

The Sheffield Elicitation Framework (SHELF, v2.0)

An “Off the Shelf” package for eliciting probability distributions

The SHELF package comprises a number of components:

1. This overview document, which should be read carefully before using SHELF.
2. Some pre-session briefing notes.
3. Blank templates and the same templates with added notes, for the following:
 - a. Pre-session pro forma to be sent out with the briefing notes to experts;
 - b. Elicitation record Part 1, to record the context and purpose of the elicitation;
 - c. Elicitation record Part 2 (in several different forms), to record the elicitation of each probability distribution.
4. Software for fitting distributions using the R package, and instructions for its use.

What’s new in version 2?

SHELF version 2.0 is a significant development from version 1, featuring:

- Completely revised and more powerful software for fitting distributions
- Templates for more than twice as many different elicitation methods
- Updated guidance in all documents

Elicitation and SHELF

Elicitation is the process of capturing expert knowledge about one or more uncertain quantities in the form of a probability distribution. It can be done informally, but when the expert judgements are sufficiently important it is necessary to employ a formal procedure in the interests of quality and defensibility. SHELF is such a formal procedure for elicitation.

But SHELF is more than this. Good elicitation generally requires a *facilitator* who has expertise in the process of elicitation. The facilitator guides the expert(s), manages the process and at the end delivers the elicited probability distribution. SHELF provides not only the tools for a facilitator but also copious advice on their use.

The developers of SHELF are co-authors of one of the leading textbooks in the field:

“Uncertain Judgements: Eliciting Experts' Probabilities”, by A. O'Hagan, C. E. Buck, A. Daneshkhah, J. R. Eiser, P. H. Garthwaite, D. J. Jenkinson, J. E. Oakley and T. Rakow. Published in 2006 by Wiley. ISBN: 978-0-470-02999-2.

SHELF draws extensively on the research and conclusions for best practice in this book, but is also updated to reflect more recent experience.

By using SHELF, the facilitator can say that the elicitation has been conducted in an open and well-structured way that accords with best practice in the field. The SHELF name is a mark of quality.

The elicitation process

The facilitator needs to plan carefully in order to ensure a successful elicitation. The process begins with identifying the experts. SHELF is a framework for eliciting beliefs of one or more experts, such that if there are several experts they are brought together as a group. There are other frameworks for elicitation in which the experts are kept separate, but the SHELF view is that it is preferable to elicit their beliefs together as a group. A group should ideally not comprise more than about five experts: having too many experts will lead to unnecessarily long discussion, and it should be possible to cover all relevant expertise with just a few experts.

Having identified the experts and fixed a date when they can all attend, some preliminary *briefing material* should be sent to the experts well before the meeting. They should be told that they are expected to read this carefully in advance (and, where the experts are being paid for taking part, the payment should allow for the time to absorb this material). Briefing material may be short or may include substantial training documents (for instance concerning probability and its use to represent expert knowledge). Experts should be invited to contact the facilitator about any matters raised in the briefing.

SHELF is not prescriptive about the initial briefing material, but we emphasise that this is an important part of the process. SHELF includes a possible set of pre-session briefing material, in the form of a short set of briefing notes, a pro forma template and the same template with explanatory notes. The pre-session form is to be completed partly by the facilitator and partly by the expert, and is to be returned by the expert prior to the meeting. The briefing notes are designed to provide at least some minimal orientation for the expert. The form is intended to gather some information that may allow the facilitator to complete a part of the elicitation record in advance.

The elicitation session begins with housekeeping business for which a template “SHELF 1 (Context).doc” is provided in the SHELF package. Much of the ground covered in this first part of the elicitation session is extremely important. In particular, this document will note what orientation and training has been given. Training is essential, but depends on the experts. Some will need very little explanation of what probability is, for instance. Training that is additional to the orientation material is often given in this first part of the session, and handouts or slides used should be attached to the elicitation record. Unless the elicitation extends over several sessions involving the same experts, it is always advisable in this first part of the session to conduct at least one practice elicitation.

Quantities used for practice elicitation should be such that the facilitator knows the true value but the experts do not (so that the true value can be revealed at the end as part of the debriefing and discussion of that exercise). Although it is common to use general knowledge quantities such as the area of France, the population of Australia or the birth date of Tolstoy, there is much to be said for choosing practice quantities in the experts’ area of expertise.

The first part of the session ends with identifying precisely the quantities whose probability distributions are to be elicited. This can be a complex exercise involving the technique of structuring, to express the quantities of primary interest in terms of others whose distribution(s) may be easier to elicit. The elicitation then moves into the second part, in which these distributions are elicited in turn. Each requires the completion of a “SHELF 2” document. SHELF accommodates several different protocols for eliciting a distribution, identified by the letters P (Probability), Q (Quartile), R (Roulette) and T (Tertile).

- In the P (Probability) method, the facilitator asks the experts for some specified probabilities.
- In the Q (Quartile) method the facilitator asks the expert(s) for their median and upper and lower quartiles.
- In the R (Roulette) method the facilitator asks the expert(s) to indicate their probabilities for ten ranges of values, known as bins, by placing chips in the bins.
- In the T (Tertile) method the facilitator asks the expert(s) for their median and upper and lower tertiles.

