

more complex structure than the Dictator Game, what could we say concerning our original question?

Bottom line: if we want to be able to sensibly state that a DM is rational, shouldn't we always divide an experiment from which we want to eventually draw conclusions on the rationality of the subjects in two stages? In stage 1 subjects' preferences should be elicited (in an incentive-compatible way) via their choices on all the possible subsets of the possible outcomes of the game that they have to play in stage 2, and only in stage 2 their actual choices in the game should be recorded and evaluated (along with their rationality... with the caveat that maybe it could not be possible to evaluate it, since stage 1 could show that some subjects' preferences simply cannot be represented via a utility function).

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## A type of simulation which some experimental evidence suggests we don't live in

Do we live in a computer simulation? I will present an argument that the results of a certain experiment constitute empirical evidence that we do not live in, at least, one type of simulation. The type of simulation ruled out is very specific. Perhaps that is the price one must pay to make any kind of Popperian progress.

In electronics, a *soft error* is a type of error caused by a particle hitting a computer's memory banks. Early computer chips were manufactured with materials that emitted alpha particles due to radioactive decay. These alpha particles could hit memory cells and change memory values. The same phenomenon can happen if a cosmic ray hits the computer.

Suppose we live in a computer simulation with the following  $x\text{-}\hat{x}$  property: for each memory-bit  $x$  in any computer in our world, there is a memory-bit  $\hat{x}$  in the simulating computer such that  $\hat{x}$  is used to store which value is stored in  $x$ . Then any such  $x$  is subject to two different types of soft errors:

- (Internal) Soft errors caused by simulated particles hitting  $x$  in our simulated universe.
- (External) Soft errors caused by real particles hitting  $\hat{x}$  in the universe where the simulation takes place.

Further, assume the following *uni-directional property*: putting a simulated memory-bit inside a simulated vault does not protect it from external soft errors. We mean "vault" literally: a non-metaphorical barrier of hard matter in the simulated universe.

Putting a simulated memory-bit in a simulated vault might protect it from internal soft errors, because a thick vault might physically block incoming particles. The uni-directional property says this defense cannot prevent external soft errors. If we live in an external-soft-error-prone simulation with the  $x\text{-}\hat{x}$  property and the uni-directional property, no vault we build can perfectly protect a memory-bank from all soft errors, because each memory-bit  $x$  in that memory-bank remains susceptible to external soft errors caused by real particles hitting  $\hat{x}$ .

A paper by O'Gorman et al (1996: Field testing for cosmic ray soft errors in semiconductor memories, <http://ieeexplore.ieee.org/document/5389436/>, IBM Journal of Research and Development **40** (1), 41–50) describes (p. 46) the following experiment and its results. A total of 864 modules

were first run on the second floor of a two-story building for 4,671 hours, during which time, 24 soft errors were detected. Then, the same 864 modules were run for 5,863 hours in a nearby vault shielded by about 20m of rock, during which time, zero soft errors were detected.

The above results suggest that a vault of 20m of rock blocked all soft errors. By the above remarks, this is experimental evidence that we do not live in an external-soft-error-prone simulation with the  $x\text{-}\hat{x}$  property and the uni-directional property. If we do live in such a simulation, then it should not be possible to protect a simulated memory-bank with a simulated vault.

Of course, this is not a mathematical proof, merely empirical evidence. The evidence could be improved, or the thesis falsified, with further experiments. What if we repeat the experiment and soft errors are detected in the vault? Without additional technology, we are unable to tell which soft errors were simulated and which were real. (We can only distinguish them vacuously: if zero soft errors occur, then zero are simulated and zero are real.) If soft errors persist in settings more and more hostile to internal-soft-errors, that is evidence that either we're overlooking (and failing to control for) some unknown source of internal soft errors, or else that external soft errors exist. The latter would entail we live in a external-soft-error-prone simulation, albeit not necessarily one with the  $x\text{-}\hat{x}$  and uni-directional properties (maybe  $x\text{-}\hat{x}$  fails for other memory-bits besides the ones tested; maybe soft errors in the simulating computer affect non-memory components of the simulated computers, indirectly manifesting as soft errors in simulated computers; and so on).

Perhaps this paper's most interesting conclusion is just that a non-contrived simulation hypothesis is falsifiable in a concrete way. One can easily imagine many types of simulations we could live in that are not external-soft-error-prone, or that lack the  $x\text{-}\hat{x}$  property, or that lack the uni-directional property. I hope my argument will inspire falsifiable predictions of other types of simulations.

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## NEWS

### Explanation and Understanding, Ghent, 23–25 May 2018

The workshop *Explanation and Understanding* was held on May 23rd to 25th at the Royal Academy of Dutch Language and Literature in Ghent, Belgium. It was the seventh in the *Logic, Reasoning and Rationality* series of workshops supported by the Research Foundation Flanders (FWO) through the scientific research network on Logical and Methodological Analysis of Scientific Reasoning Processes. The network brings together research groups from nine European universities carrying out research on relevant topics: Adam Mickiewicz University Poznań, Free University of Brussels, Ghent University, Ruhr-University Bochum, Tilburg University, University College London, University of Antwerp, Utrecht University and Vrije Universiteit Amsterdam. For the duration of the project, from 2016 till 2020, there are two workshops organized per year, one in spring and one in autumn.

