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How About Wearing Two Hats, First Popper's and then de Finetti's?

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I am grateful to Nozer Singpurwalla for having brought up so clearly and openly these puzzling, and partly confusing, foundational issues in reliability theory, and to the Editors for the opportunity to take part in this discussion.

My comments are concerned mainly with the first part of the paper. There an important distinction is made between the concepts of *reliability* and *survivability*, by linking the former to the, in some sense, *physica*l or *objective propensity* interpretation of the probability concept advocated by Popper, and the latter to the *personalistic* or *subjective* probability concept of de Finetti.

There is a clear need for both types of perceptions: While the personalistic Bayesian point of view offers a systematic approach for statistical inference from data, well anchored in probability calculus, it does not make direct reference to the "true" states of the considered physical objects or systems. Such states, or changes in them, such as the repair of a defective part in a mechanical device, are of intrinsic importance in nearly all problems relating to reliability and risk assessment.

The existence of a certain gap between physical reality and a corresponding statistical modelling framework of reliability problems, even when based on the more traditional frequentist interpretation of probabilities, has been noted already much earlier. For example, thirty years ago Bo Bergman wrote in his review paper (Bergman, 1985): "However, some care has to be taken when this (repair) model is used; we have to distinguish between *statistical minimum repair*, for which the above interpretation (the equality between two failure rates) is taken as the definition, and *physical minimum repair*, in which case the failed unit is restored to the exact physical condition as it was just before the failure. These two kinds of minimum repair are not necessarily the same!"

Singpurwalla not only makes a distinction between the concepts of reliability and survivability; he also suggests that there would be a single conceptual framework which contains, and combines, objective physical entities and statistical tools, the latter based on de Finetti's personalistic approach to probability. Adopting this framework, he says, would entail a change in the current paradigm of reliability theory. This is not a modest claim.

I believe it is useful to first consider this possibility from a wider perspective, which is not restricted to reliability problems. To continue with another quotation, Philip Dawid has written (Dawid, 2004) on the relationship between the physical reality and our theories on it as follows: "I regard it as of vital importance to distinguish, carefully and constantly, between two very different universes, which I will term "intellectual" and "physical". Any kind of scientific, mathematical or logical theory is a purely intellectual construct. It will typically involve a variety of symbols and concepts, together with rules for manipulating them. The physical universe, on the other hand, just does its own thing, entirely ignorant of, and careless of, any of our intellectual theories. It manifests itself to us by means of observations".

This, I think, is a very fitting description of the situation which we face in statistics in general. In reliability problems, for example, nuclear power plants, cars or computer codes when in use, "just do their own thing", ignorant of our intellectual constructs or theories, whether they be based on Popperian propensities, on de Finetti's epistemic probabilities, or something else. The key link between the two universes, as stated above in the last sentence, is in being able to make observations on objects and processes belonging to the physical universe, and then transporting these observations into the intellectual one as data. Data consisting of registered values of observables in the physical world can be smuggled, through a back door, into the intellectual world, and then treated there in a probabilistic inferential framework as fixed values. What

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