Expert judgment: probabilities, parameters and MODELS!

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Objective

- All of us in this conference are concerned with uncertainty
- Uncertainty and knowledge are opposites:

  Uncertainty ⟷ Knowledge

- My aim is to consider how the experts provide their knowledge
- Aside: so how many of us have looked to the extensive literature on knowledge ….?

Objective

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- Uncertainty a… … opposites:
  - U… … Knowledge
- M… …onsider how the experts … …heir knowledge
- As… …e: so how many of us have looked to the extensive literature on knowledge ….?

Health Warning
Very tentative paper of half baked thoughts!

Experience vs Knowledge

- Experience:

  Have observed events and quantities in the world that relate to the uncertainties and risks that we are analysing

- Knowledge:

  Have abstracted an sufficient understanding from experiences to build knowledge of the ‘way the world works’ and build this into physical models

Experience vs Knowledge

- Experience:

  Have observed events and quantities in the world that relate to the uncertainties and risks that we are analysing

Mental Models

qualitative understandings of cause and effect

- Knowledge:

  Have abstracted an sufficient understanding from experiences to build knowledge of the ‘way the world works’ and build this into physical models

Knowledge and Models

- Models are one of the ways of encoding knowledge
  - **Statistical models**
    Knowledge drawn from fitting data of the interaction of entities: e.g.
    $$\boldsymbol{y} \sim \mathrm{A}\boldsymbol{x} + \boldsymbol{\varepsilon}$$
  - **Physical models**
    Knowledge of 'how the world works' built through abstraction from statistical models through insight and understanding; they encode scientific laws: e.g.
    $$d = ut + \tfrac{1}{2}at^2$$
- Statistical models (should) come with an empirical assessment of their errors in prediction
- Physical models have less explicit assessment of their prediction errors, but experts have experience of their use and accuracy (Kuhn)

Physical models are seldom unique

- Even if a physical model is precisely stated, it may be embedded and approximated differently in distinct computer codes
- Major consequence codes have many different physical and statistical models chained together in different combinations
- Different experts use different models
- So different experts experience different behaviours and errors in the output of models
- Computer codes, parameters and prediction errors depend on each other *very* closely
  - Rimpuff and Atstep

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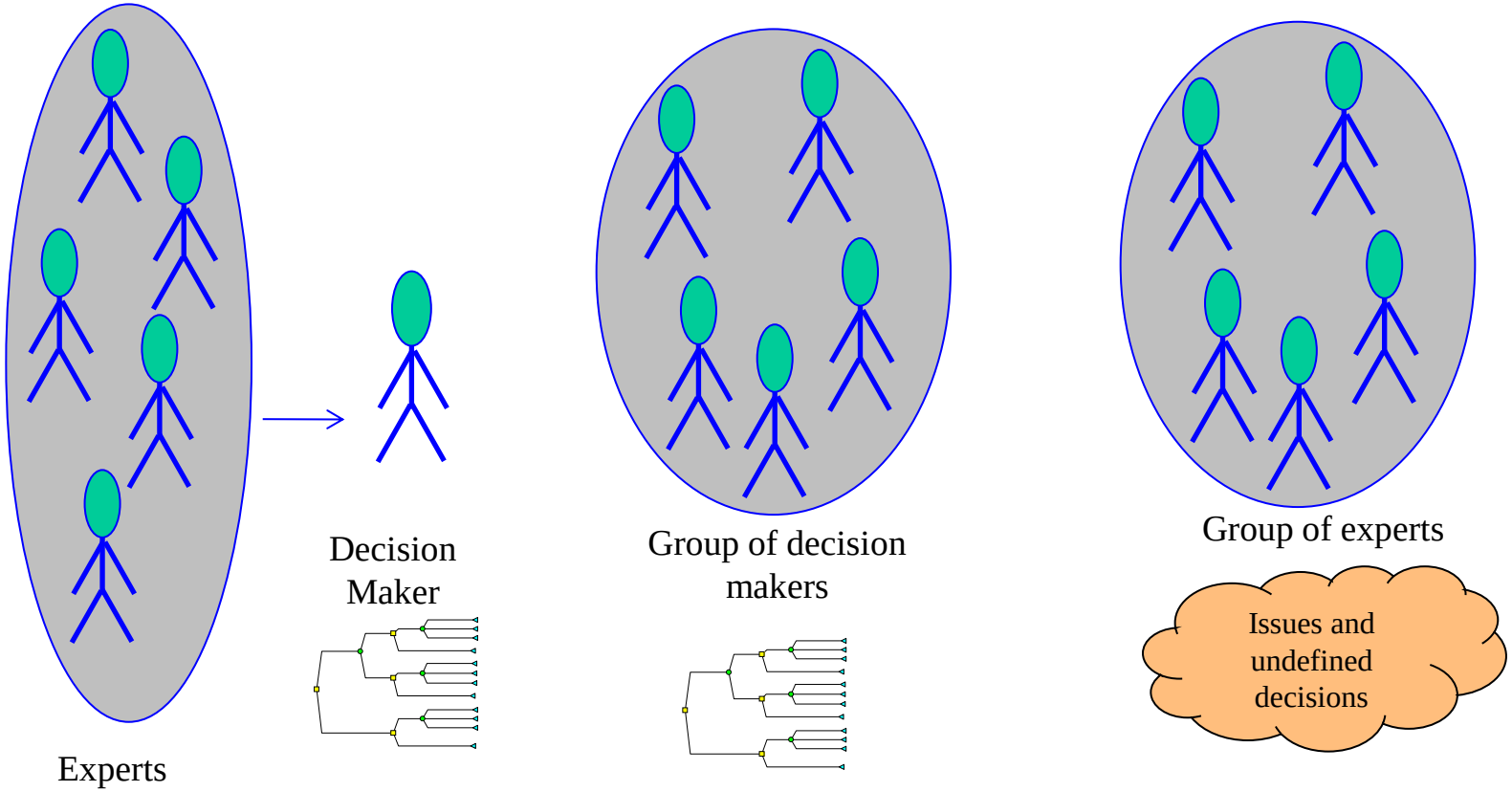
The expertise and knowledge encoded in the model needs to fully compatible with the expertise and knowledge encoded in the parameters

