

Learning Calibrated Belief Functions from Conformal Predictions

***Vitor Martin Bordini, Sébastien Destercke and
Benjamin Quost***

Heudiasyc lab

July 11, 2023

Plan

- Introduction
- Our approach

Calibration

Probability Prediction Decision

51%



Calibration

Probability Prediction Decision

51%



90%



Calibration

Probability Prediction Decision

51%



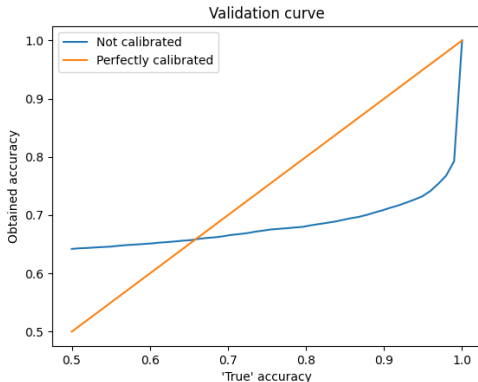
90%



Conclusion : Number itself is also important.

Problem

- Models tend to be ill-calibrated.
- Result doesn't reflect reality.



Calibration

- $h(x) = \hat{P}(y = 1)$.
- One formal definition : $P(y = 1|h(x) = \alpha) = \alpha$.
- Does our model probability reflect the real one ?
- A way to get it : **Inductive Conformal Prediction (ICP)**

Downsides of ICP

- We need a calibration set \mathcal{D}_{cal} .
- Inference time not compatible with real-time applications.

Questions

- What is the bridge between ICP and Imprecise Probability? (Belief Functions)
- How to solve ICP downsides? (Learn a model)



Plan

- Introduction
- Our approach

Constructing Belief Functions from ICP

1. Make conformal predictions from a model.

Constructing Belief Functions from ICP

1. Make conformal predictions from a model.
2. It is proven that **ICP output p is equal to a possibility distribution π .**

Constructing Belief Functions from ICP

1. Make conformal predictions from a model.
2. It is proven that **ICP output p is equal to a possibility distribution π** .
3. Normalise π into π^* so $\max \pi^* = 1$.

Constructing Belief Functions from ICP

1. Make conformal predictions from a model.
2. It is proven that **ICP output p is equal to a possibility distribution π** .
3. Normalise π into π^* so $\max \pi^* = 1$.
4. $Bel(A) := N(A) = 1 - \max_{x \in \neg A} \pi^*(x), \forall A \subseteq \Omega$.

How to overcome calibration weakness ?

- Calibration requires some data and time.

How to overcome calibration weakness ?

- Calibration requires some data and time.
- Train a model from calibrated outputs.

Learning ICP output

- Train a probabilistic model.
- Do a conformal prediction on every sample.
- Train a regressor.

