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zur Erforschung von Folgen wissenschaftlich-technischer Entwicklungen
Bad Neuenahr-Ahrweiler GmbH
Direktor: Professor Dr. Dr. h. c. Carl Friedrich Gethmann

NEWSLETTER

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EDITORIAL

■ The "Graue Reihe" is produced and published by the Europäische Akademie GmbH and is a platform for shorter texts and anthologies by members of project groups, staff members or external scientists. It includes text material on current topics in Technology Assessment and Ethics of Science scientists at the Europäische Akademie GmbH and from outside continuously work on.

Unlike the book series "Ethics of Science and Technology Assessment" (Springer Verlag) the Graue Reihe publishes texts on ideas and reflections which sometimes are smaller products of the long-term research projects of the academy. These texts often are results of discussions within the working groups which go beyond the project's focus or which do not quite follow the direction of the project. Thus, the Europäische Akademie always welcomes this opportunity to publish such ideas.

The latest numbers of the Graue Reihe are:

- F. Breyer, M. Engelhard (eds.), Anreize zur Organspende (No 39, 11/06), about the German situation of organ donation. This text is the result of further themes discussed by the project group "Incentives for Organ Donation".
- C. F. Gethmann, N. Rohner, K.-U. Schrogl (eds.), Die Zukunft der Raumfahrt. Ihr Nutzen und ihr Wert (No 40, 1/07), about the future of (manned) space travel. This volume contains the lectures held at the academy´s conference in 2006.
- M. Decker, Angewandte interdisziplinäre Forschung in der Technikfolgenabschätzung (No 41, 1/07), about the concept of interdisciplinary working groups in Technology Assessment with examples of the work of the Europäische Akademie GmbH.

KM/FW

The Newsletter will report regularly on the latest publications of the Graue Reihe. For further information: www.ea-aw.de

FOCUS

Bounded Rationality

A short synthesis of a programme with possible consequences for the discussions on sustainability in schools

Laura Martignon

Humans make inferences about their world with limited time, knowledge, and computational power. In contrast, many traditional models of rational inference have viewed the mind as if it were capable of retrieving boundless knowledge with near to infinite time for making decisions. Such visions of rationality often conflict with reality. But we can use them as points of comparison to help clarify the modern vision of bounded rationality which is conditioned by its fit with reality. We start by considering two conceptual revolutions. The first one is the demise of the dream of certainty and the rise of a calculus of uncertainty, that is probability theory. This revolution is known as the probabilistic revolution in science and everyday life (Daston 1988). The second revolution concerns the way minds deal with an uncertain world. We propose replacing the image of a mind computing intricate probabilities and utilities with that of a bounded mind reaching into an adaptive toolbox.

■ Let us briefly sketch the first revolution, as it concerns our views about mind and rationality. For two millennia, following Aristotle, the Western intellectual tradition has distinguished between two kinds of knowledge. One was demonstrative proof, the other probable reasoning. The first one provided certainty, while the second one produced only uncertain knowledge. During the Reformation and the Counter-Reformation of the sixteenth century, traditional sources of certainty – particularly religion and philosophy – came under attack simultaneously. As a result, the domain of demonstrative proof shrivelled, while that of probable reasoning grew (Daston 1988). By the mid-seventeenth century, a new pragmatic rationality emerged that abandoned traditional ideals of certainty. It was a modest view, expressed by the calculus of probability invented during the same period. The modesty of this vision stemmed from an acceptance that humble humans can attain only uncertain knowledge about themselves and their world. To be rational was therefore conditioned on taming life's uncertainty. Blaise Pascal's famous wager (1669/1962) illustrates some moral consequences of this new rationality. In an atmosphere of unwavering religious certainty that God had to exist, Pascal asked: Is it rational to believe in him? Pascal proposed that one should sacrifice worldly pleasures to enhance one's uncertain prospect of salvation, because no matter how small the probability of God's existence, the payoff of living a Christian life is eternal

afterlife, and the expected reward – the (perhaps small) probability of salvation multiplied by its infinite value – is still infinite. The other alternative – eternal damnation – is infinitely awful, no matter what its probability.

