Bayesian modelling of dependence between experts

David Hartley

D.S.Hartley@warwick.ac.uk

Plan of Talk

- Bayesian Structured Expert Judgement – Problem to be solved
- Existing Bayesian Models
- Proposed New Bayesian approach for highlighting dependence between experts.
- Issues and potential resolutions
- Next Steps

Bayesian Approaches

- 1960s $\rightarrow$ 1980s. Conceptual, exploring ideas and principles.
  - Not intended for real use
- 1990s-2000s. Some attempts to use in practice, but need to make heroic assumptions about correlations and calibration
- 2010s onwards. Use of hierarchical models and MCMC to learn from seed variable data

Bayesian Approaches – Problems to Solve

- Sensitivity to complex priors
- Extensible to a broader range of cases
- More formal approach to inter-expert correlation

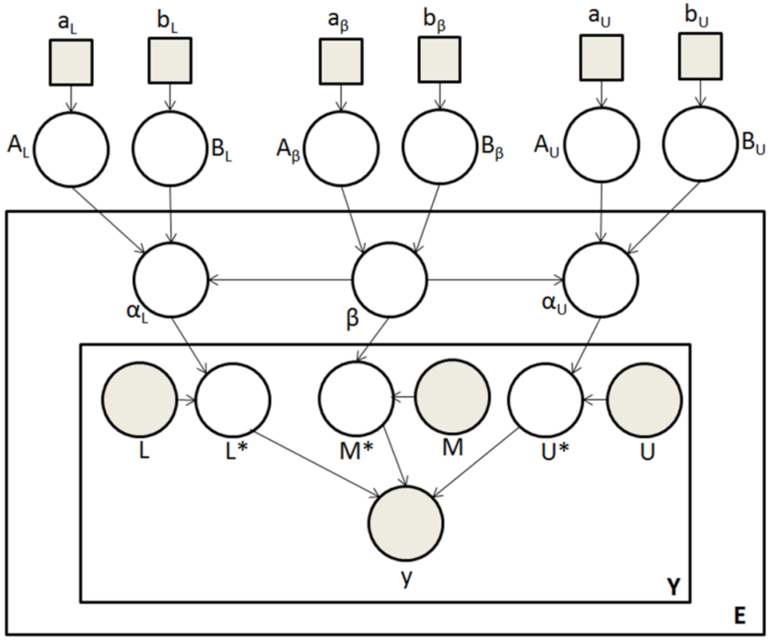
Bayesian Approaches – Underlying Structure

Calibration

Aggregation

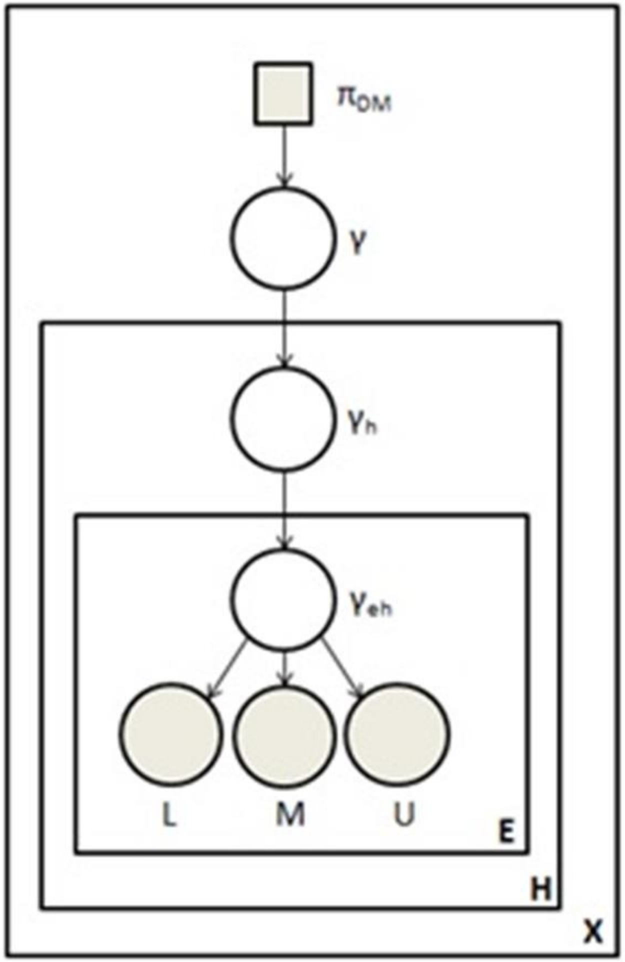
Calibration

- Clemen and Lichtendahl (2002)
- Bayesian Hierarchical modelling approach
  - recalibrates experts' forecasts based on their historical performance using multiplicative factors
  - Identifies correlation between experts