Also, the SHELF framework involves first eliciting individual distributions from each expert and then a group elicitation. Different methods may be used for the individual and group stages, so there are several forms of the “SHELF 2” document:

- In “SHELF 2 (Distribution) P.doc” the facilitator uses the P method for both individual and group elicitation.
- In “SHELF 2 (Distribution) Q.doc” the facilitator uses the Q method for both individual and group elicitation.
- In “SHELF 2 (Distribution) QP.doc” the facilitator uses the Q method for the individual elicitation but the P method for group elicitation.
- In “SHELF 2 (Distribution) R.doc” the facilitator uses the R method for both individual and group elicitation.
- In “SHELF 2 (Distribution) RP.doc” the facilitator uses the R method for the individual elicitation but the P method for group elicitation.
- In “SHELF 2 (Distribution) T.doc” the facilitator uses the T method for both individual and group elicitation.
- In “SHELF 2 (Distribution) TP.doc” the facilitator uses the T method for the individual elicitation but the P method for group elicitation.

There are blank templates for all these elicitation record documents, and there are also the same templates with added explanatory notes. In addition to describing what should be entered in each part of the template, these notes include (a) advice [in square brackets] to the facilitator on carrying out the relevant task, and (b) notes *in italics* on the rationale for this task, and how it contributes to good elicitation.

The facilitator is free to choose which SHELF 2 protocol to use. We have tried in version 2.0 to offer all the versions that we think can lead to good elicitation. However, it is worth saying that our current favourites are QP, R, RP and TP. There are some comments in the annotated templates comparing the protocols.

Time in the elicitation session itself is at a premium, so the facilitator should be well prepared. In particular, he/she should have blank templates (SHELF 1 and a SHELF 2 for each distribution to be elicited) with basic data filled in already where possible. He/she will also find it useful to have hard copy printouts of the annotated versions of the forms, to refer to during the session.

The forms should be filled in live during the session, and preferably projected so that all participants can see the record as it is built up. The facilitator will find it helpful to have an assistant for this purpose, and/or to compute fitted distributions.

Techniques

The SHELF protocols require distributions to be fitted, distributions to be plotted and feedback data to be computed in real-time. It is essential that the facilitator ensures that he/she has access to suitable software, and is fluent in its use. SHELF includes some basic software in the form of procedures in the R language, together with notes on their use, but the facilitator or his/her assistant may use whatever they find best suited to the task and/or their skills.

Ideally, graphs of fitted distributions should form part of the elicitation record. The facilitator should also check that he/she knows how to produce graphs and to paste them into the SHELF 2 documents (or can produce graphs as attachments to those documents).

It goes without saying, though, that the facilitator's most important technique is simply the ability to manage the process and the interaction between the experts. The notes for the various SHELF documents try to highlight things that the facilitator needs to watch out for, but there is no substitute for practical elicitation experience.

Using SHELF with one expert

Although a formal and careful elicitation process such as SHELF is generally used for elicitation from several experts, it is straightforward to adapt the SHELF materials for use with a single expert. The elicitation should be recorded on a "SHELF 1" form and either P, Q, R or T "SHELF 2" forms. All of the fields in the "SHELF 1" form are relevant. In the "SHELF 2", leave blank the "Group elicitation" field, but the subsequent feedback (and possible iteration) remains important.

The R software routines include functions to assist with single expert elicitation, including a probability-based method that is not used in multi-expert elicitation.

About SHELF

This is only the second version of the Sheffield Elicitation Framework. It will continue to evolve in response to the experiences of people using it and according to the wish of its developers to extend its capabilities.

Comments are welcomed by Tony O'Hagan (shelf@tonyohagan.co.uk) and Jeremy Oakley (j.oakley@sheffield.ac.uk).

We would particularly welcome offers of additional materials or suggested amendments to components of SHELF.

The SHELF package is available from the website <http://tonyohagan.co.uk/shelf/>.

Copyright

All materials in the SHELF package are made freely available, but they are nevertheless covered by copyright. They may be copied for the purposes of conducting elicitation, for private study or personal use. They may **not** be reproduced on any website, offered for sale or otherwise distributed without the written permission of either Tony O'Hagan or Jeremy Oakley.

You may amend the templates, briefing document or software, but must not represent the amended items as part of the SHELF package. Amended documents must therefore have headers removed and titles/contents edited to remove any implication that they are SHELF documents. Note that many SHELF documents are supplied for convenience in PDF format, but Microsoft Word versions may be obtained on request if you wish to amend them.

Provided that you use the un-amended SHELF templates for parts 1 and 2 of the elicitation record, and the elicitation is conducted strictly in accordance with the guidance notes here and in those templates, then you may say that the elicitation is conducted according to the SHELF framework (even if you use different or amended briefing material, different or amended software or additional supporting materials).

The appropriate form of citation in published work is:

Oakley J. E. and O'Hagan, A. (2010). SHELF: the Sheffield Elicitation Framework (version 2.0), School of Mathematics and Statistics, University of Sheffield, UK. (<http://tonyohagan.co.uk/shelf>)