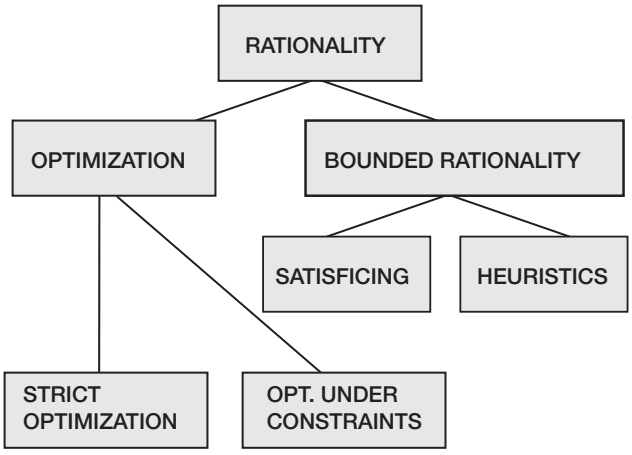
Pascal's wager marks a deep, irreversible change within the trinity of *Ratio-Intellectus-Fides* that had sustained as a column of the philosophical edifices of Western tradition. Pascal was a deeply religious man and yet, his Ratio had gone beyond Fides and dared to "bet" to resolve a "holy" argument. The new rationality expressed by the calculus of probability was not just an intellectual revolution of thought, but also one of moral and religious attitudes.

The probabilistic revolution has shaped our picture of the mind in fields ranging from cognitive science to economics to animal behaviour. Mental functions are assumed to be computations performed on probabilities and utilities. The moment one moves beyond simple constrained settings – such as those psychologists and computer scientists study – in respect of real-world situations that people actually live through, the time, knowledge, and computation that probabilistic models demand, grow unfeasibly large. As a consequence, when these models meet the rigours of reality, they turn into a psychology more applicable to supernatural beings than to mere humans. The premise of Herbert Simon who introduced the term bounded rationality is that much of human reasoning and decision making can be modelled by relatively simple rules which do not involve much computation and do not compute utilities. This theoretical upheaval embraces the earlier probabilistic revolution's emphasis on uncertainty without sharing its focus on probability theory, either as a description or as an attainable norm of human behaviour. The four major visions of rationality that continue to struggle with each other in this second upheaval are shown in the figure below.

Optimization and *Optimization under Constraints* are two forms of Optimization. Both assume that a rational mind will consistently choose to maximize some sort of expected utility which is computed by means of an extension of the calculus of probability that takes into account not just the probabilities of outcomes but also the so called subjective utilities these outcomes may have for each subject. In the case of Optimization under Constraints it has been the effort of important branches of decision analysis to come up with more realistic conditions for decisions under uncertainty. These more realistic conditions set up boundaries to the possible values of certain utilities. Let us think for a moment – and for the scope of illustration – of Charles Darwin's famous struggle which he diligently documented, between the two alternatives "marry" and "not marry".

Darwin had divided a sheet of paper in two columns and had written all the consequences of marrying in the first column: "Children (if it please God), constant companion, object to be beloved and played with, forced to visit and receive, relations but terrible loss of time".

Later, when he started writing down the consequences of not marrying, he came to the conclusion that: "It is intolerable to think of spending one whole life, like a neuter bee, working, working, and nothing after all. – No, won't do. Imagine living all one's day solitarily in smoky dirty London's House. Only picture to yourself a nice soft wife on a sofa with good fire, and books and music perhaps…" (Darwin 1887/1969:232–233). All these struggles ended soon thereafter, when he fell in love with his cousin Emma Wedgwood. He eventually concluded his struggle by writing the words "Marry, marry, marry: there is many a happy slave".



Imagine that Darwin had attempted to resolve his question by maximizing his expected utility. He would have had to attach probabilities to outcomes and multiply them by their utility. If he then had considered many candidates for marrying, he would have had enormous computational costs. Adding constraints to his optimization would have set boundaries to the considered intervals, say, he would only have considered women between 20 and 25 years of age. In other words, constraining his optimization would have just added work. Yet, luckily for Darwin, emotions took over and cut off the need for further deliberation.

Herbert Simon vehemently rejected the reduction of his invention, bounded rationality, to optimization under constraints. He even explicitly wrote "bounded rationality is not the study of optimization in relation to task environments" (Simon 1991:35). Simon's vision of bounded rationality has two interlocking components: the limitations of the human mind on the one hand, and the structure of the environment in which the mind operates on the other. The first component of his vision embodies that models of human decision making should be based on what we actually know about the mind's function. One form of bounded rationality is therefore *satisficing*, a word that originated in Scotland, and means finding a *good enough* way out. Humans do not optimize – claimed Simon –, they satisfice. But what are the strategies they use in everyday life to achieve satisficing levels? Reinhard Selten and his research group created mathematical theories that explain how satisficing can be carried out effectively (Selten 1996). Herbert Simon himself had also postulated first rules for satisficing.

