

Validation of uncertainty-oriented environmental models

A review of the existing approaches

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Model “Validation”

- *In environmental modeling,*

whether model outcomes are consistent with observational data, or the model is a representation of physical reality

Positivist

Relativist

- *In decision sciences,*

‘establishing confidence in the model by judging its usefulness with respect to some purpose

Representativeness

Usefulness

- *In Merriam-Webster,*

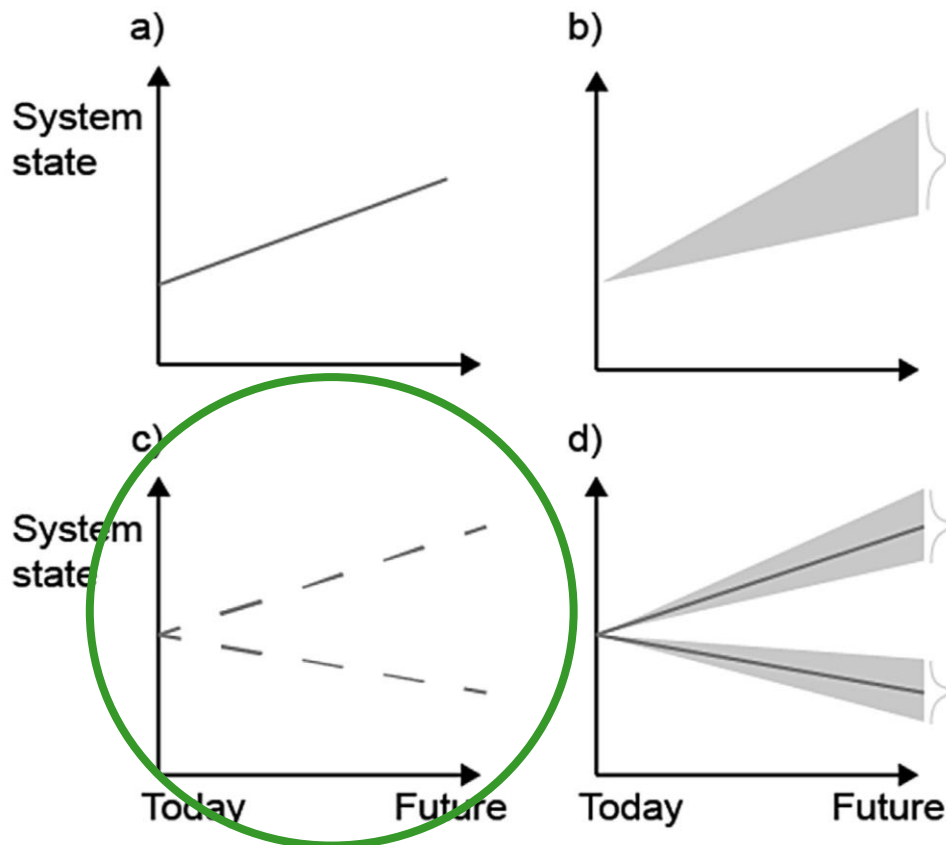
valid : “well-grounded and justifiable

Formal techniques, Data

Participatory techniques

...uncertainty-oriented models

Three complementary paradigms for modelling the future



Source:
Maier, H., Guillaume, J., van Delden, H., Riddell, G.,
Haasnoot, M., Kwakkel, J., 2016. An uncertain future,
deep uncertainty, scenarios, robustness and adaptation:
How do they fit together? *Environmental Modelling &
Software* 81 154-164.

Validation of uncertainty-oriented models

Requirements
for
uncertainty-
oriented
models

What are the existing validation viewpoints, **in a general** modeling context?

What are the existing validation viewpoints, when models are used for **scenario exploration**?



