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Minimising information needs: how does decision making under deep uncertainty do it?

Joseph Guillaume
Aalto University, Finland

Ultimate goal:
How should uncertainty be handled?

What are the different ways uncertainty *can* be handled?

What ways do we *say* uncertainty is handled?
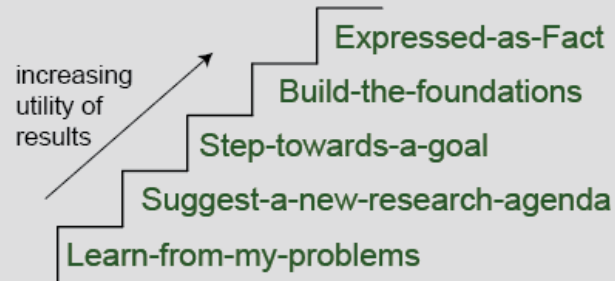
How are information needs reduced?

- **Analysis of "uncertainty framing" in journal abstracts**
- **Typology of tactics for reducing info needs**
  - How do arguments for action handle uncertainty?
  - Enable efficient decision making, not just coping with limitations
  - Extend reach of our community

Analysis of uncertainty framing

- **"Communicating how uncertainty affects the interpretation of a conclusion"**
- **Classifying claims in abstracts, based on qualifiers, structure of argument**
- **177 abstracts in the journal Water Resources Research in 2015**

- There is clearly enough water
- According to standard methods, there is enough water
- The analysis demonstrates that there is enough water
- The model (R^2=0.8) indicates that there is enough water
- In my professional opinion, there is enough water
- We do not know whether there is sufficient water
- Water supply will not be an issue
- This analysis of consumption helps determine whether there is enough water
- The analysis provides an initial estimate of the water balance to determine if there is enough water
- Further work is needed
- There is enough water as long as demand growth does not exceed 5%
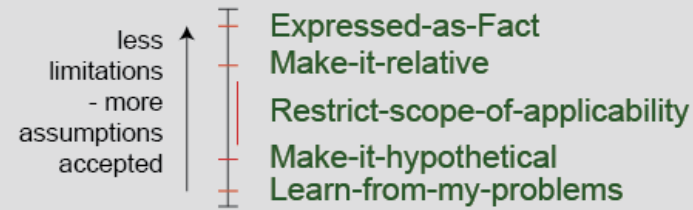- Based on these assumptions, there would be enough water
- …

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a) Maturity and utility

To what extent is the conclusion ready to be used?

increasing utility of results

Expressed-as-Fact
Build-the-foundations
Step-towards-a-goal
Suggest-a-new-research-agenda
Learn-from-my-problems

Uncertainty can be reduced in the long term by delaying a definitive conclusion and investing in future work
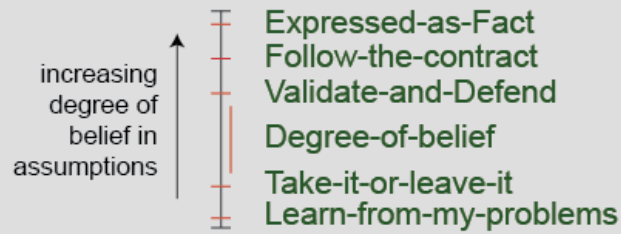
b) Scope of a claim

What limitations are there on how the conclusion can be used?

less limitations - more assumptions accepted

Expressed-as-Fact
Make-it-relative
Restrict-scope-of-applicability
Make-it-hypothetical
Learn-from-my-problems

Uncertainty can be reduced in the short term by making assumptions that limit scope of applicability
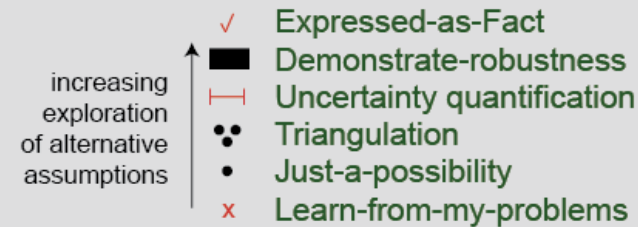
c) Level of belief in a conclusion

How certain is the author that the conclusion is true?

increasing degree of belief in assumptions

Expressed-as-Fact
Follow-the-contract
Validate-and-Defend
Degree-of-belief
Take-it-or-leave-it
Learn-from-my-problems

Uncertainty can be described in terms that allow reasoning about uncertain information

d) Depth of analysis

How thoroughly has the issue been examined?

increasing exploration of alternative assumptions

✓ Expressed-as-Fact
■ Demonstrate-robustness
⊢ Uncertainty quantification
∴ Triangulation
• Just-a-possibility
x Learn-from-my-problems

