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Extending TransSet: An Individualized Model for Human Syllogistic Reasoning

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Syllogistic Reasoning

- Syllogistic reasoning is one of the oldest domains in reasoning research
- Usually, syllogistic tasks have the following form:

Some A are B.
Some B are C.

What, if anything, follows?

- Two quantified premises with terms A, B, C
- Four possible quantifiers:
  All, Some, No, Some ... not
- Task: Find quantified relation between (A, C) or "No Valid Conclusion" (NVC)

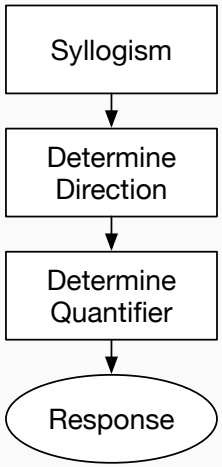
- There are substantial differences between individuals when solving these tasks, yet most models only describe the average reasoner
- "No Valid Conclusion" seems to be a point of vantage: Several biases towards and against NVC are discussed in the field

→ We use this to extend TransSet, a model that was shown to describe the average reasoner well, to account for individuals[1]

[1] Brand, D., Riesterer, N., & Ragni, M. (2019). On the Matter of Aggregate Models for Syllogistic Reasoning: A Transitive Set-Based Account for Predicting the Population. In T. Stewart (Ed.), Proceedings of the ICCM 2019 (pp. 5-10).

TransSet

- TransSet consists of two phases:



1. Determine direction
   Search for a transitive path between the end-terms to determine the direction of the conclusion
2. Determine quantifier
   Propagate a set along the path to determine the quantifier of the conclusion

- If any phase fails, NVC is concluded

$\rightarrow$ The likelihood of a phase to fail might depends on an individual's attitude towards NVC

$\rightarrow$ We introduced parameters to describe the individual characteristics

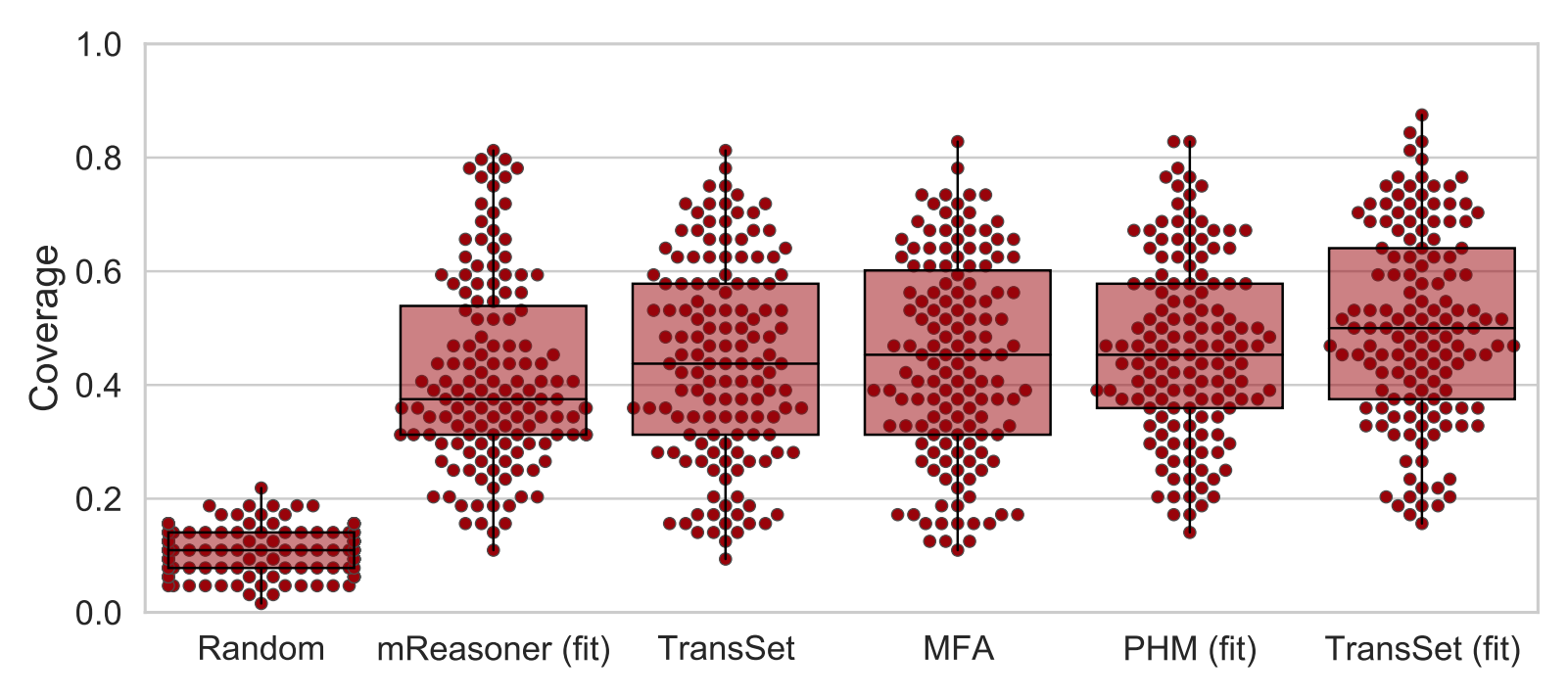
Individualizing TransSet

- We introduced 4 parameters representing biases and strategies, thereof 2 against and 2 towards NVC
  - NVC aversion: Individuals can have a bias against NVC and try to prevent phases from failing
  - NVC anchor: Preference when choosing a term to determine the direction if failing of the direction phase should be prevented
  - Negativity: Reasoners can have strategies to directly infer NVC from negative quantifiers
  - Particularity: Reasoners can have strategies to directly infer NVC from two particular quantifiers

→ We fitted the model to each participant in the dataset[2] to evaluate the model's ability to cover the individual patterns

[2] Taken from the CCOBRA framework (https://github.com/CognitiveComputationLab/ccobra)

Results



- The extension improved the model significantly (44% $\rightarrow$ 50%)
- TransSet outperformed two state-of-the-art models, PHM and mReasoner
- It surpassed the most-frequent answer (MFA), the statistical upper limit for aggregate models

$\rightarrow$ It shows the potential of the individualization of models exploiting specific properties of the domain