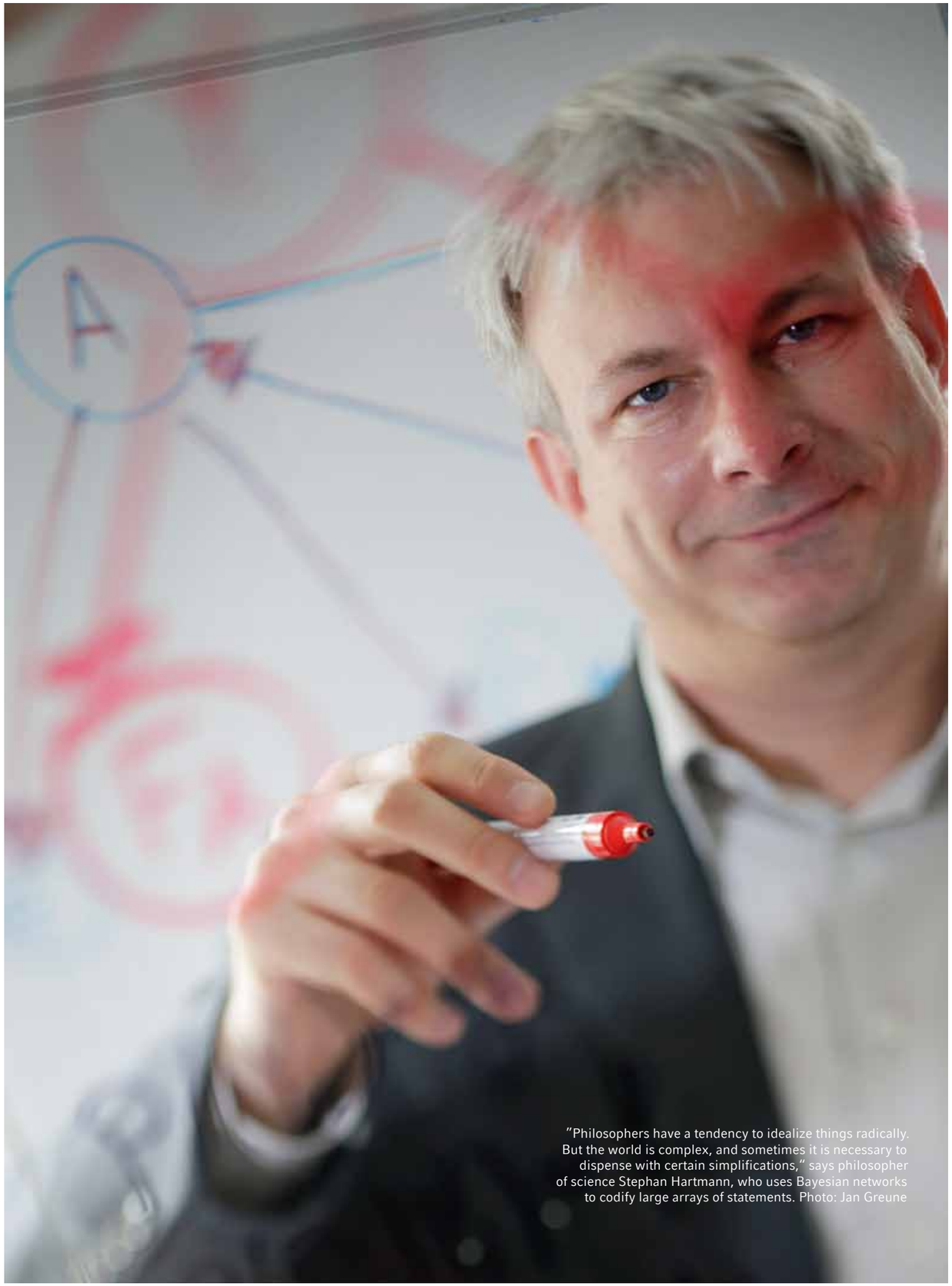
Hartmann: One possibility is to view our knowledge base as a network of statements or propositions. In addition, we have sources of our information that are more, and less, reliable. But our information must "hang together" in some sense. For example, let's say I know that Anna smokes. Then I also know that the probability that Anna has heart trouble is higher than average. Now, let's suppose I know that Anna smokes only from Bert, whom I don't regard as especially trustworthy. The question then arises, how does this affect my estimate of the probability, i.e. the relative strength of my belief, that Anna actually has heart problems? The actual probability depends on the initial, so-called prior probability but also on the reliability of my source for the information that Anna smokes. What God says has greater weight than if someone else makes the same assertion. Considerations of this sort also play a very practical role in assessments of the credibility of witnesses in court cases.

