

Discussion

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This collection of papers gathering and promoting highly successful applications of Statistics is a good antidote for anyone feeling somewhat defensive about Statistics. The focus on the successful use of Bayesian methods has produced a powerful and stimulating set of stories; the Editors and Authors are all to be congratulated on their successful efforts to bring out the stories behind these analyses. The papers are relatively short (as was required by the Editors) and a good measure of their success is that they both stand alone and motivate the reader to follow up and read the original papers.

The article on the search for the wreckage of flight AF 447 (Stone et al.) is fascinating. The description of the careful and detailed thinking about what might have happened, the evaluation and inclusion of relevant empirical evidence to quantify the possible scenarios and the final success of the analysis in assigning substantial posterior probability to where the wreckage was ultimately found are all inspiring. Like many inspiring articles, it challenges us to think about both the difficult issues of the particular problem considered and general issues about the overall approach. I think a Bayesian analysis is highly appropriate for this problem, but it is not so easy to explain why and it is clear that, as always, the analysis itself has to be done extremely well.

One motivation for doing a Bayesian analysis for this problem (and one that is commonly articulated) is that the event in question is unique so it is not meaningful to think about replications. This is not really convincing because hypothetical replications are hypothetical whether they are conceived of for an event that is extremely rare (and in the extreme happens once) or for events that occur frequently. Moreover, it turns out later that nine past crashes were deemed similar enough to be used to provide information for constructing the prior, making it difficult to argue that the event really is unique.

Another widely used motivation for Bayesian analysis is that it propagates the uncertainty correctly. This

is true and important, but it is also true that it propagates only the uncertainties that we decide to include in the model. We make choices over what uncertainties to include and we also make relatively arbitrary choices which we subsequently treat as fixed. For example, were the uncertainties in the weights for the different scenarios or the chosen α propagated through to the conclusion? As a practical matter, I do not believe we can or should try to propagate all uncertainty, simply that we should not get too carried away and forget about aspects we have treated as certain. This highlights the fact that the Bayesian approach is a tool that is extremely useful for combining the quantitative information we choose to use and are able to express in terms of distributions but which, like any tool, needs to be used well to be effective; the tool on its own does not solve the problem but needs to be applied by highly skilled people.

The four unsuccessful searches that preceded the final, successful search highlight some of the issues. They too used assumptions and information to select the search location. Presumably they did not use a Bayesian analysis? If they did not (and it is not really possible with the benefit of hindsight to go back and redo this fairly), differences between the particular techniques used may be outweighed by differences in the information and beliefs that fed into the analysis. For example, the fourth search based on possible drift concentrated in a small rectangle relatively far from the actual crash site. Would a Bayesian analysis based on the information used to come up with that search rectangle have produced different results? It is difficult to be sure from the maps but it looks like a passive acoustic search actually covered the crash site but that the wreckage was not discovered. We can interpret this as measurement error or as using an incorrect prior. The searchers tried to find the sonar beacons, not realizing that these had failed and were not operating. The successful search both allowed for this possibility (at least by not ruling out that area as having been previously searched) and, because so much time had elapsed that the beacons could not have been expected to still work, adopted different technology in the search. Had they adopted the belief that the area had been searched so the wreckage could not be there and built this into the

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