Randomness is an unavoidably epistemic concept

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Are there any truly ontologically random events? This paper argues that randomness is an unavoidably epistemic concept and therefore ascription of ontological randomness to any particular event or series of events can never be justified.

THE CONCEPT OF RANDOMNESS PLAYS A CENTRAL ROLE in many fields of enquiry – from quantum physics to statistics, from forecasting to cryptography – and is a crucial ingredient of the neo-Darwinian theory of evolution. How we understand randomness has serious theoretical and practical implications. Antony Eagle suggests:

> The views about randomness in which philosophers currently acquiesce are fundamentally mistaken about the nature of the concept. Moreover, since randomness plays a significant role in the foundations of a number of scientific theories and methodologies, the consequences of this mistaken view are potentially quite serious.

I agree with Eagle's statement and the seriousness of the problem; his proposal that randomness is unpredictability is a step in the right direction, but it does not address several relevant questions, such as whether the concept of randomness is an epistemic or an ontological one, or both. Roughly, an *epistemic concept* concerns our *knowledge*, whereas an *ontological concept* concerns 'reality', whatever it is, which is crucially distinct from our knowledge or lack of it.

In other words, if randomness is unpredictability, it is unpredictability *by whom*, *of what*, and *under what conditions*? We must differentiate between randomness *as a product* and randomness *as a process*, as Eagle and others suggest, but that distinction leaves the above question unanswered. It is important to note at this point that mere aperiodicity is not necessarily unpredictability – the example of *pi* being the most obvious one, since its digits are aperiodic but predictable.

I propose that any discussion of randomness must consider the unavoidably epistemic nature of the concept of randomness. In other words, randomness concerns knowledge: something which is believed to be random, for all intents and purposes, to an observer or a set of observers (all the scientists with the most up to date data and models, for example), is not *necessarily* random *in se* despite all the evidence (such as experimental data or statistical models) that suggests it is.

As the existence of strong pseudo-random number generator (PRNG) algorithms demonstrates, output of a high quality PRNG with a *sufficiently large interval* (that meets all known randomness tests that it is subjected to) will *rationally* be *seen as random* (because it will pass all given randomness tests). But it *will not be random in se,* because *we know* that its output is generated by a PRNG, which itself is an antithesis of whatever randomness is, and that is exactly what was intended by whoever created the PRNG. Note the 'sufficiently large interval' requirement above: let R_{min} be the minimum acceptable interval for a given series of PRNG, however large; it follows that for any series a PRNG with interval larger than R_{min} will pass as random without being random.

We have therefore a situation where observers must *rationally conclude* that the given series of numbers or events is random – because it passes randomness tests that satisfy our conception of randomness – while *in se* it is not random, as a product of a PRNG or a similar process. In other words, it may walk like a duck, quack like a duck, but it is not a duck.

It requires little imagination to conceptualise any series of events as numbers, and to see that any such series satisfies the above scenario. It therefore follows that of no series may we be certain

that it is random *in se*, short of us possessing divine omniscience. To conclude, *randomness-to-us* is not necessarily *randomness-in-se*: there is always the possibility, whatever the evidence to the contrary, that any or all series are not random. And if there is such a possibility, randomness is an epistemic, and not an ontological concept.

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References

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