Existing
validation
approaches

- Text-mining of the academic literature
- Online survey

Overview of the model validation literature

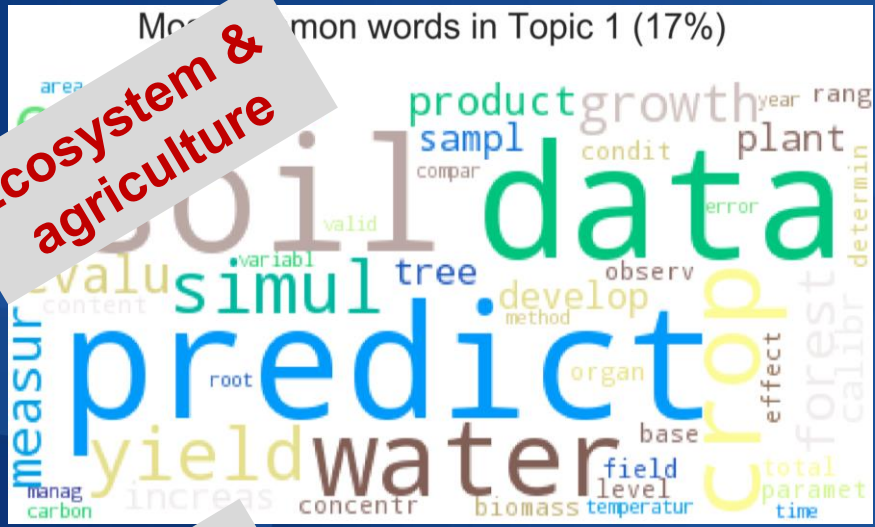
Text-mining analysis

	DATASET I	DATASET II
<i>Any of the title, abstract or keywords include</i>	"model validation" OR "model validity" OR "model evaluation" OR "model assessment"	("model validation" OR "model validity" OR "model evaluation" OR "model assessment") AND scenario
<i>Years</i>	1980-present	
<i>Language</i>	only English	
<i>Predefined Scopus fields</i>	<ul style="list-style-type: none"> ▪ Environmental science ▪ Agricultural and biological sciences ▪ Energy ▪ Social sciences ▪ Economics, econometrics and finance ▪ Decision sciences ▪ Multidisciplinary 	
<i>Number of documents returned</i>	15821	1124

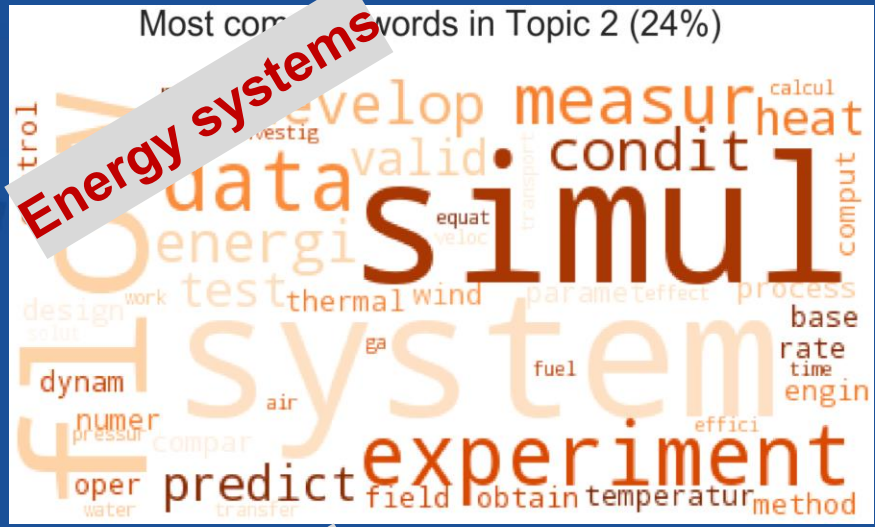
Overview of the model validation literature