The various contexts in which EJ is used

The Expert Problem	The Group Decision Problem	The Text-Book Problem



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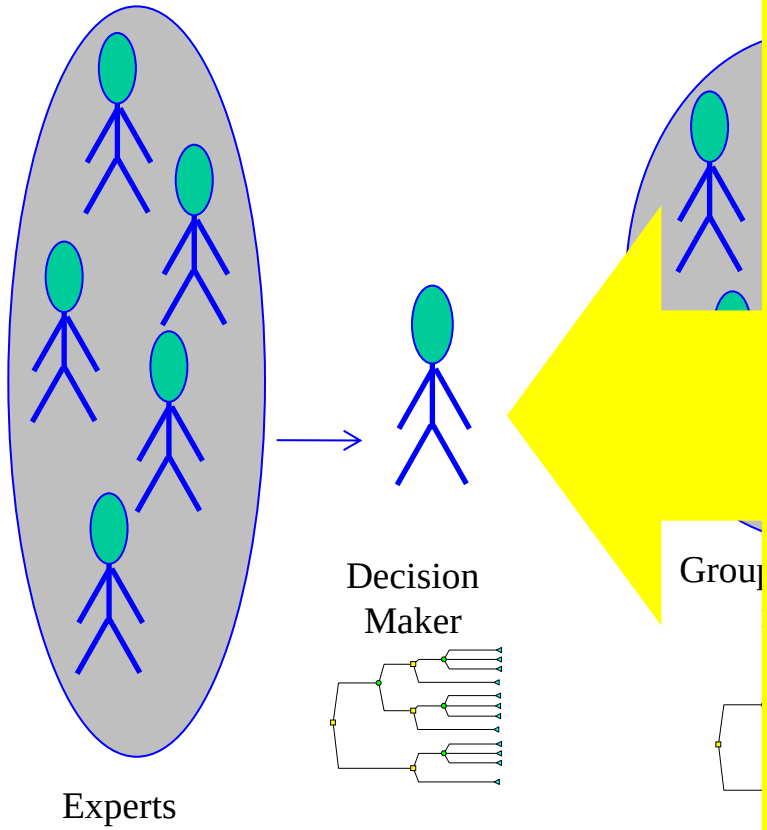

Focus of Discussion

- well defined risk or decision analysis;
- relevant uncertainties have been identified.

Experts are to be consulted to provide their experience and knowledge in setting probabilities

Why we involve experts

We involve experts in risk and decision analyses for their:

- experience
- knowledge

to help in predicting risks and the consequences of possible policies and actions.

We also want to understand how much error their might in their predictions

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We also want to understand how much error their might in their predictions

I will argue that our methods focus more on eliciting experience than on knowledge

And hence we underestimate the error

Expert Judgement and Probability

- We are concerned with eliciting uncertainties from experts and aggregating these into some balanced view.
- We will encode uncertainties as probabilities
- Assume that we collect calibration data over seed items
- Without calibration data,
  - we have no way of assessing the quality of the experts' judgements
  - no data to assess to assess *our* (i.e. the DM's) uncertainty in *their* assessments
  - *Their* confidence (spread) alone does not define *our* uncertainty
  - So think of Cooke's classical model or Bayesian methods

