

Unifying Models for Belief and Syllogistic Reasoning

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Belief Effect in Syllogistic Reasoning

Is the conclusion of the following syllogism correct?

No addictive things are inexpensive.
Some cigarettes are inexpensive.

Therefore, some addictive things are not cigarettes.

- 92% accept the conclusion (Evans et al., 1983), although it is not valid
- However, without believable content, only 8% accept it!
- Background knowledge and belief has an effect on our reasoning

Traditional Models vs. Belief Models

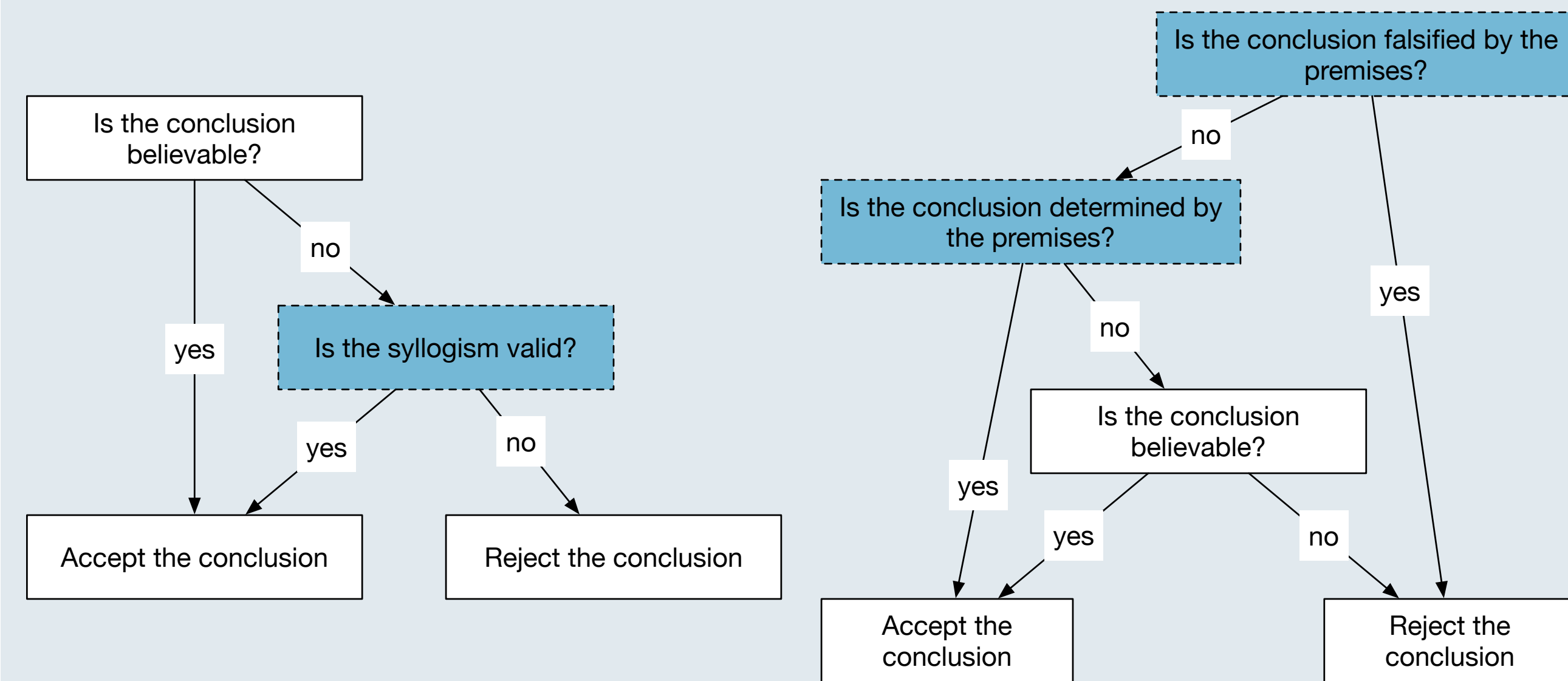
- Traditional models for syllogistic reasoning usually focus on the structure of a syllogism
- Models are able to predict conclusions for all syllogisms
- Experiments usually rely on neutral content to avoid the belief effect
- Models for the belief effect rely only on the believability
- Often analyzed via experimental manipulations on a small subset tasks
- Tasks are selected to reduce structural effects
- Models are mostly statistical models
- We aim at combining both worlds to obtain better predictive models