Dataset I

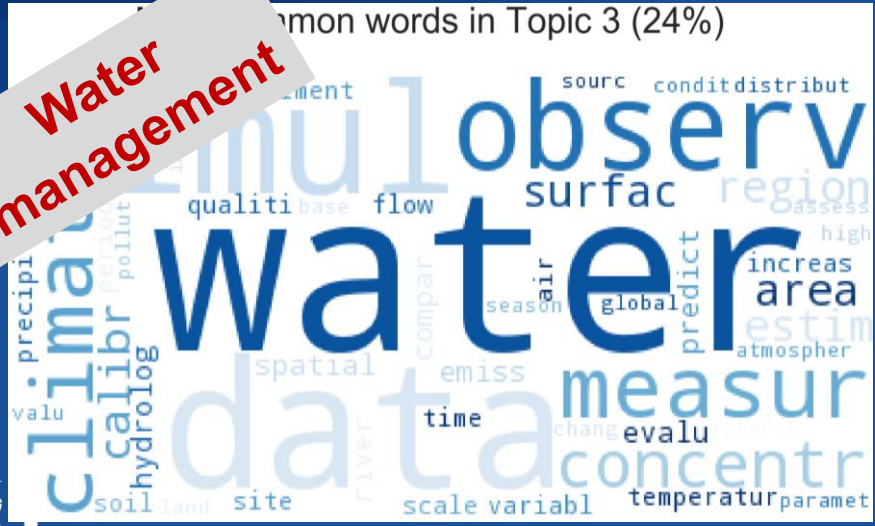
Ecosystem & agriculture



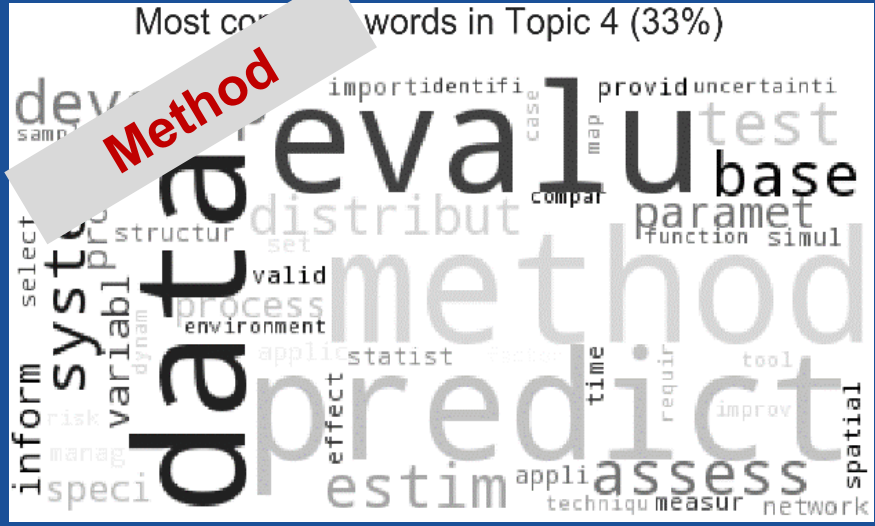
Energy systems



Water management

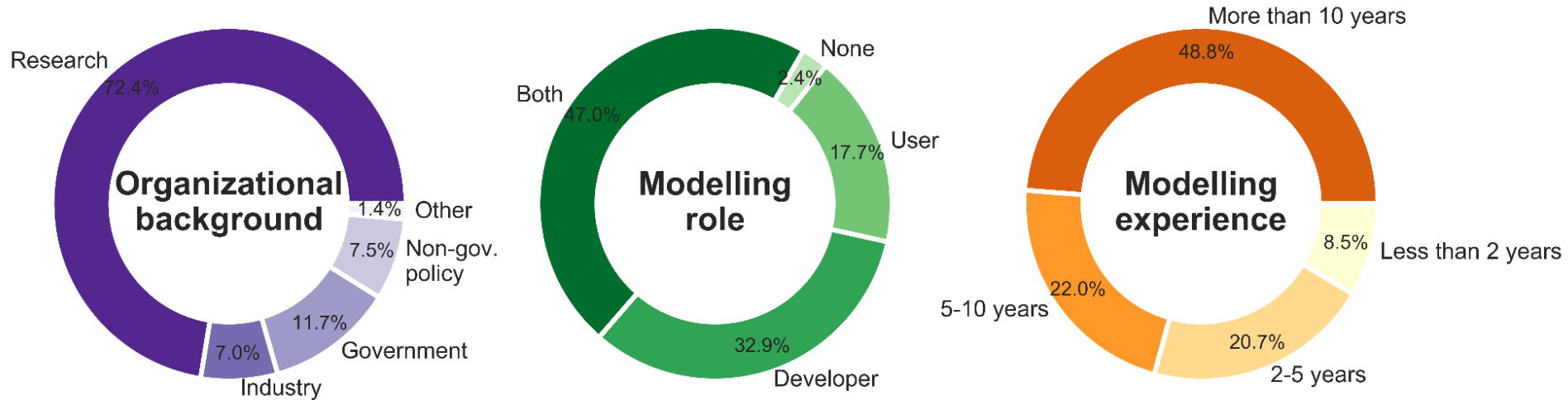


Method



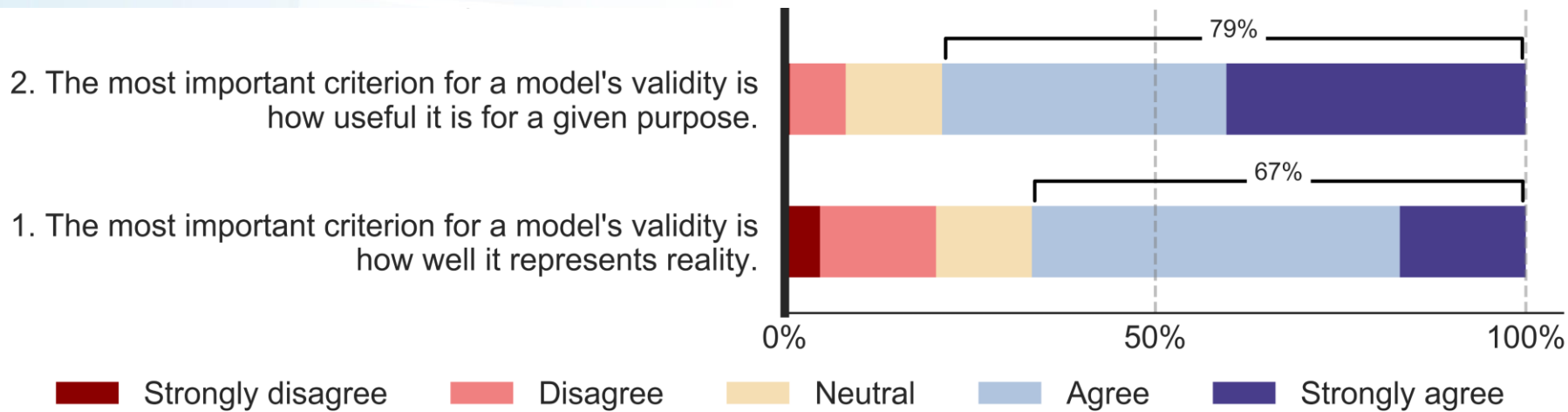
Survey on Model Validation

