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Neural Network Analysis of Biexponential Decay Curves Using Regularized Input Data[1] MICHAEL ROZOWSKI, Applied Mathematics Statistics, and Scientific Computation, University of Maryland, College Park, JAY BISEN, CHUAN BI, National Institute on Aging, National Institutes of Health, WOJCIECH CZAJA, Department of Mathematics, University of Maryland, College Park, RICHARD SPENCER, National Institute on Aging, National Institutes of Health — Parameter estimation for biexponential models is of importance throughout the biomedical sciences, where simultaneously occurring exponential processes yield a joint signal. One example of particular interest is magnetic resonance relaxometry, in which biexponential analysis is used to characterize tissue samples. Much work has been performed to improve parameter estimates for this notoriously ill-posed problem, including neural network (NN) approaches. Typically, these perform on par with nonlinear least-squares (NLLS) methods; this is not surprising, since the application of a NN does not change the problem's underlying condition number. We present a new method for NN-based biexponential analysis, in which regularized versions of an experimental decay are presented to the NN. This is fundamentally different from conventional error function regularization at the output layer. With our method, the NN's input is a collection of signals, which we call a regularization trajectory, defined by parameter recovery via nonregularized NLLS and Tikhonov regularized NLLS. We demonstrate that training on regularization trajectories results in a uniform and substantial improvement in both the accuracy and precision of parameter estimates across a wide range of biexponential models.

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