Book of Abstracts

AQP2016 Conference

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Toni Acín

What can and cannot be said about randomness using quantum physics

It is usually said that quantum physics is, contrary to classical physics, intrinsically random. The intrinsic randomness of quantum physics follows from the fact that it is possible to observe correlations among quantum particles for which there exists no classical and deterministic model. The observation of these correlations, however, requires some assumptions about the setup. In particular, it requires some initial randomness, which makes the whole argument apparently circular.

We discuss how it is possible to relax this circularity and conclude that an intrinsic form of randomness with no classical analogue does exist in the quantum world.

Hans Briegel and Thomas Müller

Introduction to the Conference

In our joint introduction, we will map out the current debate about agency and quantum physics as we view it from the perspective of the joint project that is hosting the AQP2016 conference.

We start by describing the tension that arises in an attempt to understand real agency — the agency of us human beings, but also of other species of animals and perhaps of certain (future) artefacts — within the world that we understand to an ever increasing level of detail through physics and the other sciences.

We show how this tension relates to the dialectics of the philosophical free will debate, arguing that there is far too little work on the crucially important question of how, in detail, agency could be a feature of a thoroughly indeterministic world. After all, quantum physics tells us that our world is indeterministic, so that in order to dispel worries that agency, or human freedom, might just

be an illusion, we need to understand how it could be that, based on what the world is like, agency can get a foothold here.

A core idea behind our work is that as for physics, so for this philosophical issue, building detailed formal models is illuminating. In our project, we research a novel class of models called "projective simulation". In projective simulation, an environmental stimulus is fed into an associative stochastic network of episodic memory clips and couples out to motor action after a random walk through the space of clips. Projective simulation is, therefore, a fundamentally indeterministic process. We argue that this process, if suitably complex, can exhibit real agency, thereby providing a "how possibly" explanation for the existence of agency in our world. We will describe several aspects of current research on projective simulation, including different learning and deliberation schemes for classical and quantized versions of the model. We also illustrate some of the current and future applications of projective simulation.

In the last part of our introduction, we discuss the relation of our work to recent advances in the debate about quantum foundations, which have seen a surge of interest in the role of agency for understanding that enormously successful physical theory. We focus on Quantum Bayesianism (QBism), which is based on the notion of an agent updating her subjective expectations in interaction with her quantum environment. We discuss the question of how an agent that is itself described as a physical system can find a home in a QBist view of the world.

Andrew Briggs

The Unreasonable Effectiveness of Curiosity

Time and again advances in what we would now describe as science have taken place in a culture or community that is interested in questions which lie beyond the rim of the material world. So far from being opposed to progress in rigorous science, questions about agency may actually promote it. In considering agency as it relates to human responsibility, we need first to address the vast gulf between the exquisitely tested quantum theory of the physics laboratory and the very classical experience of our everyday us-sized lives. At the interface between philosophy and experiment, progress has been made in: (i) tests of the Leggett-Garg inequality; (ii) quantum interference within increasingly complex molecules; (iii) investigation of continuous spontaneous collapse. The pure curiosity which stimulated these investigations may lead to advances both in understanding agency and in practical technologies. Eugene Wigner described the miracle of the effectiveness of mathematics as a wonderful gift which we neither understand nor deserve. The same could be said of curiosity.

Jan Broersen

A stit-logic approach to agency, power and opportunity in Newtonian time and space

We extend stit logic by adding a spatial dimension. This enables us to distinguish between powers and opportunities of agents. Powers are agent-specific and do not depend on an agent's location. Opportunities do depend on locations, and are the same for every agent. The central idea is to define the real possibility to see to the truth of a condition in space and time as the combination of the power and the opportunity to do so. The focus on agent-relative powers and space-relative opportunities firmly roots effectivity of an autonomous choice making agent in a space-time picture. Our space-time view will be classically Newtonian, since we will assume relativistic phenomena do not play a role in agentive effectivity. We show how our semantics naturally distinguishes between different kinds of histories; histories that reflect real (factual) possibilities and histories that reflect counterfactual possibilities (of a particular hypothetical kind). Furthermore, we discuss how the spatial picture sheds light on conceptual problems plaguing the central stit property of 'independence of agency'. At several points in the paper we will emphasise and defend the differences with Belnap's theory of agency in relativistic branching space-times.