The seventh workshop was organized by the Centre for Logic and Philosophy of Science of Ghent University, which coordinates the activities of the network, and the Department of Phi-

philosophy of the Vrije Universiteit Amsterdam, The Netherlands. The theme of the workshop, explanation and understanding, is one that is attracting a lot of attention in current philosophy of science. While most philosophers agree that science aims for explanation, and that one of the aims of explanation is to provide understanding, the unresolved question is how to account for this link between explanation and understanding. Most earlier accounts of explanation either took understanding to be of little philosophical interest—as merely a psychological phenomenon without epistemic import—or they considered the notion redundant—arguing that everything philosophically interesting could be captured with explanatory concepts, making ideas on understanding superfluous. Either way, for a long time the philosophy of science by and large ignored understanding, focusing on explanation instead. Things are very different now: the last two decades have witnessed a flourishing philosophical literature on the relation between explanation and understanding. And perspectives diverge greatly: while some argue that current ideas about understanding offer nothing distinctively new and relevant over and above explanatory concepts, others stress the distinctive role of understanding vis-à-vis explanation, and yet others make the case that one can have understanding without explanation.

Most of this recent literature appears to focus on full-fledged theories and explanations, neglecting other aspects of the explanatory enterprise. For instance, how does the idea of understanding play out in the context of explorative phases preceding scientific discovery, or in the early phases of discovery? What is the epistemic role of understanding in the usage of how-possibly models or hypothetical models to explain aspects of real systems? How does understanding relate to abstraction and idealization practices?

The workshop brought together 21 participants who presented talks on a great variety of topics related to the main theme. A number of talks discussed general issues, such as the relation between explanation and understanding, ontic versus epistemic conceptions of explanation, and the possibility of understanding without explanation. Other issues that were discussed included specific types of explanations (e.g., minimal structure explanations, narrative explanations) and the understanding they provide and the issue of whether, and if so how, various types of models—such as how-possibly models and machine learning models—can provide understanding. Finally, a number of talks discussed how understanding is achieved in different scientific disciplines and fields, such as evolutionary biology, population genetics, quantum mechanics, medical science, mathematics, history, ecology, and criminal law.

The keynotes (summarised below) were delivered by Matteo Colombo (Tilburg), Caterina Marchionni (Helsinki) and Alexander Reutlinger (Munich).

The backdrop of Matteo Colombo's keynote, "I know that I know nothing. Explanation, Prejudice, and Intellectual Humility??", is the robust phenomenon that people are prejudiced towards members of groups with a worldview they perceive to be dissimilar from their own. In his talk, Matteo brought together ideas and methods from existing literatures on explanation and intellectual humility, and discussed how people's intellectually humble explanatory reasoning might impact the relationship between dissimilarity and prejudice.

In her keynote, "Explanatory norms as frictions to integration: the case of economics and its neighbours??", Caterina Marchionni looked at the relationship between economics and

neighbouring fields, and examined ways in which field-specific norms about explanation hinder the integration of mechanistic models across fields. She argued that the mechanism-based unity of science championed by Craver and other mechanistic philosophers is better captured by the image of a (dis-unified) cubist painting than that of a (unified) mosaic.

In the keynote, "Understanding and Non-Causal Explanation??", Alexander Reutlinger, argued that there is a unified account of causal and non-causal explanations, viz., the counterfactual theory of explanation, and he elaborated how this theory of explanation could provide a fruitful building block for a unified view of causal and non-causal modes of understanding.

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## Calls for Papers

**FORMALIZATION OF ARGUMENTS:** special issue of *Dialectica*, deadline 31 July.

**RELIABILITY:** special issue of *Synthese*, deadline 11 November.

**INSTRUMENTALISM ABOUT EPISTEMIC RATIONALITY: FOR AND AGAINST:** special issue of *Synthese*, deadline 30 October.

## WHAT'S HOT IN . . .

### Medieval Reasoning

Anyone passingly familiar with Ancient or Medieval Philosophy has probably noticed that those thinkers had a fondness for making categorisations and distinctions – along with the same cut-throat polemical attitude and penchant for splitting hairs that most philosophers still have today. The traditional debates about the classifications and divisions of logic are numerous, extensive and (in)famous enough to ring a bell even with non-specialists: is logic a tool or a part of philosophy?; is it a scientific discipline (*scientia*) or a practical technique (*ars*)?; is it primarily about language (*scientia sermocinalis*) or about reason (*scientia rationalis*)?; what is its subject? The list could go on and on. It is easy to guess that the answers to these questions are often not clear-cut and tend to intermingle. But, overall, the consensus is that traditional logic is wider than contemporary logic and includes several ontological, linguistic, epistemic and even psychological issues that many of us wouldn't even consider to be logic in the first place. In a sense, a lot of traditional logic deals with meta-logical questions, with problems pertaining to the philosophy of logic, and with what we would define as "reasoning". As far as the "reasoning" aspect is concerned, it would be incorrect to believe that it was exhaustive of the traditional logical practices and

