

# Model Fitting Under Uncertainty: A Practical Analysis of Derivative-Free Optimization for Cognitive and Computational Neuroscience

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**Presentation Abstract Summary** Fitting complex behavioral, cognitive, and neural models can be difficult and time-consuming. Standard optimization methods may fail dramatically in searching through the parameter landscape when models are evaluated via simulation, and gradients are unavailable. To determine which optimizer should be used in this case, we built a benchmark suite of model-fitting problems based on real data and published models, drawn from six studies in cognitive, behavioral and computational neuroscience.

We tested many common optimizers (e.g., `fminsearch` and `fmincon` in MATLAB) and competitive derivative-free methods such as CMA-ES and Multilevel Coordinate Search (MCS).

We also developed and tested a novel algorithm, Bayesian Adaptive Direct Search (BADS), which has a smaller computational cost than state-of-the-art Bayesian optimization methods in machine learning.

We found that an optimizer's performance can vary substantially even within the same project, for different datasets.

Only BADS performed consistently well with real data, generally outperforming other methods on non-smooth or noisy target functions (up to at least 15 parameters).

Our analysis can help researchers choose the right optimizer for the problem at hand, and shows great promise for Bayesian optimizers, and BADS in particular, as general tools for robust fitting of complex models in computational neuroscience.

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