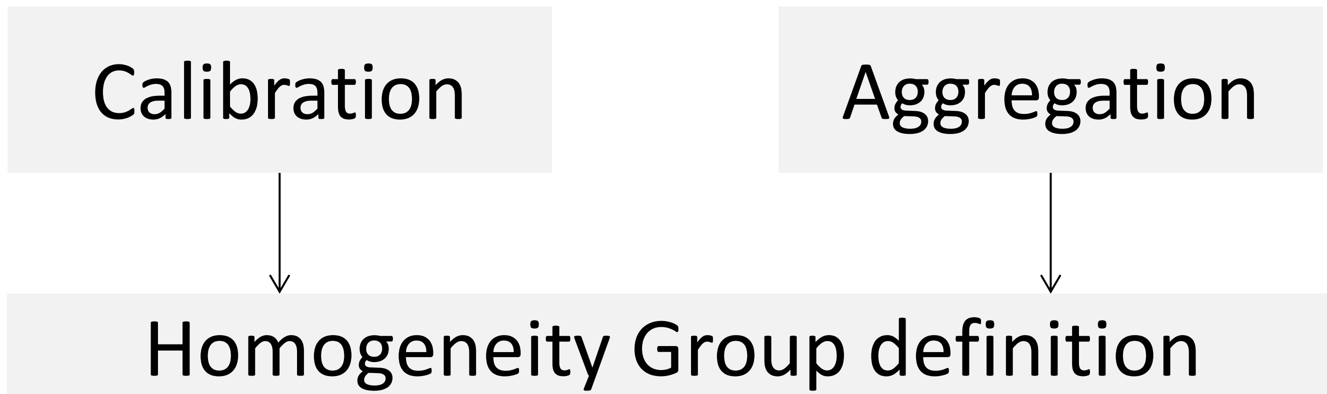


Aggregation

- Albert et al (2012)
- This model clusters groups of experts into homogeneity groups and then utilising a Supra Bayesian Parameter Updating approach assess the variation both between and within these homogeneity classes.