Uncertainty can be described by considering the effect of alternative assumptions

e) Relatability

Is the conclusion consistent with the reader's prior knowledge?
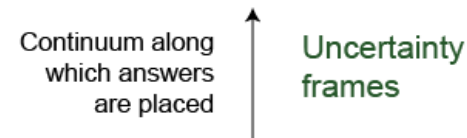
Repeat-with-shifted-scope
New-view-on-existing-result
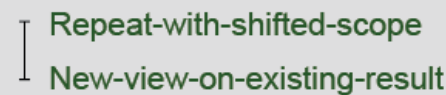
Uncertainty can be handled in communication by anticipating differences in opinion between the reader and author

Legend for sub-tiles

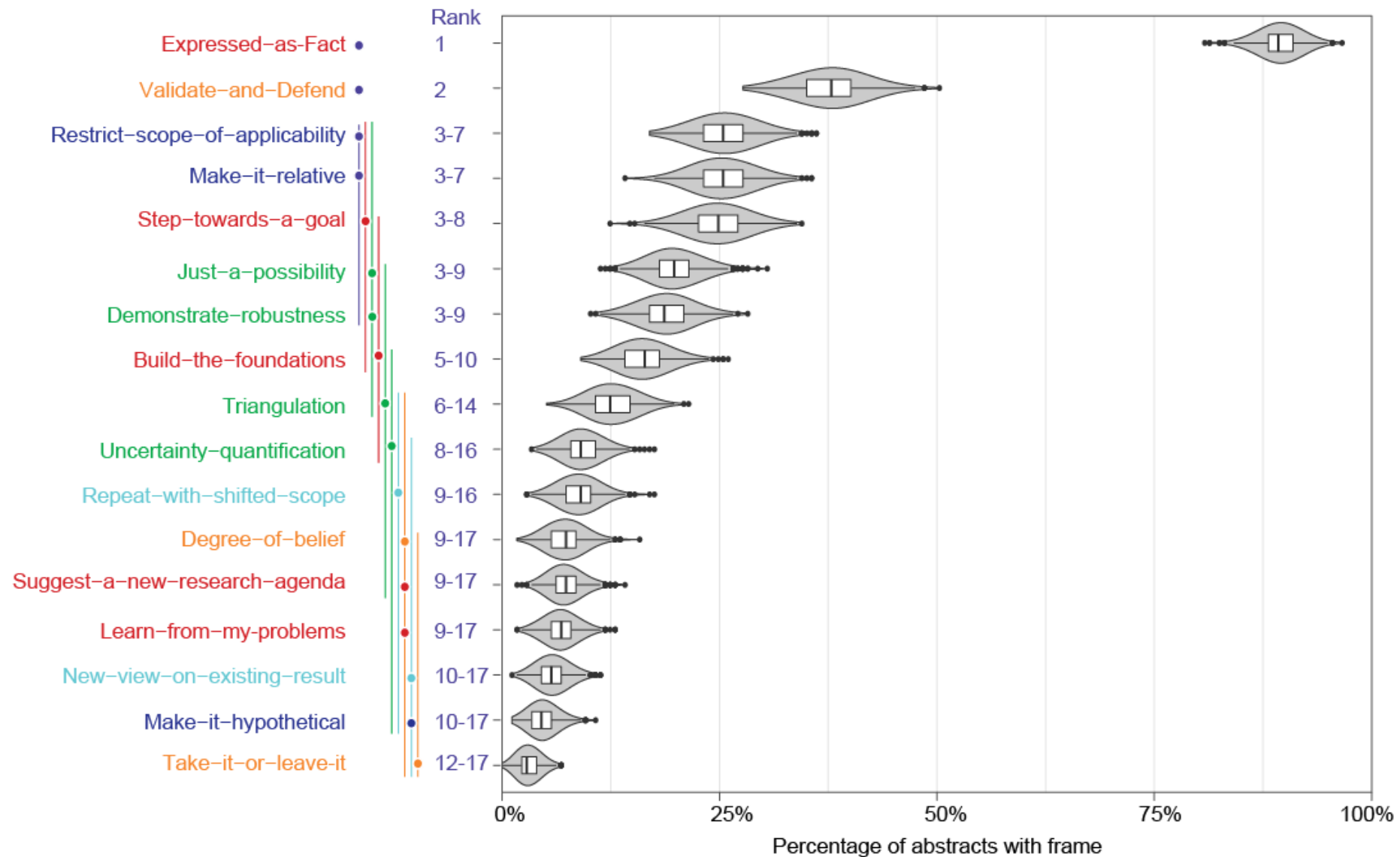**Category of frames**

Core question

Continuum along which answers are placed

Uncertainty frames

Rationale of core question

Guillaume et al. 2017 WRR

	Rank
Expressed-as-Fact	1
Validate-and-Defend	2
Restrict-scope-of-applicability	3-7
Make-it-relative	3-7
Step-towards-a-goal	3-8
Just-a-possibility	3-9
Demonstrate-robustness	3-9
Build-the-foundations	5-10
Triangulation	6-14
Uncertainty-quantification	8-16
Repeat-with-shifted-scope	9-16
Degree-of-belief	9-17
Suggest-a-new-research-agenda	9-17
Learn-from-my-problems	9-17
New-view-on-existing-result	10-17
Make-it-hypothetical	10-17
Take-it-or-leave-it	12-17