Probabilities of Events

Assessed holistically

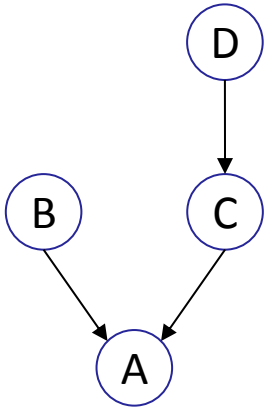
$P(A)$ or $P(A_1)$, $P(A_2)$, ….,$P(A_n)$

- Bayesian methods can recalibrate and aggregate these
- Can conceive of classical methods to estimate calibration curve and recalibrate
- Experts are assumed to draw on experience of (similar) past events
- No formal model, but maybe mental models

Probabilities of Events

Assessed by decomposition

E.g. P(A) = P(A|B,C,D)xP(B)xP(C|D)xP(D)

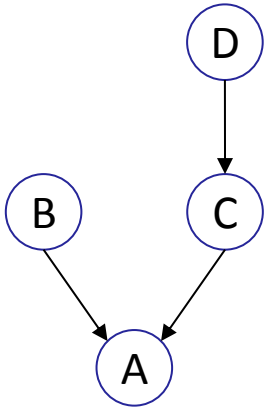


- Suppose experts provide *their own* decomposition and conditional independencies (i.e. *their own* mental model and)
  - decomposition is part of the elicitation process
  - Decompositions may be different for each seed or target event
- Suppose calibration data are collected on the ultimate seed and target events
- Then can treat as if assessed holistically

Probabilities of Events

Assessed by decomposition

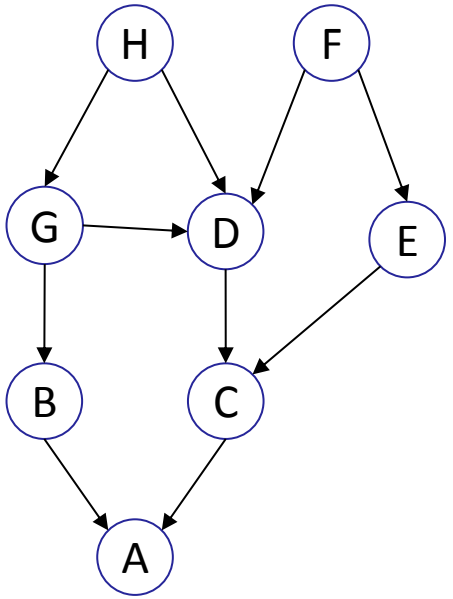
E.g. $P(A) = P(A|B,C,D) \times P(B) \times P(C|D) \times P(D)$



- But now suppose that the decompositions are given by the analyst
- Conditional independence structure may not correspond with the experts' mental models.
- So what would we be calibrating?
- How do we allow for any uncertainty arising from analyst's possible misperception of conditional independencies?
- Need to calibrate (expert⊗analyst) pairs using calibration data on ultimate target variables, A.
  i.e. **calibrate the process of expert & analyst working together**

Belief Nets, CEGs, etc

- Same argument applies to more complex belief nets and other decompositions of probability distributions
- Calibrate
  - at the level of the ultimate target levels
  - if analyst provides net, (expert⊗analyst) pairs
- And if different experts do different nodes …?
  - Leonelli, Smith, …



Expert judgement of quantities

- In many cases we ask experts to predict some observable, but unknown quantity:
  - e.g. the height of a spring tide.
- Many methods deal with this
  - Cooke's classical
  - Bayesian
  - ....
- Note two points:
  1. Ask for a prediction of an observable
  2. Calibration data set needs to refer to similar observables

Expert judgement of parameters

- Most risk and decision analyses use consequence models
- These models inevitably involve parameters
- Parameter values are obtained from:
  - Hard data where possible
  - Explicit expert judgement with careful assessment in some cases
  - Implicit, unnoticed expert judgement in many cases
- Modelling error is usually forgotten
- Model choice, a key expert judgement, is seldom used as a driver of overall uncertainty
- **So if consequence models convey much expert knowledge into the in analysis, we treat that knowledge in a cavalier fashion and ignore the uncertainty they introduce**

Expert judgement of modelling uncertainty

- Don't think of eliciting parameters, but of eliciting modelling uncertainty
- Cooke and others have been arguing against eliciting parameters. Instead elicit observables and fit the model to these.
- But to do this, we rely on the fitted parameters and their uncertainty 'taking up' all the variation
- Maybe add in modelling error:

$$y = f(x, \theta) + \varepsilon$$

  i.e. fit both parameters and a modelling error
- Maybe we will need consider (expert⊗model⊗analyst) triplets.

Conclusion

- None yet …
- But I am very uncomfortable that we are ignoring the expertise built into the model and the uncertainty that this introduces.

Thank you