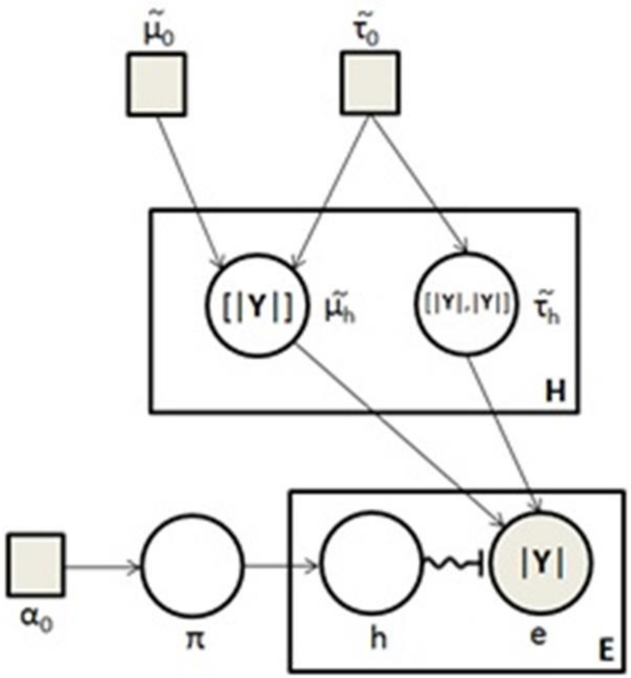


Bayesian Approaches – Underlying Structure

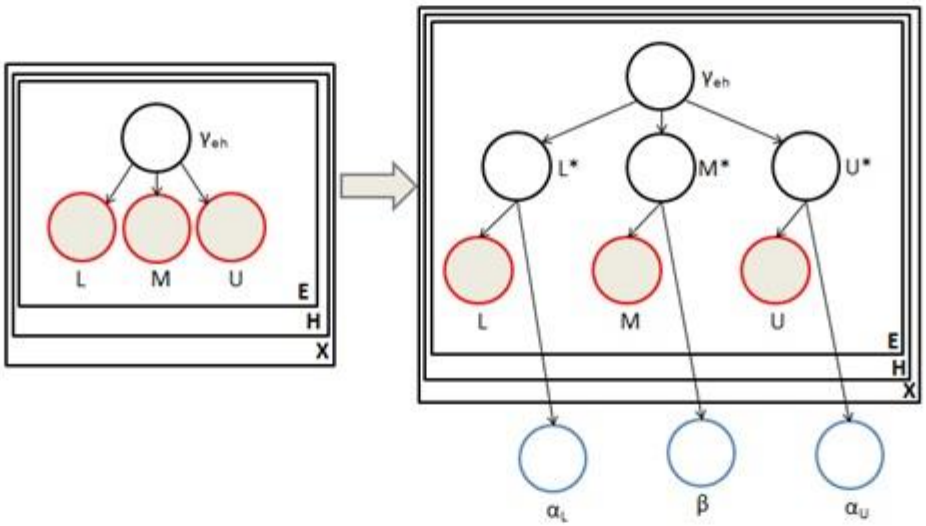


Grouping of Experts

- Hartley and French (circa 2017)
- Clusters experts into homogeneity groups using a Dirichlet Process mixture model to analyse calibration data sets.

