Prediction can be safely used as a proxy for explanation in causally consistent Bayesian GLMs

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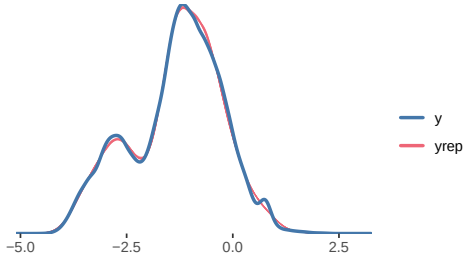
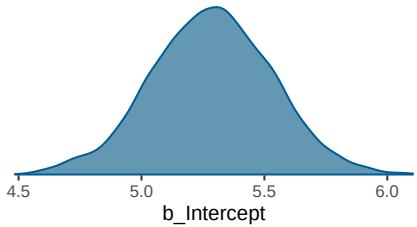
Research Goals

Prediction



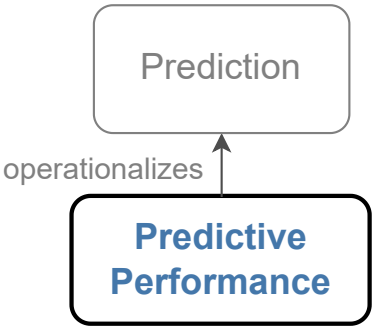
Explanation



Prediction

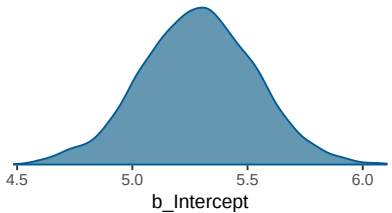
Compare model output to real-world observables.

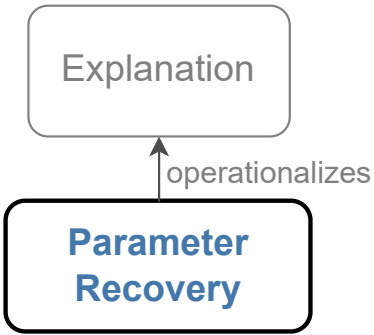
```
##       elpd_diff se_diff
## msln3    0.0       0.0
## mln3  -277.0       8.7
## sln2  -418.7      19.6
## ln2   -539.8      19.0
```



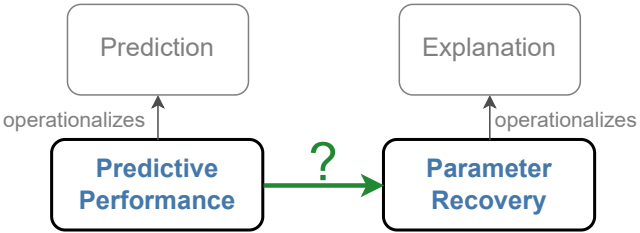
Explanation

Understand the inner workings of a process.

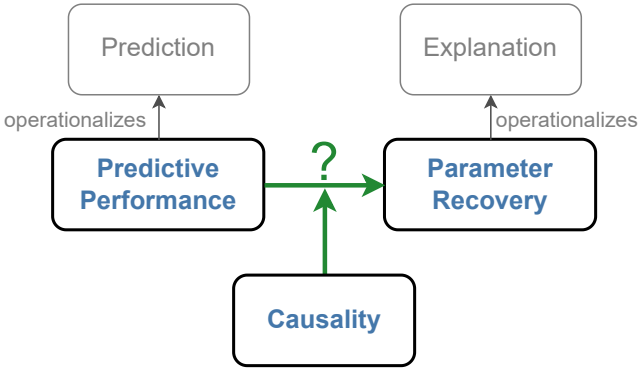




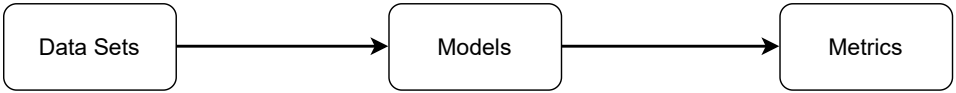
Prediction as Proxy for Explanation



The role of causality?

