The Full Employment Theorem in Probability Kinematics

For probability kinematics (the normative theory of which updating procedures of probability assignments are appropriate in the light of new evidence or observation), the majority view of philosophers can be undermined in favour of the majority view of statistical physicists. At issue is what I am calling the *Full Employment Theorem* (FET). It states that in order to redistribute probabilities one needs a trained epistemologist to apply situation-appropriate tools from a wide range of methods in a pluralistically arranged toolbox (Dempster-Shafer belief functions, possibility measures, ranking functions, relative likelihoods, and so forth). The idea to associate the problem with the employment of epistemologists is based on critical comments made by E.T. Jaynes and alludes to a full employment theorem in computer science. Advocates of FET may view it as a caricature. What is germane to the debate is whether we must be particularists about probability updating and consider each case in its proper context or whether there are general updating procedures which can be defended as rationally superior independent of individual cases.

FET may not be false, but I claim that the arguments presented so far for FET fail, for example in Joseph Halpern's book *Reasoning about Uncertainty*. The negation of FET is the claim that there are formal methods that we can successfully apply to all cases in which a probability assessment needs to be adjusted in view of new evidence, without the need for case-by-case interpretation by an epistemological expert. Advocates of FET brandish counterexamples, the pre-eminent one being Bas van Fraassen's *Judy Benjamin* problem. It is alleged that this problem, under the application of the preferred formal method (MaxEnt, see below), produces counterintuitive results. Therefore, so goes the reasoning, the universality claim fails and FET (at least a non-caricature version of it) stands.

If your observation comes in the form of an event, a plausible way to update your probabilities is by conditioning. If your observation comes in the form of a redistribution of probabilities over a partition of the event space, it is plausible to use Jeffrey conditioning. Observation can be even more general and come in the form of affine constraints (as in the *Judy Benjamin* problem). If Jeffrey conditioning cannot be applied to an affine constraint, we can use the Principle of Maximum Entropy (MaxEnt), based on the intuition that the observation should lead to an adjustment that in terms of information minimally affects the probabilities. Some, especially statistical physicists, say that MaxEnt delivers the unique solution to this problem that fulfills a set of basic rationality requirements. Advocates of FET believe that MaxEnt is only one of many different strategies to update probabilities rationally. They claim that the *Judy Benjamin* problem decisively subverts the generality of MaxEnt.

I will show various ways in which their arguments go awry. Formal methods show the following: (1) The results provided by MaxEnt for the Judy Benjamin problem are supported, not contradicted, by an intuitive approach that prima facie should support the advocates of FET. (2) The independence assumptions which render the MaxEnt results counterintuitive are improperly applied by advocates of FET; in particular, it is a mistake to treat *Judy Benjamin* as a case for Jeffrey conditioning (for example in Igor Douven's treatment of the problem). (3) The method of coarsening at random does not apply to the *Judy Benjamin* problem once the analogy to the *Three Prisoners* problem is fully appreciated (pace Grünwald and Halpern).

The *Judy Benjamin* case is not one in a long list of counterexamples to the generality of MaxEnt. Almost all of the criticism leveled at MaxEnt as a general updating procedure is expressible by the dynamics of the *Judy Benjamin* case, even if critics choose not to use it. Criticism of MaxEnt that is not related to the *Judy Benjamin* case is poorly developed in the literature and allows for strong lines of defence for MaxEnt (always assuming some basic commitment to Bayesian epistemology on both sides of the argument).

In conclusion, philosophers have not made a persuasive case for full employment, and scientists who use the Principle of Maximum Entropy spanning a variety of disciplines can do so without worry until formal epistemologists can make a more convincing case for particularism in the application of probability updating methods.