Backgrounds of the survey respondents



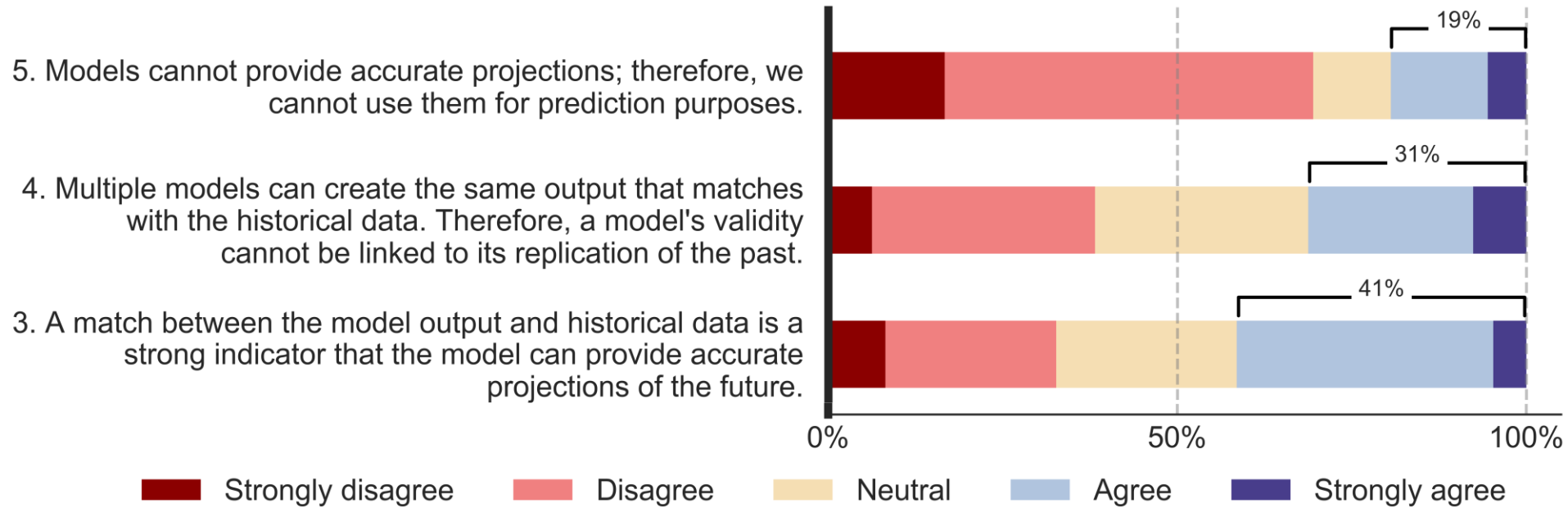
Survey on Model Validation

Representativeness vs Usefulness



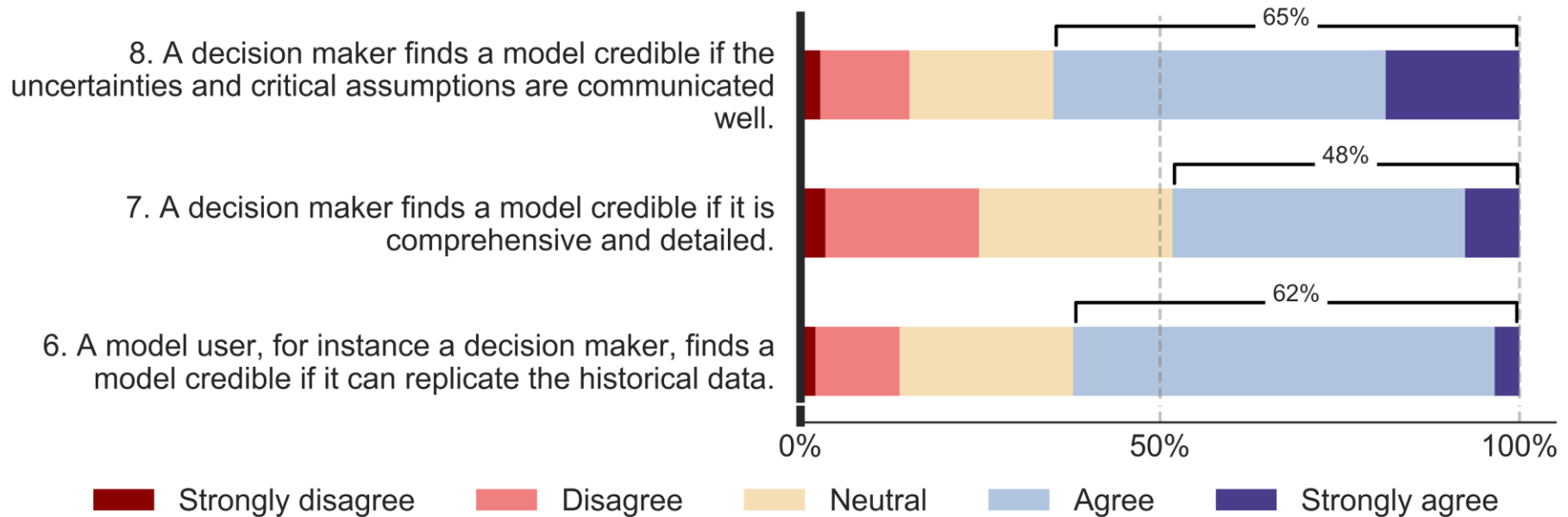
Survey on Model Validation

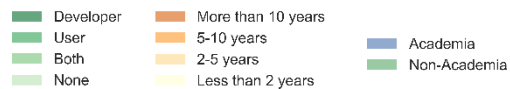
Data



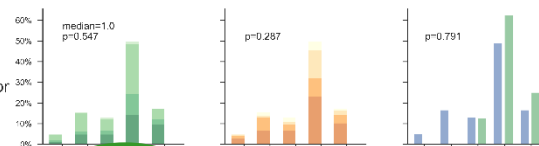
Survey on Model Validation

Decision maker's view

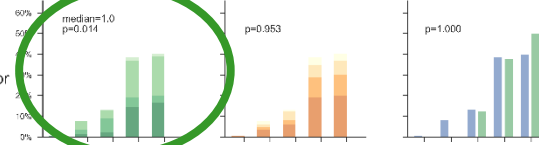




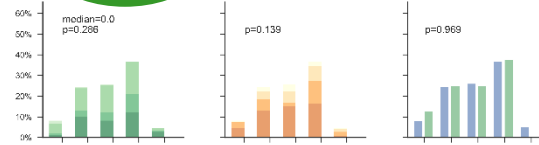
1. The most important criterion for a model's validity is how well it represents reality.