> Coherence is often a good indicator of truth

And what about coherence?

Hartmann: If new information makes sense in the context of my existing belief system, I will be more inclined to believe it than I would if it seems absurd to me. In the ideal case, the new information is positively correlated with other statements. The stronger the positive correlation between individual propositions, the more coherent my belief system becomes. This relationship can be defined in a mathematically rigorous fashion, and we and others have presented detailed proposals for this that have already been tested in psychological experiments. Such quantitative measures then allow one to answer more wide-ranging questions regarding, for example, the relationship between coherence and truth. Is a more coherent set of beliefs likely to be closer to the truth than a less coherent one? Coherence is indeed often a good indicator of truth. Let's take a bank robbery, which was observed by three witnesses. The first witness reports that the robber drove away in a Peugeot, the second mentions a French accent, and the third noticed that the robber wore Louis Vuitton shoes. That gives a clearly coherent picture. And if Pierre, Luigi and Pawel are the only suspects, the coherence of the eye-witness testimonies will greatly strengthen the suspicion that Pierre, the Frenchman, was the robber. In fact, we can analyze situations like this in detail with our formal models. This makes it possible to investigate one of the big philosophical problems, the question of when coherence is an indicator of truth, in a rigorous way (a task that would be far more difficult, if not impossible, in the absence of formal models).

You have been joint head of the Munich Center for Mathematical Philosophy (MCMP), together with your colleague Hannes Leitgeb, Professor of Logic and Philo-



"Philosophers have a tendency to idealize things radically. But the world is complex, and sometimes it is necessary to dispense with certain simplifications," says philosopher of science Stephan Hartmann, who uses Bayesian networks to codify large arrays of statements. Photo: Jan Greune

sophy of Language, since October 2012. How have your hopes for the MCMP turned out so far?

Hartmann: I had the great good luck to join a Center that had been in existence for two years and was already running smoothly. My Chair effectively doubles the Center's capacity and, in terms of content and methodology, it complements what was already there. The MCMP's objective is to apply mathematical methods to all kinds of philosophical problems, and we hope – and believe – that diverse branches of philosophy can benefit from this approach. So the more people from different philosophical and scientific backgrounds cooperate with us, the better. In addition, I think it is important to take the empirical sciences into account to a greater extent. We need the input and the motivation they can bring, and it is exciting to see what fields like physics, economics, political science, the neurosciences or psychology have to say about certain issues. We are making good headway in this area, not least because the different faculties at LMU have shown great interest in collaborating with us.

How does that actually work on an everyday basis?

Hartmann: We have a steady stream of guests at the MCMP, so discussion groups, formal and informal, play a large role. We have reading groups, on the Philosophy of Physics and on Social Epistemology for instance, where we don't just read what others have written. We always focus on a specific problem and work on it together. In one project with a physicist and a philosopher, we took up the so-called "no-alternatives argument", which string theorists like to invoke to justify their theory. As you know, string theory is a highly ambitious physical theory. Unfortunately, it is not yet experimentally testable. Nevertheless, the theory has a number of attractive features; it unifies the four fundamental physical forces, for instance. Now, attempts have been made to find alternatives that are equally powerful – so far, without success. And this failure is seen by some as a confirmation of the theory itself. After all, if there were a workable alternative, it would certainly have been found by now …

Is that a legitimate argument?

Hartmann: That's the 64,000-dollar question! We set out to define conditions in which such an argument would be acceptable. It is perfectly conceivable that it might sometimes work, but when? Related arguments are often used in everyday situations. Imagine you come into the kitchen in the morning, and the cheese you left on the table the night before is gone. Maybe there are a few scattered bits of cheese on the table, and you notice a small hole in the wainscoting. Now we don't have many hypotheses to consider. The best explanation (and in this case the only plausible one, perhaps) is that we had a night visitor – a mouse. So we conclude that our best explanation is the true one. The "no-alternatives argument" in science works in a similar way. Actually, I am particularly interested in the relationship between how we draw conclusions in everyday life and how scientific inferences work. One apparent difference is that, in everyday situations, we have only a finite number of alternative explanations to consider. In the area of theoretical science, on the other hand, there are, in principle, infinitely many possibilities. And indeed, in our formal analysis, we were able to show shown that the no-alternatives argument is acceptable only if the possibility that there are infinitely many alternatives (to string theory, in this instance) can be ruled out.