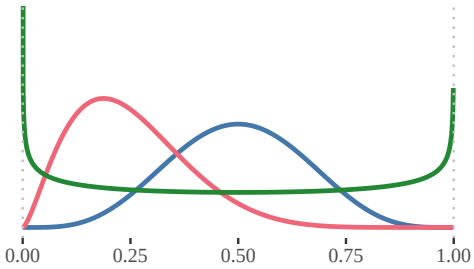


Simulation Study Setup

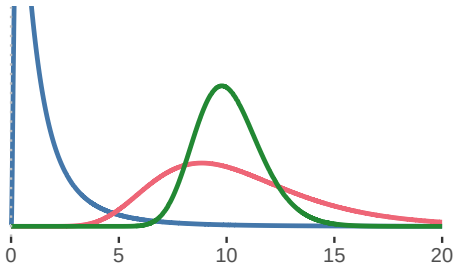


Data

Double-bounded Data

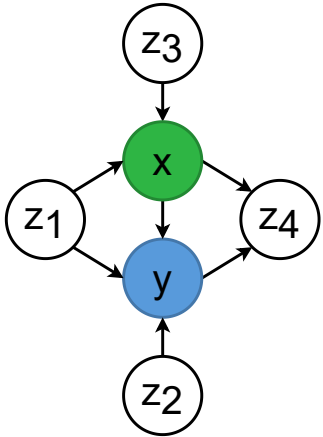


Lower-bounded Data



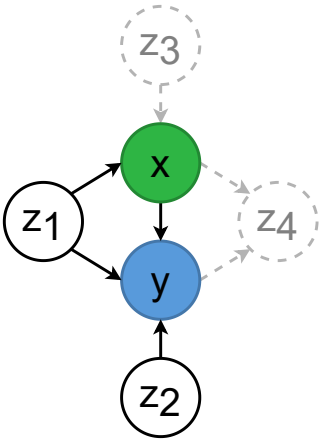
Simulation DAG

- x: treatment
- y: outcome
- z_1: fork
- z_2: ancestor of y
- z_3: ancestor of x
- z_4: collider

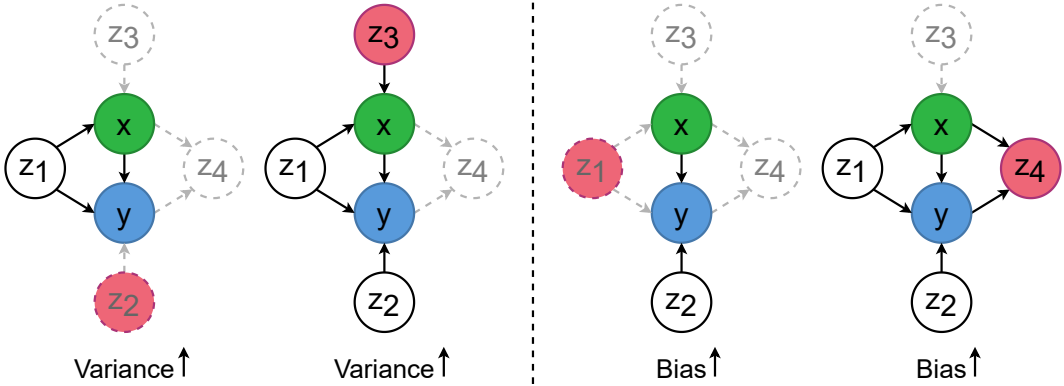


Ideal Model

- condition on x, z_1 and z_2
- $y \sim x + z_1 + z_2$
- unbiased
- minimal variance



Misspecified Models



Predictive Performance Metric

Expected log predictive density (ELPD)