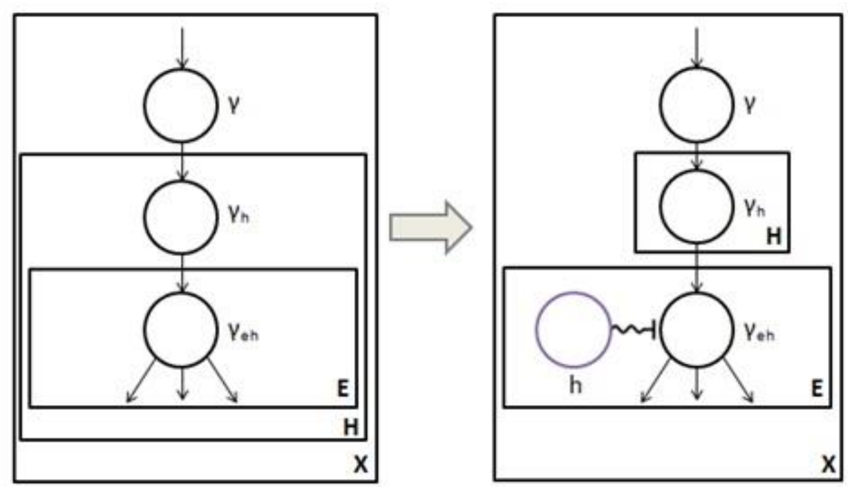


Linking the models

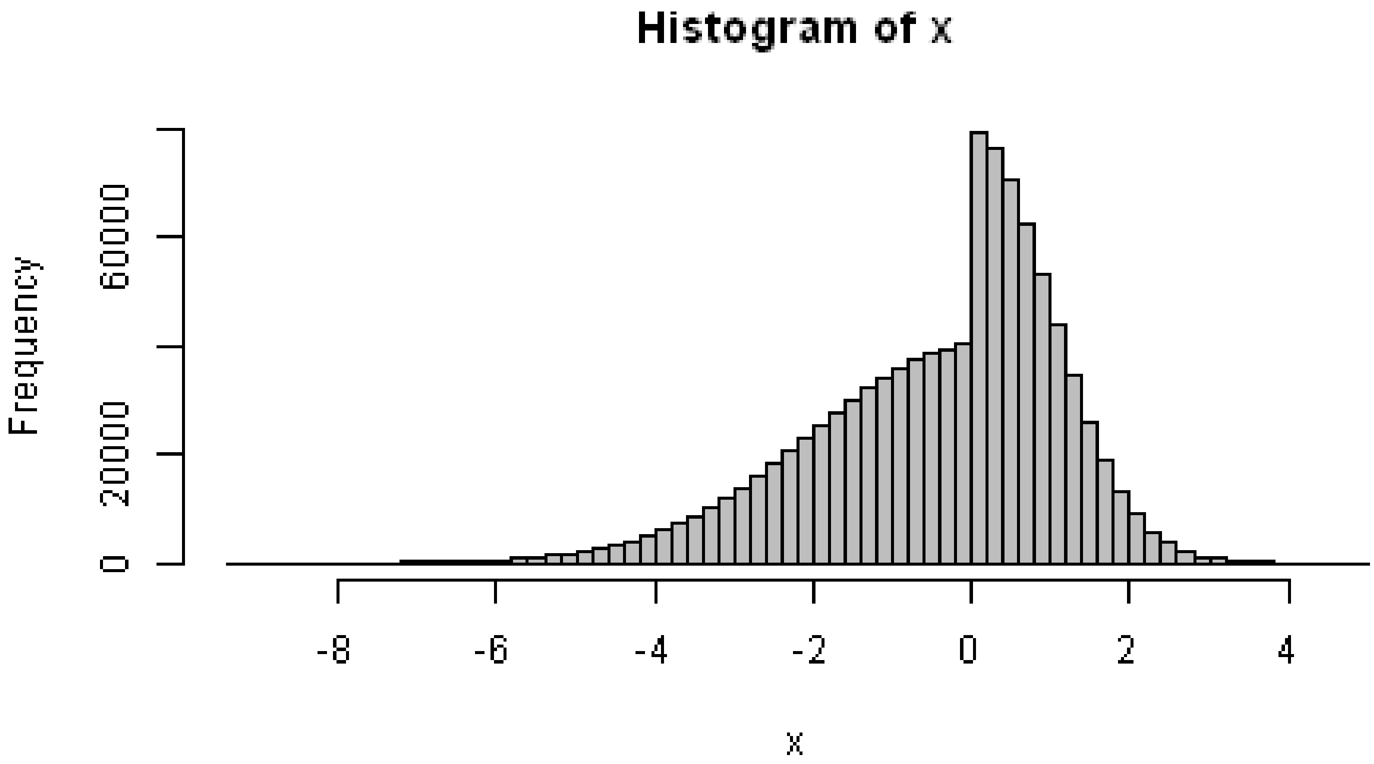


Linking the Calibration and the Aggregation Model

Linking the Homogeneity Groups to the Aggregation and Calibration Models



Reparametrising the Calibration Model



Reparametrising the Calibration Model

	0.05	0.5	0.95	Actual
Item__1	102.5	242	335	292
Item__2	117.5	244	344	24
Item__3	132.5	245	346	150
Item__4	147.5	250	347.5	97
Item__5	162.5	252.5	347.5	823
Item__6	180	257.5	347.5	223
Item__7	197.5	280	347.5	27
Item__8	222.5	300	347.5	287
Item__9	238	318	352.5	356
Item__10	260	337	380	508
Item__11	279	357.5	408	187
Item__12	298	375	437.5	12
Item__13	318	396	460	556
Item__14	337.5	415	485	20
Item__15	357.5	435	509	585
Item__16	375	458	534	609
Item__17	392.5	477.5	560	552
Item__18	410.5	500	586	178
Item__19	430	520	617.5	87
Item__20	447.5	540	649	88
Item__21	462.5	558	680	578
Item__22	477.5	578	710	191
Item__23	501	597.5	741	84
Item__24	522	617.5	770	33
Item__25	540	638	800	546

	mean	sd
miscal[3,1,1]	5.342	2.068
miscal[3,1,2]	0.8828	0.1114
miscal[3,1,3]	5.302	1.574

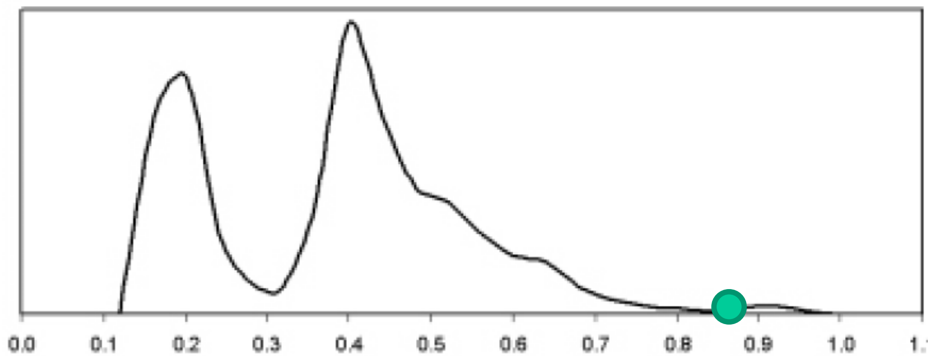


Figure 2: Posterior distribution for Expert 3's β.