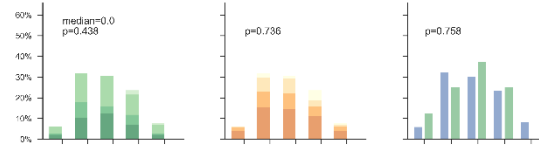
2. The most important criterion for a model's validity is how useful it is for a given purpose.



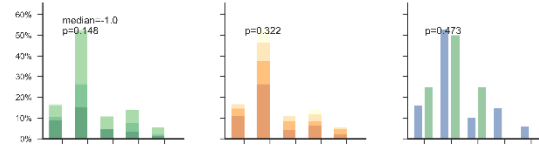
3. A match between the model output and historical data is a strong indicator that the model can provide accurate projections of the future.



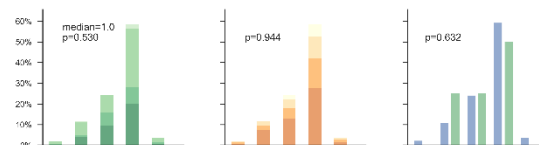
4. Multiple models can create the same output that matches with the historical data. Therefore, a model's validity cannot be linked to its replication of the past.



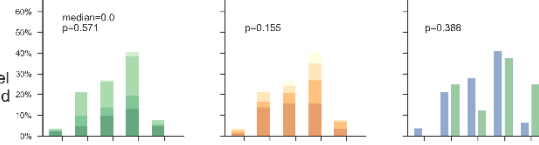
5. Models cannot provide accurate projections; therefore, we cannot use them for prediction purposes.



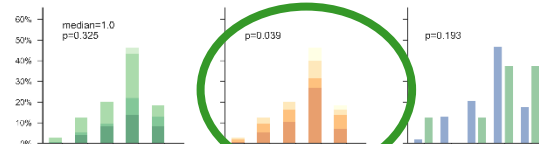
6. A model user, for instance a decision maker, finds a model credible if it can replicate the historical data.



