Purpose: Compares convergence rates for different optimizers based on total function evaluations (function + gradient evaluations). Sorted by fastest overall convergence (weighted average). Best performer is highlighted in bold, QQN variants in green.

Table 1: Convergence Speed Analysis: Mean Iterations to Reach Improvement Milestones

Optimizer	**Mean Function Evals to 50% Improvement**	**Mean Function Evals to 90% Improvement**	**Final Convergence Function Evals**
QQN-GoldenSection	1.3	3.7	11.1
L-BFGS	2.7	4.1	13.6
QQN-Bisection-1	1.3	4.3	15.7
QQN-Bisection-2	1.9	5.6	14.3
L-BFGS-Aggressive	1.3	4.3	17.4
QQN-StrongWolfe	1.6	4.2	19.1
QQN-CubicQuadraticInterpolation	2.2	5.7	23.8
L-BFGS-MoreThuente	3.5	6.2	28.5
L-BFGS-Limited	4.4	8.4	43.9
GD-AdaptiveMomentum	11.6	19.1	24.4
GD-Momentum	10.3	20.8	37.6
L-BFGS-Conservative	7.7	18.9	55.8
Adam-Fast	15.6	27.3	47.2
GD-Nesterov	22.2	31.3	49.9
Adam-Robust	13.5	32.0	82.1
Trust Region-Aggressive	45.3	81.8	91.0
GD-WeightDecay	12.6	29.7	292.4
GD	26.1	71.6	257.5
Trust Region-Standard	77.6	139.8	155.5
Trust Region-Precise	127.3	229.0	255.4
Trust Region-Adaptive	198.2	356.7	396.8
Trust Region-Conservative	209.6	377.4	419.8