	Original Forecast for 0.5	New Model Adjusted Median	Clemens and Lichtendahl Adjusted Median	Actual Result
Item__1	242	207	99	292
Item__2	244	209	100	24
Item__3	245	209	100	150
Item__4	250	214	103	97
Item__5	252.5	216	104	823
Item__6	257.5	220	106	223
Item__7	280	239	115	27
Item__8	300	257	123	287
Item__9	318	272	130	356
Item__10	337	288	138	508
Item__11	357.5	306	147	187
Item__12	375	321	154	12
Item__13	396	339	162	556

Higher than Actual Result

Lower than Actual Result

Approach to assessing the suitability of the model

- Expert Judgement studies from the Delft Database
- Take a hold out sample from the seed variables
- Utilising remaining seed variables use both Cooke's model and the Bayesian Approach to forecast the missing data
- Iterate through the seed variables to vary the hold out sample to build up a set of forecasts.

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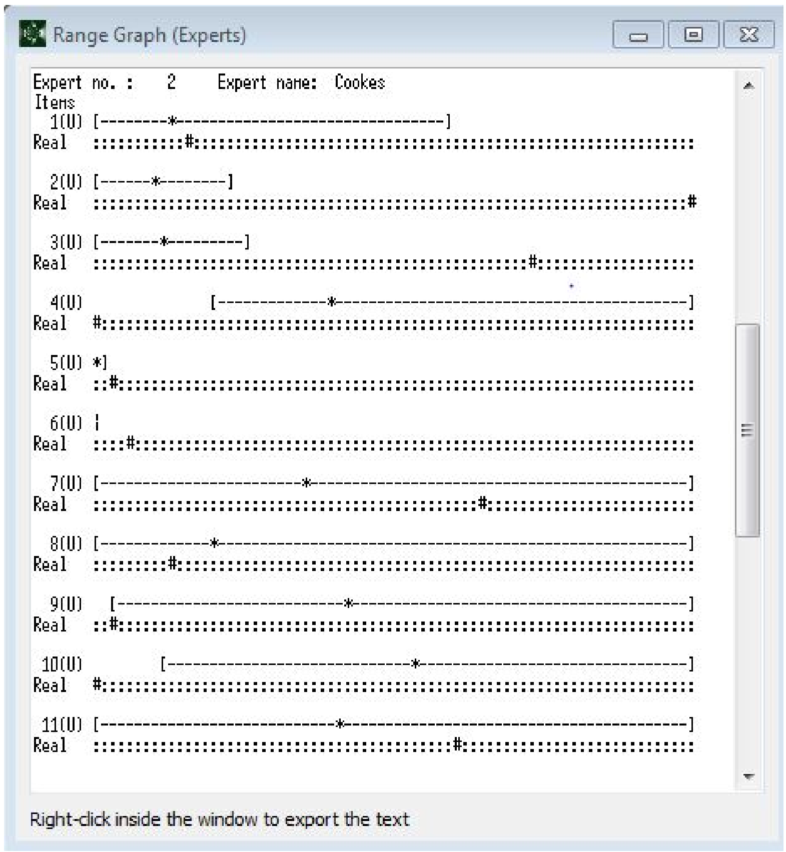
- Run all of the forecasts through Cooke's model

Results

Dams
Space Debris
Ground Water Transport
Montserrat



Issues and Next Steps

- Varying/Logarithmic scaling issues
- Calibration impact to variables with variables existing within a predefined range.
- Number of seed variables available

Issues and Next Steps

- Varying/Logarithmic scaling issues

  - Consider using the approach outlined in Wiper & French '95 and pass the variables through the DM;s prior
- Calibration impact to variables with variables existing within a predefined mean.

  - *Consider post modelling truncation of variables.*
- Number of seed variables available

  -Perform some sensitivity analysis utilising a case study and removing seed variables.
- Potential Risk of Bias from the ROAT approach

  -Perform cross-validation on permutations of greater than 1 removed variables

Apply the model to the set of more recent studies in the Delft Database

Thank you