Vedran Dunjko

Quantum artificial intelligence

Artificial intelligence is the study of artificial yet intelligent agents - machines which are flexible, rational, perceive their environment, and take actions that maximize their chances of success. Despite the technological breakthroughs of the last few decades, the dream of human-level, general purpose intelligence is still far out of hand, and the majority of active research of the field has more sober goals. Can the more powerful architecture of quantum computers offer a quantum leap for intelligent agents? I will talk about the basic trends in the emerging field of quantum artificial intelligence, and, more specifically, in the field of quantum machine learning. I will present results which, for the first time, show quantum improvements in reinforcement learning — a learning scenario which forms a bridge between standard machine learning settings, and full blown artificial intelligence. In doing so, we broach the fundamental question of what "to learn" can even mean in a fully quantum-mechanical description of the world.

Chris Fuchs

QBism and Danny Greenberger's Big Red Button

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Nicolas Gisin

Free Will comes first

I shall argue that when thinking about human agents, free will comes first in the logical order. Indeed, without free will there is no way to make sense of anything, there would be no rational thinking, no explanatory power and no experimental science: how could one decide what and when to test our theories? More generally, without free will, how could one decide which arguments to trust and which ones to reject? To paraphrase Rabelais, "science without free will is but the ruin of intelligibility".

Contrary to some beliefs this is not in contradiction with physics, neither quantum nor classical which both are non-deterministic. Both involves some (poorly understood) creative time. Indeed, I shall argue that the mathematically real numbers, although highly efficient in physics theories, are not physically real; hence Newtonian mechanics is not deterministic (except in some boring situations like the harmonic oscillator and the two-body gravitational problem). I'll also argue that quantum physics involves three kinds of probabilities, one being "true randomness", i.e. non necessary dynamical events. Finally, I'll argue that today's science is far from final; hence one shouldn't be surprised that one can't "close the circle". In particular physics has to find a way to go beyond "time as a mere evolution parameter" and something like a "science of signs that make sense" remains to be invented.

Pim Haselager

The senses of agency: processes, distortions and implementations

How do I make a distinction between something I do and something that happens to me? According to recent research in cognitive psychology and neuroscience two different types of processes are involved: a process of comparing efferent motor copies with reafferent perceptual inputs, and a process of self-interpretation regarding the contiguity between intention and action. I will briefly review both processes, and examine their vulnerability to distortions. Finally, I will investigate the various issues involved in the attempt to implement both processes in robots.

Robert Kane

The Complex Tapestry of Free Will Revisited: Control, Freedom and Will

My presentation will begin with a sketch of the history of my engagement with the age-old philosophical problem of free will, an engagement that is now nearly

50 years in duration. My goal from the beginning was to shed light on how one might make sense of a traditional free will that was incompatible with determinism (a libertarian free will, as it is called) in the light of modern science. This meant answering objections prevalent since ancient times that such a free will, involving indeterminism, was unintelligible and would amount to mere chance or luck or mystery. It also meant avoiding all traditional appeals to unusual forms of agency or causation (uncaused causes, noumenal selves outside space and time, non-event agent causes, prime movers unmoved, etc.) that could not be accounted for by ordinary modes of explanation familiar to the natural and human sciences. I came to realize early on that there could be no simple solution to this problem. A solution, if any was possible at all, I came to believe, would require piecing together a "complex tapestry" of ideas and arguments that involved rethinking many traditional assumptions about free will and a host of related notions including agency, choice, control, self-formation, will-setting and others. In the remainder of the paper, I sketch out some of the basic features of this complex tapestry developed in the intervening decades and answer objections to it. In the process, I show how indeterminism might be involved in exercises of free will without reducing it to mere chance or luck or mystery. Whether the indeterminism is in fact involved in appropriate ways and in appropriate places is an empirical and scientific question that cannot be settled by a priori reasoning. But I believe it remains an "open" scientific question and consider how contemporary developments in the sciences might bear upon it.