- $\triangle \text{ELPD}_{\text{loo}}$
- less is worse

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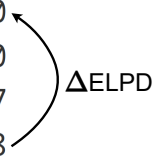
```



Parameter Recovery Metrics

Same link

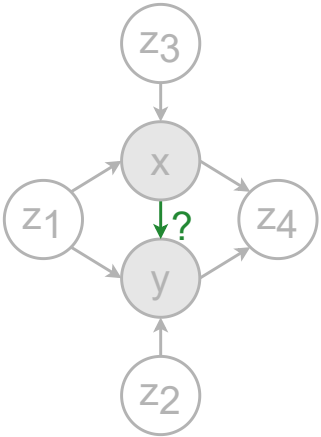
- bias and RMSE

  of samples

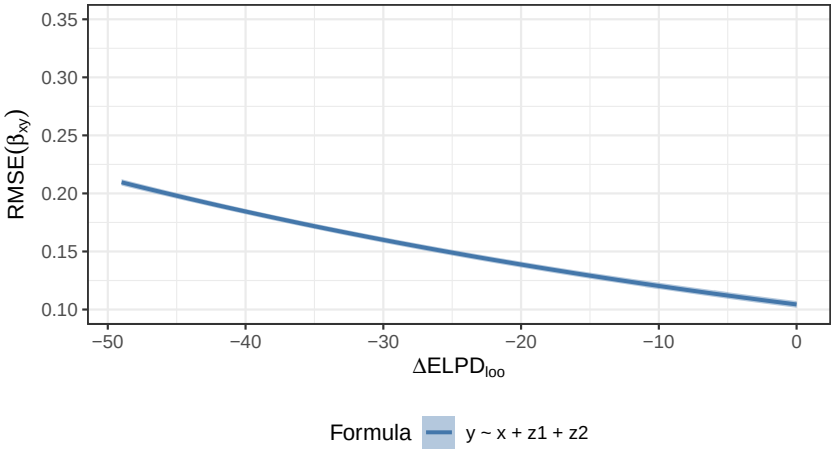
Across links

- false positive ratio (FPR)
- true positive ratio (TPR)

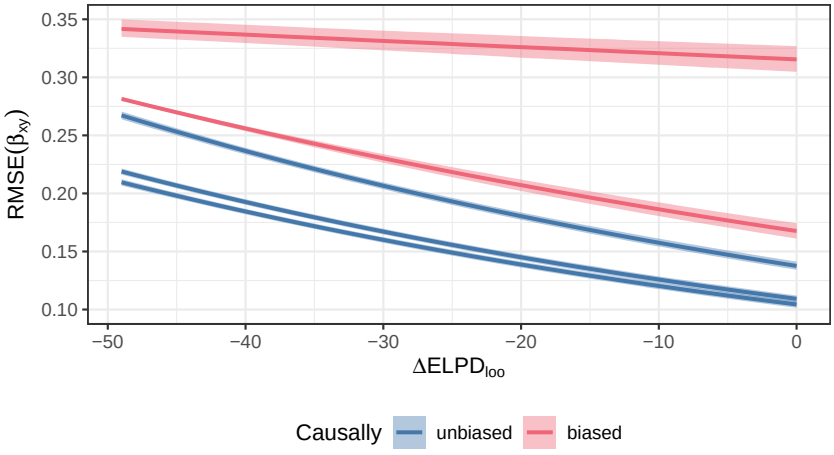
  of the posterior mean



RMSE Result


0.35
0.30
0.25
0.20
0.15
0.10
RMSE(β_{xy})
−50
−40
−30
−20
−10
0
ΔELPD$_{loo}$
Formula
y ~ x + z1 + z2

RMSE Result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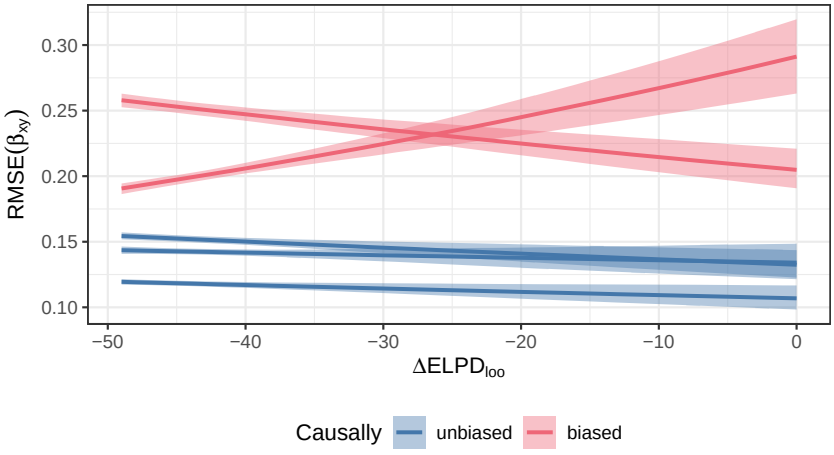
ΔELPD$_{loo}$
Causally
unbiased
biased

RMSE Result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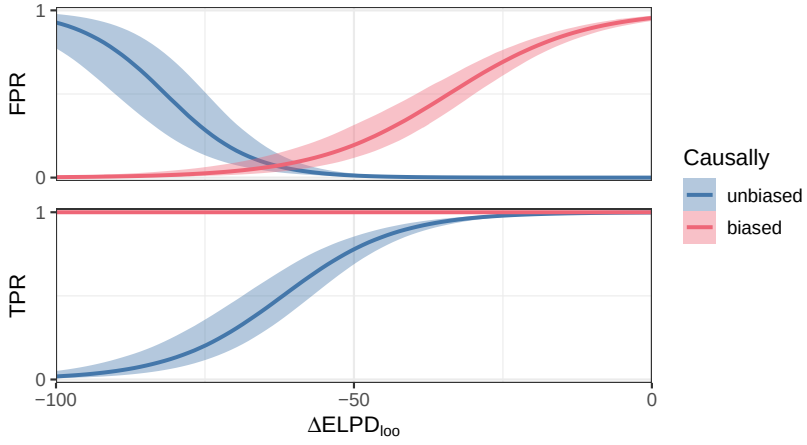
