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Software update

Update (1.2) to ANDURIL and ANDURYL: Performance improvements and a graphical user interface

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A B S T R A C T
This is an update to PII: S2352711018300608 and S2352711019302419. In this paper, we present three main improvements of ANDURIL and its python version ANDURYL. First, the MATLAB version ANDURIL is brought to the Python version standard by implementing (i) user defined quantiles and (ii) the possibility to deal with missing values. Second, the computational engines of both ANDURIL and ANDURYL were significantly improved making calculation time lower and improving further accuracy. Finally, a standalone Graphical User Interface is presented which we believe will make the software more accessible to practitioners of Cooke’s method.

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Software metadata

Code metadata

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Support email for questions

Code: ANDURYL v1.2
GitHub (peer review version)
GNU General Public License
Python, PyQt5, Numpy, Matplotlib
Python version 3.6+
Available from GUI and Github
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1. Motivation and significance

Software implementing Cooke’s classical model [1] for structured expert judgment was presented in [2] and [3]. The earlier
In this update:

1. ANDURIL is brought to the Python version standard by implementing: (i) user defined quantiles and (ii) the possibility to deal with missing values. These features will not be discussed further. The reader is referred to [3] for an explanation of the main features now also available in AI v1.2 (ANDURIL version 1.2).

2. The code of both ANDURIL and ANDURYL was significantly improved, reducing the calculation time. The calculation times on a PC with an Intel Core i5-5300U CPU of 2.3 GHz for robustness analysis (global weights without optimization) for the study presented in [5] are shown in Table 1. Up to 4 of the 13 calibration questions at a time were excluded, resulting in 1092 combinations of excluded items. The MATLAB version AI v1.2 is 30 times faster than AI v1.0 for the study under consideration. Similarly AY v1.2 is a factor 15 faster than AY v1.1 and approximately 220 times faster than AI v1.0.

|               | AI v1.0 | AY v1.1 | AI v1.2 | AY v1.2 |
|---------------|---------|---------|---------|---------|
| 15 min        | 60 s    | 30 s    | 4 s     |

MATLAB version is named ANDURIL (AI) while the Python version is ANDURYL (AY).
determined by interpolating each of the two experts’ quantiles. Fig. 1 illustrates the process of interpolation for much quicker and without inaccuracies due to the discretization used in the numerical integration. Although the PDF between the given quantiles is uniform (or log-uniform), this gives the same results as solving the integral, but long as the PDF between the given quantiles is uniform (or log-uniform), this gives the same results as solving the integral, but

determined by interpolating each of the (two in this case) experts’ quantiles. Fig. 1 illustrates the process of interpolation for much quicker and without inaccuracies due to the discretization used in the numerical integration.

The new code led to improved accuracy of both AI and AY. That is, both solutions are closer to EXCALIBUR (CC). The differences between CC and AI and AY for the 7 studies where differences were observed, are shown in Table 2. This will be elaborated further below.

3. A standalone Graphical User Interface of ANDURYL is presented. A screenshot of the GUI is presented in Fig. 2.

2. ANDURYL and ANDURIL code improvement

The main improvement in speed and accuracy is the result of a different implementation for calculating the Decision Maker’s (DM) cumulative distribution function (CDF). In version 1.0 and 1.1, the DM’s CDF was calculated by integrating the probability density function (PDF) of the weighted DM’s numerically (quadrature method) through an anonymous function. Solving it directly density function (PDF) of the weighted DM’s numerically (quadrature method) through an anonymous function. Solving it directly...
• The AY code is separated between calculation and user interface functionalities so that the Python-module can also be used from a script or Jupyter notebook. For research purposes this is a useful functionality.

• The fact that AY is still significantly faster than AI, as shown in Table 1, is due to differences in implementation. In AI several expensive operations are re-calculated for different iterations. In AY the amount of data that is re-calculated is minimized.

4. Comparing with previous studies

In [4], 33 post-2006 studies using Cooke’s classical method are presented using CC. We use these data to compare output from AY and AI to both CC, the MATLAB implementation AI of the v1.0 paper [2] and the Python implementation of the paper [3].

The differences are smaller compared to the results from the last code version. For two studies, "Hemophilia" and "Ice sheets" the differences are still significant. For four other studies the results seem to be due to rounding errors. Of the remaining 26 studies, the majority have equal results. Table 2 shows the differences for the studies where differences are still observed.

5. Conclusions

The Python module named ANDURYL (AY) has been extended with a graphical user interface and is available as stand-alone executable. The MATLAB toolbox named ANDURIL (AI) for combining expert judgments applying Cooke’s method has been further extended by adding functionalities for user defined quantiles and handling missing values. The stand-alone GUI enables practitioners and researchers that have no Python or MATLAB experience to apply Cooke’s method with ANDURYL. For users that are more familiar with programming, the MATLAB toolbox and Python GUI are a means to perform or analyze expert elicitations in a reproducible way. The improved speed and accuracy contribute to this cause. Both codes are open source to encourage usage and further development.

CRediT authorship contribution statement

Guus Rongen: Methodology, Software, Writing - original draft. Cornelis Marcel Pieter ‘t Hart: Methodology, Validation. Georgios Leontaris: Methodology. Oswaldo Morales-Nápoles: Conceptualization, Writing - review & editing, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

[1] Cooke R. Experts in uncertainty: Opinion and subjective probability in science. Environmental ethics and science policy, Oxford University Press; 1991.
[2] Leontaris G, Morales-Nápoles O. Anduril: A matlab toolbox for analysis and decisions with uncertainty: learning from expert judgments. SoftwareX 2018;7:313–7. http://dx.doi.org/10.1016/j.softx.2018.07.001.
[3] ‘t Hart CMP, Leontaris G, Morales-Nápoles O. Update (1.1) to ANDURIL – A MATLAB toolbox for analysis and decisions with uncertainty: Learning from expert judgments: ANDURYL. SoftwareX 2019;10:100295. http://dx.doi.org/10.1016/j.softx.2019.100295, URL http://www.sciencedirect.com/science/article/pii/S2352711019302419.
[4] Colson AR, Cooke RM. Cross validation for the classical model of structured expert judgment. Reliab Eng Syst Saf 2017;163:109–20.
[5] Puig D, Morales-Nápoles O, Bakhtiari F, Landa G. The accountability imperative for quantifying the uncertainty of emission forecasts: evidence from Mexico. Clim Policy 2018;18(6):742–51.