Percentage of abstracts with frame

Category of frames:
Maturity and utility
Scope of a claim
Level of belief
Depth of analysis
Relatability

Vertical lines indicate frames
that are statistically equally frequent:

12-17
Range of possible ranks
given uncertainty

Bootstrapped uncertainty in
frequency of occurrence of frames:

Probability density function
Q25 Q75
Q50
1.5*Interquartile range

Guillaume et al. 2017 WRR

Tactics for reducing information needs

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?

What (uncertain) information will I use?

Eat

How am I going to use it?

How will the argument avoid needing perfect Information?

Fundamental tactics:

?

What (uncertain) information will I use?

Specifying info requirements	e.g. maximise utility e.g. satisficing
Deferring info acquisition	e.g. Ask for clarification e.g. Someone else decides for me
Action to influence uncertainty	e.g. Custom order
Risk-based reasoning	e.g. probabilities e.g. scenarios

⟶ Eat

Layering argumentation for different uncertainties

? **Are constraints satisfied?**

e.g. Use only info in menu

e.g. Plan for offsetting

e.g. Agree to share or swap

e.g. Lower your expectations

e.g. Explain your choice

Specifying info requirements

Deferring info acquisition

Action to influence uncertainty

Risk-based reasoning

First option that satisfies triple bottom line:
- **Feels good**
- **Socially accepted**
- **Good conscience**

(Specify info reqs)

→ **Eat**

Risk-based reasoning: degree of belief

Turn a probability or performance statistic into a decision

Specifying info requirements

**Sufficiently certain
(Standard of acceptance)
Maximize likelihood/expected value**

Deferring info acquisition

**Accept risk
(Expect failure)**

Risk-based reasoning – what should be done given degree of belief?

Action to influence uncertainty

Change the problem, and the degree of belief

Risk-based reasoning

**Probability bounds analysis
Second-order probabilities**

Risk-based reasoning: plausible scenarios

Enabling fundamental tactics for complex situations

Specifying info requirements	**Precautionary principle (plausible and unacceptable)**	
	Robustness (bounding rule+summarising rule)	**Risk-based reasoning – what should be done given scenarios are plausible**
Deferring info acquisition	**Adaptive pathways (relations between scenarios)**	
Action to influence uncertainty	**Select mitigation, shaping actions**	
Risk-based reasoning	**Assign probabilities**	

Risk-based reasoning: limited scope

e.g. hypotheticals, conditional statement

Specifying info requirements

Solve a theoretical problem

Deferring info acquisition

Plan future research
Give to decision maker
e.g. scenario discovery
e.g. inverse methods

Risk-based reasoning – what should be done in a pure exploration?

Action to influence uncertainty

Theory made reality

Risk-based reasoning

Determine plausibility
Assign probability

I can make a decision now because

Specifying info requirements

Process only needs some information about alternatives

Deferring info acquisition

The information acquisition process is ongoing

Action to influence uncertainty

I can influence the effect of uncertainties in consequences of my decision

Risk-focussed reasoning

My reasoning has considered acceptability of uncertainty in consequences, i.e. the risks involved

Specifying info requirements

Process only needs some information about alternatives

Make-it-relative

Deferring info acquisition

The information acquisition process is ongoing

Build-the-foundations
Step-towards-a-goal
Suggest-a-new-research-agenda

I can make a decision now because

Action to influence uncertainty

I can influence the effect of uncertainties in consequences of my decision

Repeat-with-shifted-scope
New-view-on-existing-result

Risk-focussed reasoning

My reasoning has considered acceptability of uncertainty in consequences, i.e. the risks involved

Characterisation of uncertainty

Restrict-scope-of-applicability
Make-it-hypothetical

Uncertainty-quantification
Triangulation
Expressed-as-fact

Degree-of-belief

Specifying info requirements

Deferring info acquisition

Demonstrate-robustness
Validate-and-Defend
Follow-the-contract

Take-it-or-leave-it

Conclusions

- **No free lunch: decisions become possible because of information introduced about how to handle uncertainty**

- **Four fundamental tactics to combine**

  - *Specifying info requirements, Deferring info acquisition, Action to influence uncertainty, Risk-based reasoning*

- **Argument mapping can help hierarchically decompose treatment of information needs**

- **Many methods can be used in several fundamentally different ways**

- **We are far from capturing all the ways of handling uncertainty**

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**Joseph.Guillaume@aalto.fi
@jha_guillaume**