

# Bayesian Models for Free-response Receiver Operating Characteristic Analysis

Issei Tsunoda

November 26, 2020

## Abstract

The free-response receiver operating characteristic method developed by Chakraborty is a generalization of receiver operating characteristic analysis, but Chakraborty used a non-Bayesian approach. This paper aims to reconstruct Chakraborty's technique using a Bayesian approach and to verify that our models fit practical datasets. We also develop a Bayesian model for comparing modalities.

(Hierarchical) Bayesian modeling, Signal detection theory, Radiology, FROC analysis, individual differences, observer performance

## References

- [1]. Chakraborty, D.P. (1989). Maximum likelihood analysis of free-response receiver operating characteristic (FROC) data. *Med Phys.* Jul-Aug;16(4):561-8. DOI: 10.1118/1.596358
- [2]. Johnson, T.D.I. & Johnson, V.E., A Bayesian hierarchical approach to multirater correlated ROC analysis. *Stat Med.* (2006). Jun 15;25(11):1858-71. DOI: 10.1002/sim.2314
- [3] Dorfman, D.D., Berbaum, K.S., & Metz, C.E. (1992). Receiver operating characteristic rating analysis: Generalization to the population of readers and patients with the jackknife method. *Investigative Radiology*, 27, 723-731.
- [4] Swensson, G. (1996). Unified measurement of observer performance in detecting and localizing target objects on images, *Medical Physics* 23. pp. 1709-1725 doi: 10.1118/1.597758

[5] Dev Chakraborty; Observer Performance Methods for Diagnostic Imaging, Foundations, Modeling, and Applications with R-Based Examples.

[6] Stan Development Team (2019). RStan: the R interface to Stan. R package version 2.19.2. <http://mc-stan.org/>.

[7] Bayesian data analysis; Andrew Gelman, John B. Carlin, Hal S. Stern, Donald B. Rubin; Texts in statistical science; Publisher: Chapman & Hall/CRC, Year: 2004

[8] Bayesian analysis of a ROC curve for categorical data using a skew-binormal model; Balgobin Nandram and Thelge Buddika Peiris (This paper is nice!); 2018 volume 11 369-384; Statistics and its interface