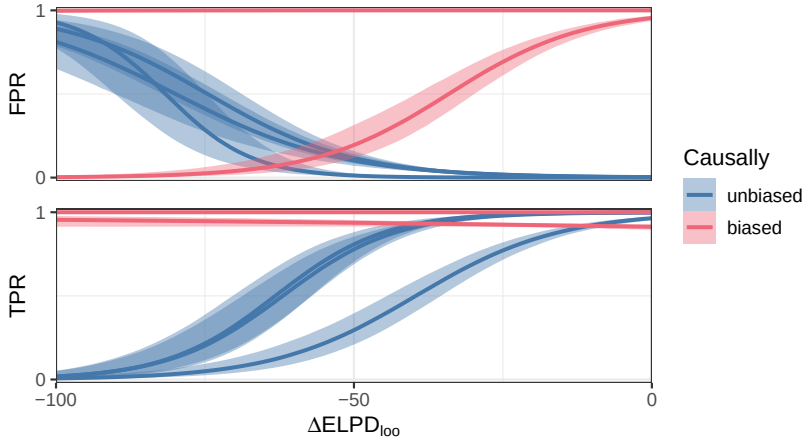
Calibration Result



Calibration Result



Summary

Unbiased Models

- Explanation improved with improving out-of-sample predictive performance.
- The trend is highly consistent across individual data sets.

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Unbiased Models

- Explanation improved with improving out-of-sample predictive performance.
- The trend is highly consistent across individual data sets.

Biased Models

- Show no consistent behavior.

Conclusion

Given a set of GLMs,
that all share the same unbiased causal model,
prediction can be safely used as a proxy for explanation.

Contact

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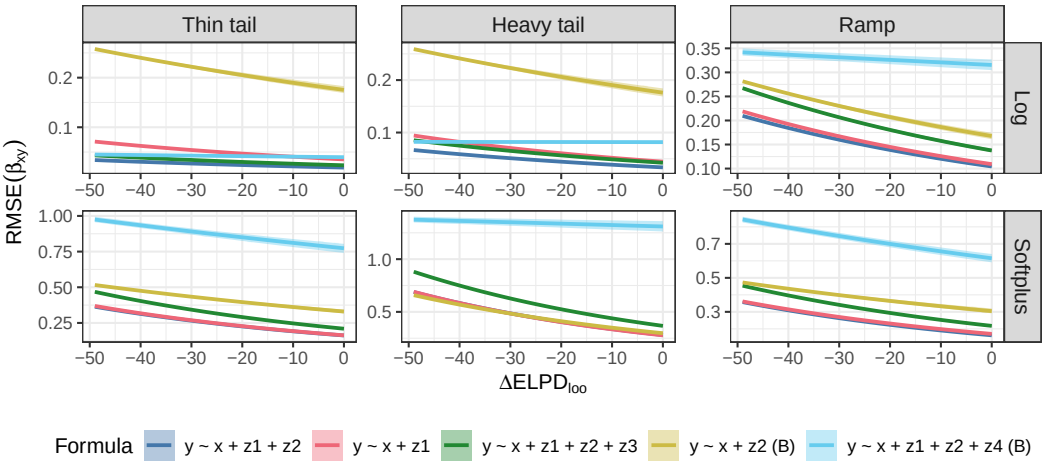
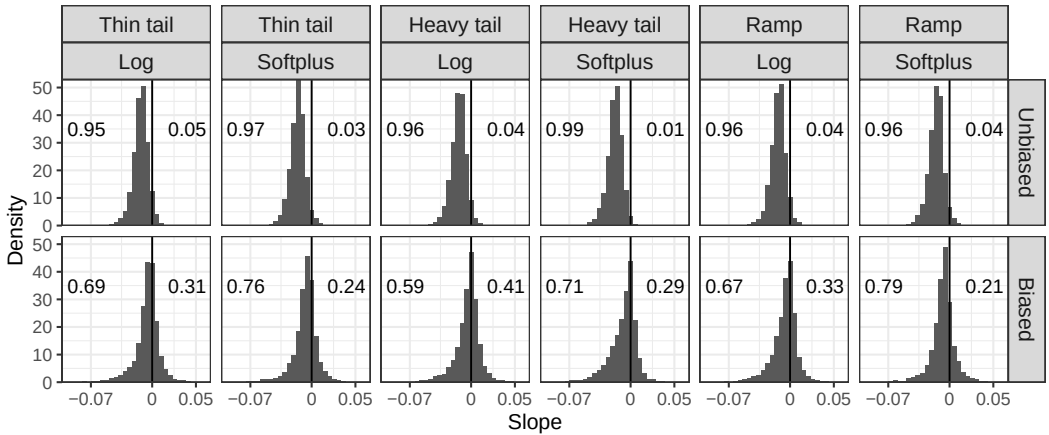
More Results



More Results



More Results