7. A decision maker finds a model credible if it is comprehensive and detailed.



8. A decision maker finds a model credible if the uncertainties and critical assumptions are communicated well.

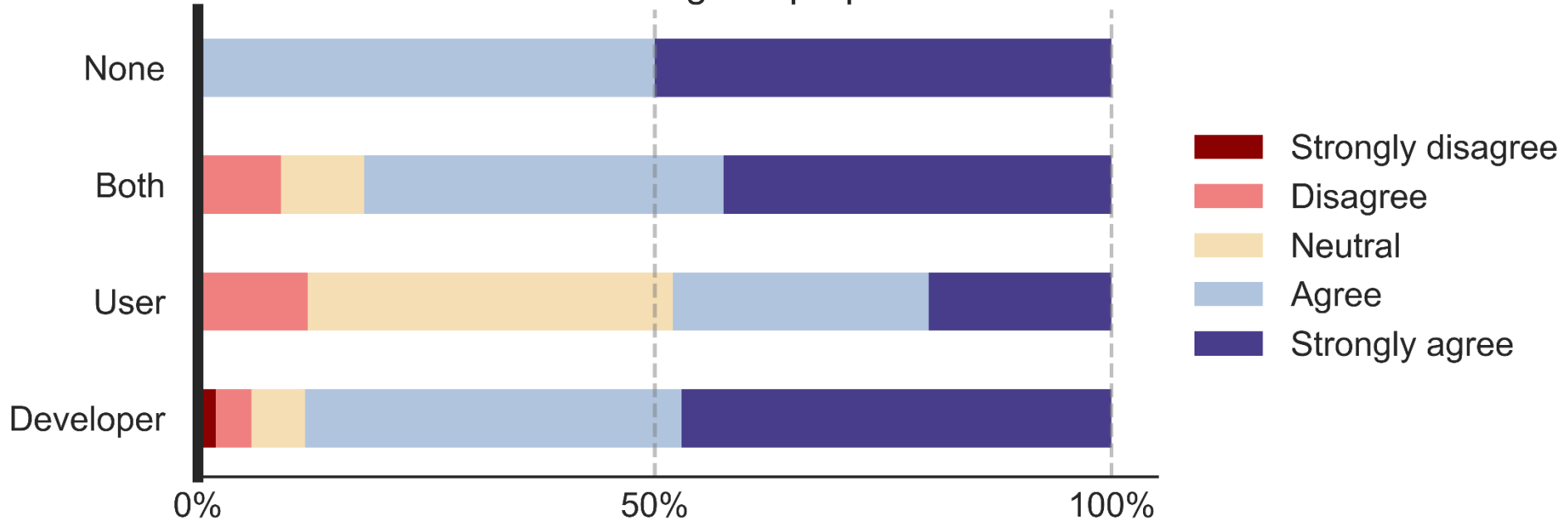


(a) (b) (c)

Survey on Model Validation

Modelling role

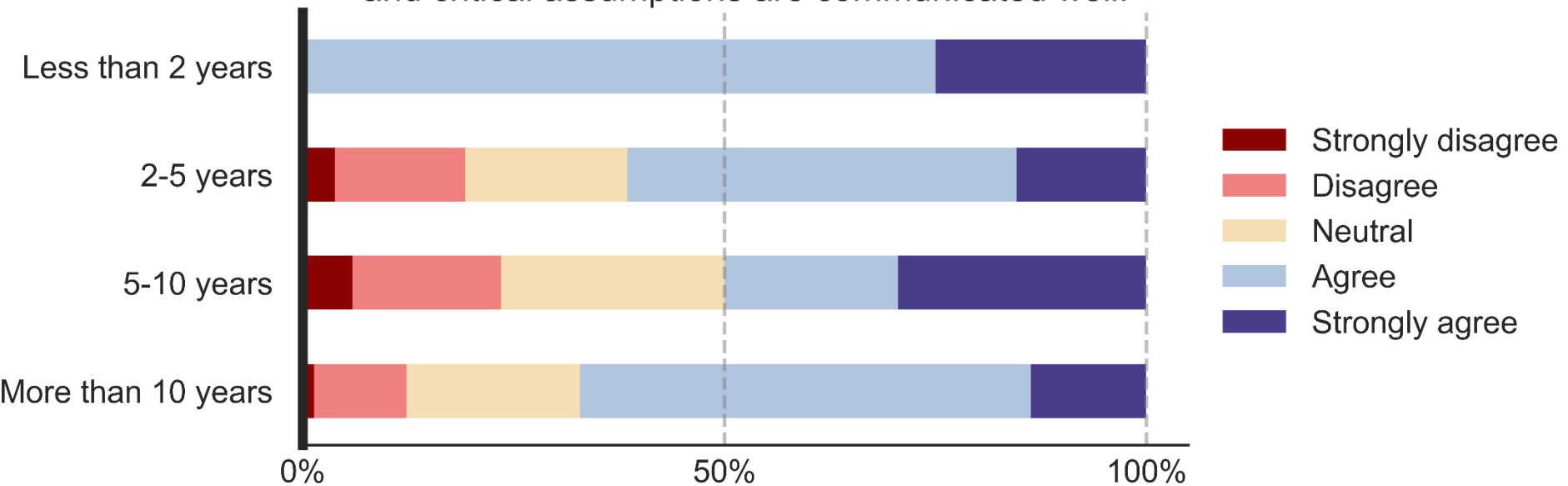
The most important criterion for a model's validity is how useful it is for a given purpose.



Survey on Model Validation

Experience

A decision maker finds a model credible if the uncertainties and critical assumptions are communicated well.



Conclusions

- Data-oriented validation for predictive power
- ... even when models are used for scenario exploration
- No dichotomy of representativeness vs usefulness
- Strong support for comparison to historical data
- Structure and scenario ensemble are more important in the validation of uncertainty-oriented models

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