With input from case studies and experiments

So we've now got as far as Sir Arthur Conan Doyle, the creator of Sherlock Holmes: "When one has eliminated the impossible, whatever remains, however improbable, must be the truth."

Hartmann: Exactly, that's a neat analogy! If the number of possibilities is finite, then I can, in principle, check each in turn. And when there is only one left, I know it has to be the right one. However, if there are infinitely many possibilities, this procedure can't work, of course.

You and Hannes Leitgeb are both Humboldt Professors. Does this mean that the future of the MCMP is financially assured?

Hartmann: We are in the fortunate situation of getting a lot of money from the Alexander von Humboldt Foundation, for which we are grateful. Humboldt Professorships are awarded for 5 years. Hannes Leitgeb's began in October 2010, mine 2 years later. So for its first 7 years, the MCMP is exceedingly well endowed. And LMU has graciously agreed to provide generous support for the Center after that, albeit not on the same level as a Humboldt Professorship of course. In addition, we and our colleagues already submit grant applications to various foundations and other agencies. And I am pleased to say that many visiting researchers are willing to come and work with us at their own expense. I regard the terrific support we receive from the Humboldt Foundation as capital to be expanded and invested in a sustainable manner.

So you are devoting the money to the development of structures?

Hartmann: Yes. We want to create structures, recruit (and hold on to!) talented people and establish a presence in exciting fields. The goal is to discover how far our mathematical approach can take us, and perhaps get an idea of where its limits lie. There are

Fulfillment of the prophecy is followed by God's demand that the aged Abraham sacrifice his young son Isaac. An angel stays his hand (as depicted by Rembrandt). Photo: akg/Lessing

certainly plenty of challenging problems to work on. They are all around us, so to speak, and we want to explore new areas, such as the philosophy of mind and the field of formal ethics. So it is important to have close contacts with people who have a background in these disciplines. And that happens in the Munich Center for Neurosciences (MCN), in which Hannes Leitgeb and I are actively involved, and in our exchanges with members of other units in the Faculty of Philosophy, in particular Professor Nida-Rümelin's group. In addition, we have started a long-term project with the physicists, in which many physics students participate. In order to extend our own range of technical competence, we will soon be recruiting a programmer as well as a psychologist who will carry out experiments in cognitive science. This will further underline the interdisciplinary nature of the MCMP.

You are also exploring new ways of reaching a wider audience for your lectures and talks. Does the future of teaching in Germany lie in media technology?

Hartmann: I think so, yes. We now offer a course on the open online platform Coursera. Coursera is accessible worldwide, and LMU is the first German university to take part in it. We have also set up an iTunes Library, which is very popular; we use Facebook and we run a blog (m-phi). That helps us to arouse interest in our work and our area of study, and extends our international reach and network of contacts. Naturally, our primary concern is to do excellent research and publish it in the best journals. But we also want to show scholars who do not have the opportunity to visit in person what is going on here. And now a few mouse clicks on iTunes is all it takes.

You are a philosopher and a physicist. Why do you now work in philosophy rather than physics?

Hartmann: I originally wanted to be a physicist or a mathematician, and physics and

mathematics were the only subjects that really interested me. However, towards the end of my time in school, I had a teacher of religion, Frau Schmidt, who used to say that my interests were much too narrow: "You don't want to be a nerd, do you? There's so much more than just physics and mathematics." I can't say I really believe her, but I began to dabble in philosophy on the side. Then, in Gießen, I had the chance to study physics in conjunction with philosophy, and I grabbed it. Later on, for my graduate thesis in physics, I worked on theoretical models of nucleons, the basic constituents of atomic nuclei. This then led me to the

»Excellent algorithms, elegant tools«

problems that became the subject of my doctoral dissertation in philosophy. I wanted to know, for instance, how one can assess the status of such idealized models, and how they actually relate to the underlying theory? I enjoyed that so much that I decided to stick with philosophy. When I finished my doctoral degree, Luc Bovens in Konstanz got me interested in Bayesianism. This was a different world, at some remove from pure science, with greater focus on everyday examples and much more scope for philosophical intuition. Now I try to combine different approaches. On the one hand, I am interested in empirical input from case studies and, for example, from psychological experiments. On the other, I want to tackle more general philosophical questions and, for example, establish normative standards of reasoning.