One way of achieving bounded rationality is by means of heuristics. The theory of simple heuristics of the mind pictures the mind as an adaptive toolbox composed of simple tools which can be more or less organized in modules (there is an important ongoing debate on the modularity of the adaptive toolbox). Some heuristics are exceedingly simple, as the imitation heuristic which recommends you to always imitate others in rejecting, for instance, food that you do not know. Humans are much less obedient to this heuristic than animals, but by and large humans are good imitators. Decision heuristics can involve more than one step and have been studied extensively

by Gigerenzer and the ABC Research Group (1999).
Take The Best, the prototype of simple heuristics studied by the ABC Group, is a lexicographic heuristic. It orders cues or pieces of information automatically and looks at one by one, stopping the first time the corresponding cue discriminates between alternatives. This procedure makes it fast and frugal, in the sense that it actually uses little of the information stored.
That even emotions are amenable to be treated as heuristics seems an intrepid step, yet all neuroscientific discoveries of the last decades based on the analysis of the interlocking between older parts of the brain and the cortex coincide in pointing to the enormous importance of emotions for decision making. Damasio, Damasio & Christen (1996) have consistently reported, for instance (2002), that impairments of certain regions of the limbic system turn decision making impossible. These findings have motivated the effort to model emotions as heuristics that reduce the search space for decisions. Think of Darwin who confessed that an "emotion stronger than myself" had led him to stop search and become completely sure that marrying is better than not marrying.
Emotions help decision making by eliminating cost-benefit computations: think of a parent who is awakened by his or her baby's cry. Rather than computing the costs of getting up, running to check what is wrong with the child, etc., the mother or father feels the compelling emotion of parental love and gets up.
It seems, at first sight, that decisions about the preservation of ecological resources should be made within a classical that is an unbounded rationality framework. It is clear that institutions model decisions by means of strict cost-benefit analyses, even in the delicate context of sustainability. Nonetheless, a flurry of work on risk assessment shows that individual decision making remains boundedly rational when making decisions concerning risks (Gigerenzer 2004).
The decisions of individuals who grow up sensing the fear of catastrophe that emerges from reports on threatening world phenomena, trigger heuristics and emotions which go beyond any rational analysis (Gigerenzer 2004).
Evolution has endowed us with a very definite fear of catastrophes which are events with a relatively small probability but with immense disruptive consequences for the whole species. Estimating the actual risks that make catastrophes more or less probable is a complex task. But the more the fear becomes real, the more we see (Martignon 2007), the young are eager to learn and set their potential free for being of help and for collaborating to reduce the impact of catastrophes. They are willing to be guided, if only ways are shown to them that seem amenable and plausible.
Evolution is wiser than mere rationality in the end, and this is – in every sense – a message of hope.

Professor Dr. rer. nat. Laura Martignon is member of the project group "Responsibility for Future Generations. Implementation of Sustainability in Schooling" of the Europäische Akademie GmbH. She is professor for Mathematics and Mathematics Education with a focus on gender differences at the Institut für Mathematik und Informatik, Pädagogische Hochschule Ludwigsburg.
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WORKING GROUPS

PROJECT ACTIVITIES

■ Project Group **"Potentials and Risks of Psychopharmaceutical Enhancement":** 7.2.2007 in Berlin

■ Project Group **"Fuel Cells and Virtual Power Plants as Elements for a Sustainable Development Innovation Barriers and Implementation Strategies":** 22./23.1.2007 in Bad Neuenahr-Ahrweiler

SPOTLIGHT

Fuel Cells and Virtual Power Plants

■ The project group held its first feedback meeting on 22nd and 23rd January 2007 at the Europäische Akademie GmbH in Bad Neuenahr-Ahrweiler. External experts from science and practice had been invited to comment the working programme of the group. Furthermore, it was intended to get a survey of

- the current development status of fuel cells,
- the costs, market analysis, and market potential,
- the economic, legal, and political barriers in Germany,
- the chances of the fuel cells compared to concurring technologies, and
- the strategies in the direction of a virtual power plant.

The project group and the Europäische Akademie GmbH thank the participants for their fruitful contributions and comments: Dr.-Ing. Martin Rumberg (Stadtplanung, Universität Kaiserslautern) brought in specific aspects from the perspective of town planning; Rüdiger Barth, Dipl.-Ing., (IER, Universität Stuttgart) talked about the operation of power plants and electricity grid in the case of distributed generation; Alexander Dauensteiner, Dipl.-Ing., (Vaillant GmbH) and Dr. Jürgen Pawlik (Viessmann Werke GmbH & Co KG) gave insights into the current development status of fuel cell heating devices in Germany and Gesine Arends, Dipl.-Ing., (Robert Bosch GmbH) contributed to the discussion; Martin Hopfer, Dipl.-Ing., (E.ON Energie AG) and Dr. Oliver Franz (RWE Energy AG) commented on the working programme from the point of energy economics; Dr. rer. nat. Heinz Wenzl (IEE, TU Clausthal) gave insights into the management of the virtual power plant installed in the Harz region; Sabine Frenzel, Ass. jur., (Bundesnetzagentur) presented aspects of regulation and management of grids related to the focus of the project, and Dr. Michael Brand (IZES gGmbH) presented results from a recently published study on the analysis and evaluation of instruments for the market introduction of stationary fuel cells, worked out for the German Federal Ministry of Economics and Technology (BMWi). Moreover, they thank Professor Dr. jur. Dr. rer. pol. Peter Salje and Professor Dr. rer. pol. Rudi Kurz who sent written comments about the working programme.
The experts approved the direction of the working programme. The various additional aspects risen and information given in the presentations and discussions will now be proved regarding their relevance and considered for the further work of the project group.

