# Riesz Representer Fitting under Bregman Divergence: A Unified Framework for Debiased Machine Learning

Masahiro Kato*

Mizuho-DL Financial Technology, Co., Ltd.
Osaka Metropolitan University

January 18, 2026

**Abstract**

Estimating the Riesz representer is central to debiased machine learning for causal and structural parameter estimation. We propose generalized Riesz regression, a unified framework for estimating the Riesz representer by fitting a representer model via Bregman divergence minimization. This framework includes various divergences as special cases, such as the squared distance and the Kullback–Leibler (KL) divergence, where the former recovers Riesz regression and the latter recovers tailored loss minimization. Under suitable pairs of divergence and model specification (link functions), the dual problems of the Riesz representer fitting problem correspond to covariate balancing, which we call automatic covariate balancing. Moreover, under the same specifications, the sample average of outcomes weighted by the estimated Riesz representer satisfies Neyman orthogonality even without estimating the regression function, a property we call automatic Neyman orthogonalization. This property not only reduces the estimation error of Neyman orthogonal scores but also clarifies a key distinction between debiased machine learning and targeted maximum likelihood estimation (TMLE). Our framework can also be viewed as a generalization of density ratio fitting under Bregman divergences to Riesz representer estimation, and it applies beyond density ratio estimation. We provide convergence analyses for both reproducing kernel Hilbert space (RKHS) and neural network model classes. A Python package for generalized Riesz regression is available at https://github.com/MasaKat0/grr.

*Email: mkato-csecon@g.ecc.u-tokyo.ac.jp.