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Web Based Expert Elicitation of Uncertainties in Environmental Model Inputs

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When constructing and using environmental models, it is typical that many of the inputs to the models will not be known perfectly. In some cases, it will be possible to make observations, or occasionally physics-based uncertainty propagation, to ascertain the uncertainty on these inputs. However, such observations are often either not available or even possible, and another approach to characterising the uncertainty on the inputs must be sought. Even when observations are available, if the analysis is being carried out within a Bayesian framework then prior distributions will have to be specified.

One option for gathering or at least estimating this information is to employ expert elicitation. Expert elicitation is well studied within statistics and psychology and involves the assessment of the beliefs of a group of experts about an uncertain quantity, (for example an input / parameter within a model), typically in terms of obtaining a probability distribution. One of the challenges in expert elicitation is to minimise the biases that might enter into the judgements made by the individual experts, and then to come to a consensus decision within the group of experts. Effort is made in the elicitation exercise to prevent biases clouding the judgements through well-devised questioning schemes. It is also important that, when reaching a consensus, the experts are exposed to the knowledge of the others in the group.

Within the FP7 UncertWeb project (http://www.uncertweb.org/), there is a requirement to build a Web-based tool for expert elicitation. In this paper, we discuss some of the issues of building a Web-based elicitation system - both the technological aspects and the statistical and scientific issues. In particular, we demonstrate two tools: a Web-based system for the elicitation of continuous random variables and a system designed to elicit uncertainty about categorical random variables in the setting of landcover classification uncertainty.

The first of these examples is a generic tool developed to elicit uncertainty about univariate continuous random variables. It is designed to be used within an application context and extends the existing SHELF method, adding a web interface and access to metadata. The tool is developed so that it can be readily integrated with environmental models exposed as web services. The second example was developed for the TREES-3 initiative which monitors tropical landcover change through ground-truthing at confluence points. It allows experts to validate the accuracy of automated landcover classifications using site-specific imagery and local knowledge. Experts may provide uncertainty information at various levels: from a general rating of their confidence in a site validation to a numerical ranking of the possible landcover types within a segment.

A key challenge in the web based setting is the design of the user interface and the method of interacting between the problem owner and the problem experts. We show the workflow of the elicitation tool, and show how we can represent the final elicited distributions and confusion matrices using UncertML, ready for integration into uncertainty enabled workflows. We also show how the metadata associated with the elicitation exercise is captured and can be referenced from the elicited result, providing crucial lineage information and thus traceability in the decision making process.