Evaluation Foundation

- Data from meta-analysis by [1]
- Results from 22 studies
- 993 individuals that answered 16 syllogistic tasks each (usually 8 with believable content and 8 with unbelievable content)
- The conclusion was presented, and the participants were asked whether they accept it or not
- In some studies, participants were asked the same tasks twice
- Participants should respond with ratings between 1 and 6
- Models were evaluated in CCOBRA [2]
- Several baselines were used for comparison (random ratings, past ratings, individual selection of best belief model, portfolio selecting the best belief and reasoning model)
- Models were evaluated wrt. acceptance and ratings of conclusions

Belief Models

- We used two process models by [3]



Selective Scrutiny
Belief is prioritised over logic

Misinterpreted Necessity
Beliefs are considered if the conclusion does not follow logically

- The blue boxes represent the „logic mechanism“
- We used these places to integrate traditional reasoning models (mReasoner [4], PHM [5])

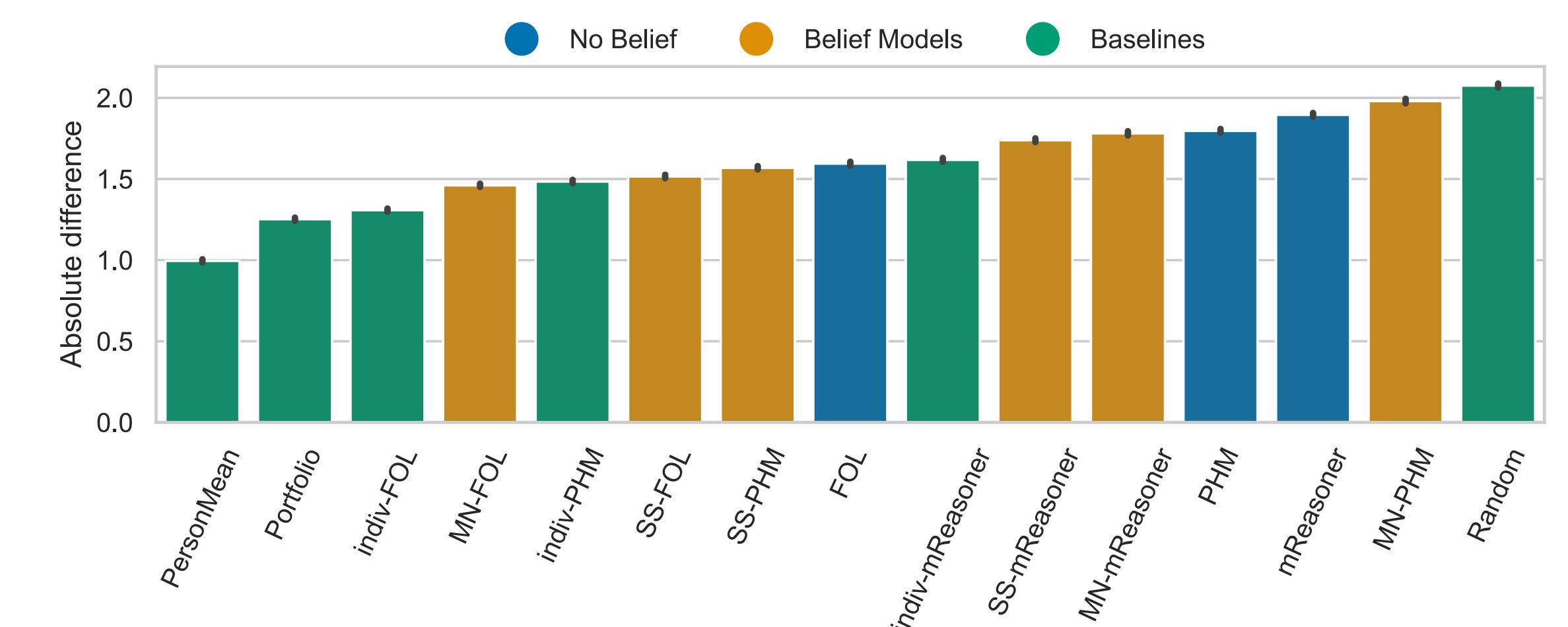
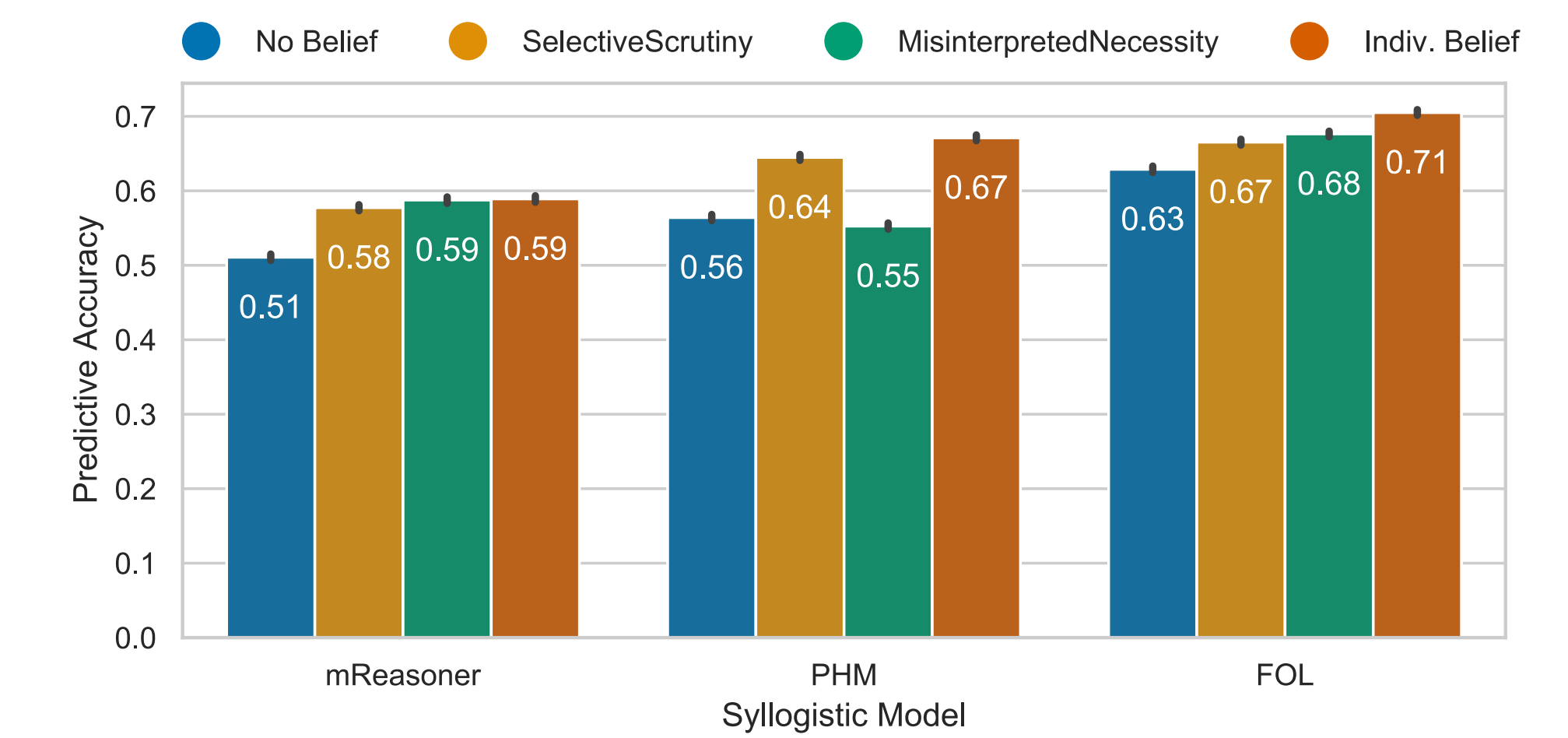
Predicting Ratings

- We leverage the paths in the belief models to derive gradations for predicting ratings

Follows?	Possible?	Believable?	Sel. Scrutiny	Mis. Nec.	No Belief
✓	-	✓	6	6	5
✓	-	✗	4	5	5
✗	✓	✓	5	4	2
✗	✓	✗	2/3	3	2
✗	✗	✓	5	2	2
✗	✗	✗	1/2	1	2

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Conclusions

- Predictive performance was improved for both, belief and reasoning models
- Models were adapted to ratings, which is richer data compared to dichotomous responses
- Data foundation introduced a bias towards logic since the tasks were specifically selected to reduce structural effects
- Reasoning research is missing general purpose data for modeling
- Results illustrate the potential stemming from unified models