NEWS

Scientific Advisory Board

■ On 18th January 2007 the academy's Scientific Advisory Board held its 24th meeting in Bad Neuenahr-Ahrweiler. The Board released the project report "Intervening in the Psyche" for publication and discussed proposals for future projects.

Intergovernmental Panel on Climate Change (IPCC)

■ From 29th January to 1st February the Intergovernmental Panel on Climate Change (IPCC) approved its recent report on the "Physical basis of climate change" for presentation to the public. In the course of IPCC's 4th assessment, this report will be followed this year by complementary reports on "Impacts, adaptation and vulnerability" and on

„Mitigation of climate change“. Dr. rer. nat. Stephan Lingner served as expert reviewer for selected chapters of all three volumes. Lingner coordinated the academy's project group “Climate Prediction and Climate Precaution” (published 2002 at Springer Verlag).

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State Secretary Klär visited Europäische Akademie GmbH

■ On 2nd February 2007 Dr. phil. Karl-Heinz Klär, State Secretary and Representative of the State of Rhineland-Palatinate to the Federal Government and for Europe (German Social Democratic Party) visited the academy. He had been invited by Professor Dr. Dr. h.c. Carl Friedrich Gethmann, who informed Klär about aims and tasks of the academy. Furthermore, two projects of the Europäische Akademie GmbH were presented: Dr.-Ing. Bert Droste-Franke, Dipl.-Phys., (project coordinator) spoke about “Fuel Cells and Virtual Power Plants as Elements for a Sustainable Development. Innovation Barriers and Implementation Strategies”. Fuel cell systems are effective high-technological energy conversion systems. The aim of the project is to identify factors which interfere with the introduction and implementation of the technology on the market and to develop strategies to change these with adequate effort and consequences.
Dr. phil. Margret Engelhard, Dipl.-Biol., (project coordinator) focused on the project “Incentives for Organ Donation”. This project was finished in May 2006 and examined diverse causes of the scarcity of organs and explored ways to alleviate this problem. It therefore addresses scientists, affected persons, health professionals, politicians and the interested public. The study was published at Springer: “Organmangel – Ist der Tod auf der Warteliste unvermeidbar?”.
Klär showed great interest in the work of the academy and promised to use his influence for book presentations etc. to be carried out in the representation of the State of Rhineland-Palatinate both in Bruxelles and in Berlin.

CONFERENCES

Spring Conference

■ This year's spring conference “Digitales Publizieren in den Geisteswissenschaften” (Digital Publishing and the Humanities) from 30th to 31st March 2007 is part of the German “Jahr der Geisteswissenschaften” (Year of the Humanities). According to the organisers the main focus of the 8th German Science Year will be on language as a tool in thinking and communications. The conference will discuss the changing conditions for the communication of the humanities itself. Applications for participations may by submitted to the Europäische Akademie GmbH.

Further information:
www.ea-aw.de or www.abc-der-menschheit.de

LECTURES

Felix Thiele
30.11.2006

■ Autonomie, Selbsttötung und psychische Krankheiten:
Fachgespräch Assistierter Suizid, Bad Neuenahr-Ahrweiler, 30.11.–1.12.2006

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PERSONALITIES

Ulrich Büdenbender, born in Siegen in 1948, holds the Chair of Civil, Energy and Labour Law at the Universität Dresden (Bürgerliches Recht, Arbeitsrecht und Energiewirtschaftsrecht). After his first state examination in 1971 he was Academic Assistant at the Institute of Civil Law at the Universität Bonn, from which he gained his Ph.D. After the second state examination (1975) he worked for the RWE Group, first as an in-house counsel (Justitiar), later on as human resource manager and from 1991 to 1998 as a member of the board of RWE AG.
During this time, he still pursued his academic work and lectured at the universities of Duisburg, Essen and Cologne. His habilitation at the Universität zu Köln (1995) dealt with the cartel control in the energy sector. In 1998, he became full professor at the Universität Dresden while keeping his honorary professorship at the Universität Essen.
The key aspects of his research include antitrust law, energy law, the reform of the law of obligation and collective labour law, with (special) emphasis on the economic questions involved. His research in energy law focuses on the legislative reform process, which he promoted with expertises and comments on the legislative procedure. His academic work comprises various commentaries, essays and numerous other publications.

Professor Dr. Ulrich Büdenbender is a member of the academy´s current project group “Societal Implications of Electrical Power Grids”.