Can you tell us more about those Bayesian networks?

Hartmann: A Bayesian network is made up of nodes, which represent statements, and arrows that connect them. The arrows depict probabilistic dependencies and independencies between the different propositions. Such a network allows one to visualize and manipulate a probability distribution over a large number of variables. There are excellent algorithms for this, which are very popular, especially in the artificial intelligence community. Bayesian networks are of particular interest to philosophers because they enable one to handle the more complex types of philosophical problems in a mathematically elegant way. Philosophers often tend to idealize things very strongly. They like to keep things simple. But the world is complex, and sometimes it is important to be able to dispense with certain simplifications. And Bayesian networks provide an elegant way of representing large collections of statements. And the theory of Bayesian networks supplies further tools with which one can develop things like the measures of coherence I mentioned earlier.

We now find ourselves in a postindustrial society, and efforts are underway to formalize work processes so as to delegate them to machines. We invent the processes and the formalized contexts and let the machines do the rest. Are you in the business of providing the philosophical underpinnings for this highly formalized society of toolmakers?

Hartmann: No, I wouldn't say that. We take advantage of automation, but in principle we could still do everything the hard way. It would just take longer. Instead, I dip into the box of tricks that the industrialized world has given us, which contains tools like Bayesian networks and computer simulations. Our research always starts with a concrete philosophical problem, which we first formulate in a precise and mathematically tractable way. This process turns it into a mathematical problem, which can then be solved with the aid of a computer, for example. Finally, we interpret the solution and ask what it means in the context of the original philosophical problem. We employ a pragmatic instrumentalist approach. We are freeloaders, if you like, poachers on scientific and technological advances that others have made – but I have no problem with that.

You once described the dilemma of mathematical philosophy in the following terms: On the one hand, we have the analytical graphs of mathematics, on the other the grand philosophical narratives. What we must work on are the cases in between. A philosophy of the spaces in between – is that what interests you? And, if so, does this mean that you have given up on the classical issues in philosophy, the foundational questions, the problem of meaning, the nature of the good life?

Hartmann: These questions are certainly not at the very top of our agenda. Nevertheless, they remain at the back of our minds and they motivate us, but I personally have little to say about them at present. On the other hand, there is a huge array of problems that are also of philosophical interest,

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is Professor of Philosophy of Science and joint head of the Munich Center for Mathematical Philosophy (MCMP). Born in 1968, Hartmann studied Philosophy and Physics in Gießen, and obtained a doctorate in Philosophy. In the years 2002-2005 he led a research group "Philosophy, Probability and Modeling" at the University of Konstanz and from 2004 until 2006 he directed the Centre for Philosophy of Natural and Social Science at the London School of Economics and Political Science (LSE). He has held professorships at the LSE and at Tilburg University in the Netherlands, where he served as Founding Director of the Tilburg Center for Logic and Philosophy of Science. In 2012 he obtained one of the prestigious Alexander von Humboldt-Professorships awarded by the Humboldt Foundation.

"Often one doesn't need deep mathematical concepts to solve intriguing philosophical problems," says Stephan Hartmann. Photos: Greune

and with which, to my mind, a great deal can be done. This is the area that I want to explore. Very often, it is a good idea to leave certain problems aside for a while, and return to them when the time is ripe

How do students react to that? After all, most of those who are interested in philosophy do not have much of a background in mathematics or physics. Can they follow where you lead?

Hartmann: Luckily enough, it frequently turns out that one doesn't need really deep mathematical concepts to solve an intriguing philosophical problem and make real progress. Very often, simple methods and a little sixth-form mathematics are enough. This is the message that we try to get across in our online lecture series "An Introduction to Mathematical Philosophy" on Coursera. And Hannes Leitgeb and I take great interest in our first-year students, which is why he regularly gives the introductory course in logic and I give the corresponding lectures in philosophy of science. We realize of course that most people in the first-year class in Philosophy are not thinking primarily of mathematical philosophy, and that's perfectly OK. But maybe there are a few who, like me, succumb to the fascination of the subject. At all events, we hope that our students soon learn to share our own enthusiasm for mathematical philosophy.