Erasmus Mayr

Doing nothing: Responsibility for omissions

Responsibility for 'pure' omissions poses a traditional problem for theories which tie moral responsibility to specific mental states of the agent, such as decisions or intentions. For in cases of 'pure' omissions, these mental states are either absent or, at least, do not seem to have the right kind of 'blameworthy' content to provide an appropriate basis for moral criticism. But also 'quality of will' accounts of responsibility, which follow Peter Strawson in rejecting a decision or intention requirement for responsibility, have difficulties in dealing with these cases, since the absence of intentions which express goodwill or respect to others does not necessarily indicate a morally objectionable fault. In my paper, I will argue that we have to look more deeply into the specific import of moral criticism and blame in order to develop a proper understanding of why and when 'pure' omissions are subject to it.

Kasia Paprzycka

Actions, Omissions, Events: In Defense of Externalism

The old action individuation debate spans two orthogonal dimensions: the debate on the nature of events (central to the debate between minimalism and maximalism) and the debate on the boundaries of agency (central to the debate between minimalism and moderationism). The former debate is of lesser interest to action theorists and accounts for much of the sense of futility in those discussions. The latter, however, is central to action theory – internalists argue that actions are (or are causes of) bodily movements, externalists think that actions reach out far beyond the limits of the agent's body. Externalism has been recently revived and defended by some agent causality theories (e.g. Alvarez, Hyman). I propose a new argument for externalism. I show that contrary to what is frequently thought, an internalist interpretation cannot express all that an externalist interpretation of action sentences can. Moreover, the latter is closer to our intuitive judgments. I also suggest that adopting an externalist perspective can help in other areas, in particular in making sense of the causal role of omissions.

Justus Piater

From Machine Learning to Agency

Machine Learning has made remarkable progress over the past two decades, both in our theoretical understanding and in its practical applicability. Artificial Intelligence, until recently understood as failed ambitions that overpromised and underdelivered, has become a fashionable term that conveys promises or threats, depending on the perspective. What are the current capabilities and limits of machine learning? Are we directly headed for autonomous artificial agents whose intelligence rivals that of humans? What are the remaining obstacles, if any? What are the promises and dangers? To what extent are artificial human-like agents desirable? Starting from our research in robot learning, I will explore such questions around agency from a machine-learning perspective.

Huw Price

The Parisian Zigzag – Is Science Safe?

Responding to the EPR argument, O. Costa de Beauregard (1953) proposed that the quantum world might allow spacelike causal influence, without action at a distance, so long as the influence takes a zigzag path, via the intersecting past lightcones of the events in question. This suggestion is related to what has come to be called the retrocausal loophole in Bell's Theorem, but – like that loophole – it receives little attention, and remains poorly understood. In this talk I

present a new argument for Costa de Beauregard's zigzag, discuss its relation to the motivation stemming from EPR and Bell, and respond to the objection that it would require abandoning assumptions essential to science. I show that this objection rests on a confusion between retrocausality and superdeterminism.

Verena Wagner

Philosophical Debates on Agency

In philosophy there are different debates for which the term "agency" is relevant. Apart from discussions within action theory itself, questions concerning agency come up in the context of moral responsibility, metaphysical implications of (in)determinism and the discussion about personhood. When we ask what qualifies as an action in contrast to mere behaviour and who qualifies as an agent, we may get very different answers depending on the respective debate that lurks in the background. In this talk, I aim at addressing some of the different aspects of agency and I will argue that we need to separate these more strictly in order to arrive at unbiased answers.