PriorDraw: A User-Friendly Interactive Tool for Translating Prior Beliefs into Probability Distributions

Hamid BULUT
University of Luxembourg,
Department of Social Sciences

Robin SAMUEL
University of Luxembourg,
Department of Social Sciences

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Expressing prior beliefs as actual probability distributions can be a complex and time-consuming task for practitioners in fields such as applied statistics and machine learning. Manual parameterisation when converting prior beliefs into corresponding parameters can be cumbersome, requiring advanced mathematical knowledge and technical expertise. Additionally, the lack of an intuitive and user-friendly tool for formulating prior beliefs can make it difficult to effectively communicate expert domain knowledge and collaborate with colleagues in solving statistical problems.

The `R` package `PriorDraw` enables the specification of prior distributions in an intuitive way, eliminating the need for manual parameterisation. All the user has to do is draw a target prior probability distribution on a regular or touch screen with a computer mouse, pen, or finger. The app will then make a probabilistic mapping to standard probability distributions. Users have the option of drawing a specific distribution on a given grid that best describes their prior beliefs about certain parameters. They then receive visual aids and feedback from the app on which distribution most closely corresponds to the drawn distribution in terms of family and parameterisation. This is achieved by using the widely used machine learning framework `TensorFlow` to train an image classification model that allows us to match the images drawn by the user (Silaparasetty 2020). The model itself is run within `Shiny`, a web application framework in `R`, providing an intuitive graphical user interface that can be run in `R` using `HTML`, `CSS` and `JavaScript` (Chang et al. 2022). We also adopted some features from `The Distribution Zoo` app to give the user a visual reference for the probability distributions (Lambert and Cooper 2019).

Future developments include increasing the precision of the software's pattern recognition to ensure an even more accurate translation of prior beliefs into distributions. Furthermore, a seamless connection of the Shiny app within `R` is planned, so that it can intuitively and conveniently translate prior beliefs into corresponding parameters from other software packages such as `brms` or `rstanarm` within `RStudio` or alternative IDEs and visualise them as prior predictive distributions. The app is currently limited to commonly used families of continuous probability distributions. Hence, efforts will also be made to include support for discrete distributions. Additionally, the tool is also well suited as a teaching aid, as it provides a hands-on approach to learning about probability distribution functions.

Keywords: Bayesian Statistics, Prior Beliefs, Probability Distribution, Visual, Interactive, Tool.

Bibliography

Chang, Winston, Joe Cheng, JJ Allaire, Carson Sievert, Barret Schloerke, Yihui Xie, Jeff Allen, Jonathan McPherson, Alan Dipert, and Barbara Borges. 2022. "Shiny: Web Application Framework for r." https://CRAN.R-project.org/package=shiny.

Lambert, Ben, and Fergus Cooper. 2019. "The Distribution Zoo." https://github.com/ben18785/distribution-zoo.

Silaparasetty, Nikita. 2020. "The Tensorflow Machine Learning Library." In, 149–71. Apress. https://doi.org/10.1007/978-1-4842-5967-2_8.