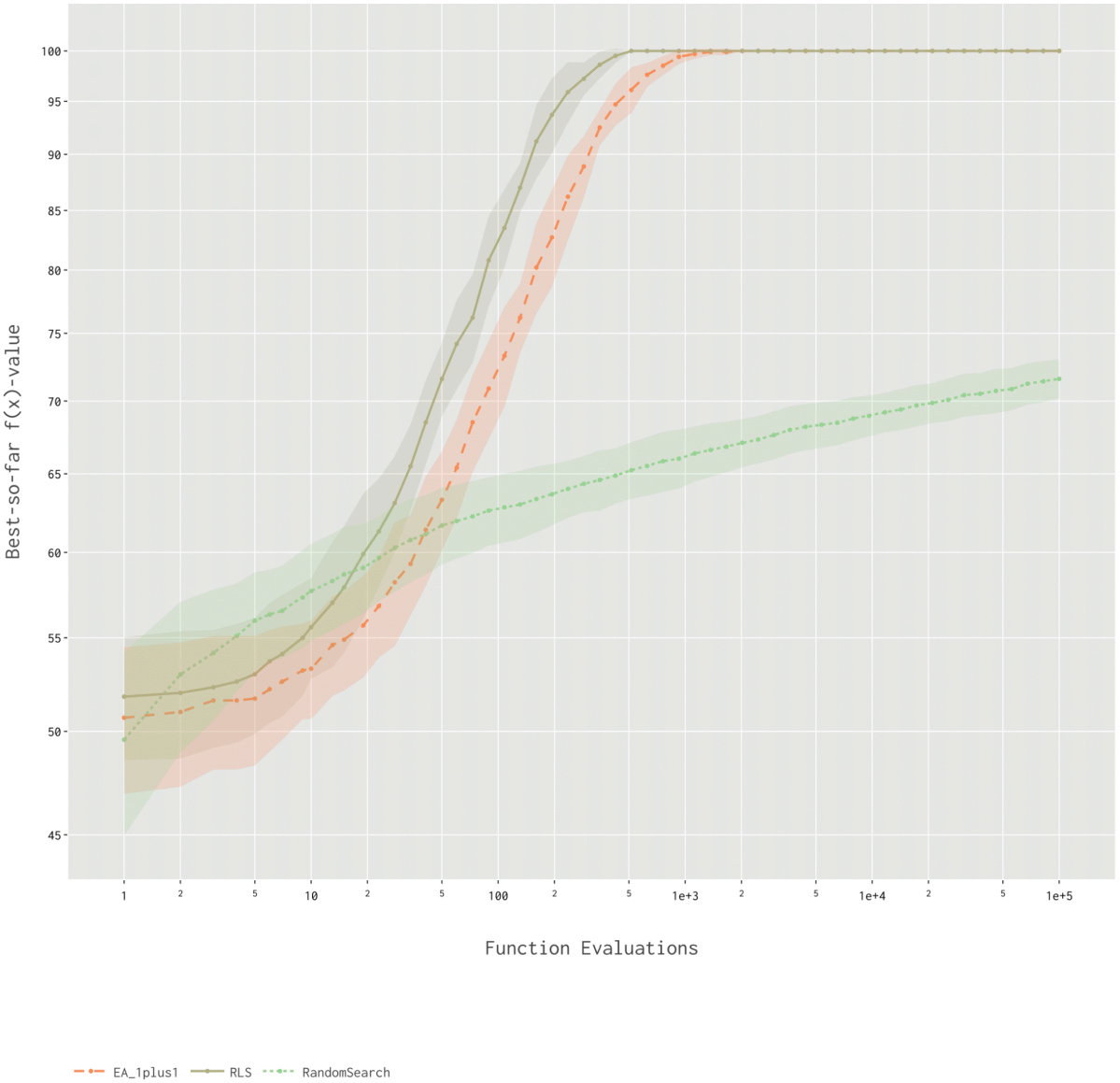
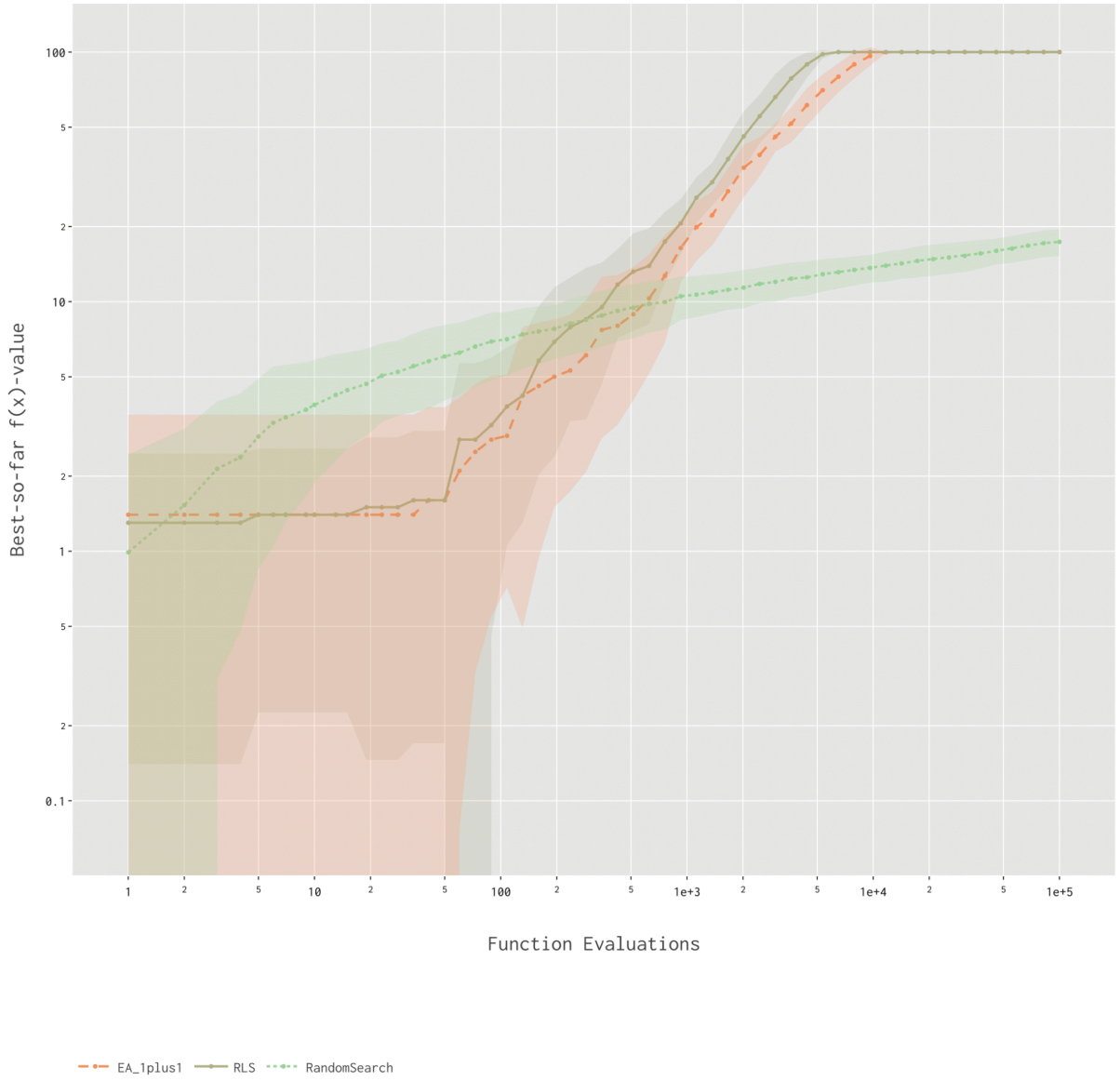
Random Search, RLS and EA (1+1) Plots with summaries and interesting Observations



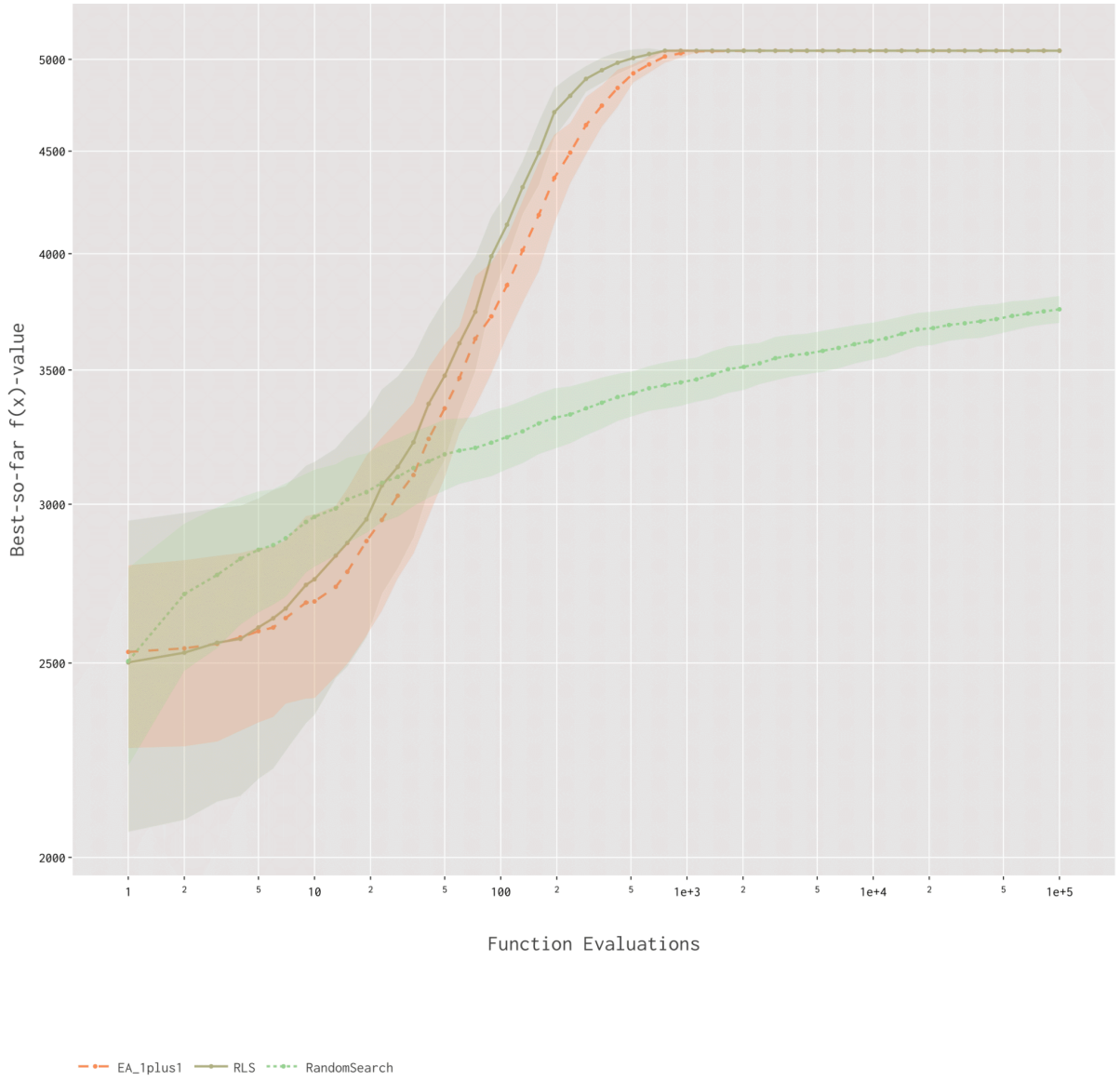
Problem: F1 (OneMax)

RLS converged to the optimum value of 100 in around 500 evaluations whereas EA (1+1) achieved it in around 1000 evaluations. Random Search failed to converge to the optimum and stopped at around 72. RLS was twice as fast as EA (1+1), this is expected since OneMax rewards every single-bit improvement and RLS flips one bit per iteration. Both RLS and EA (1+1) show consistent performance when converging whereas Random Search shows higher variance throughout.



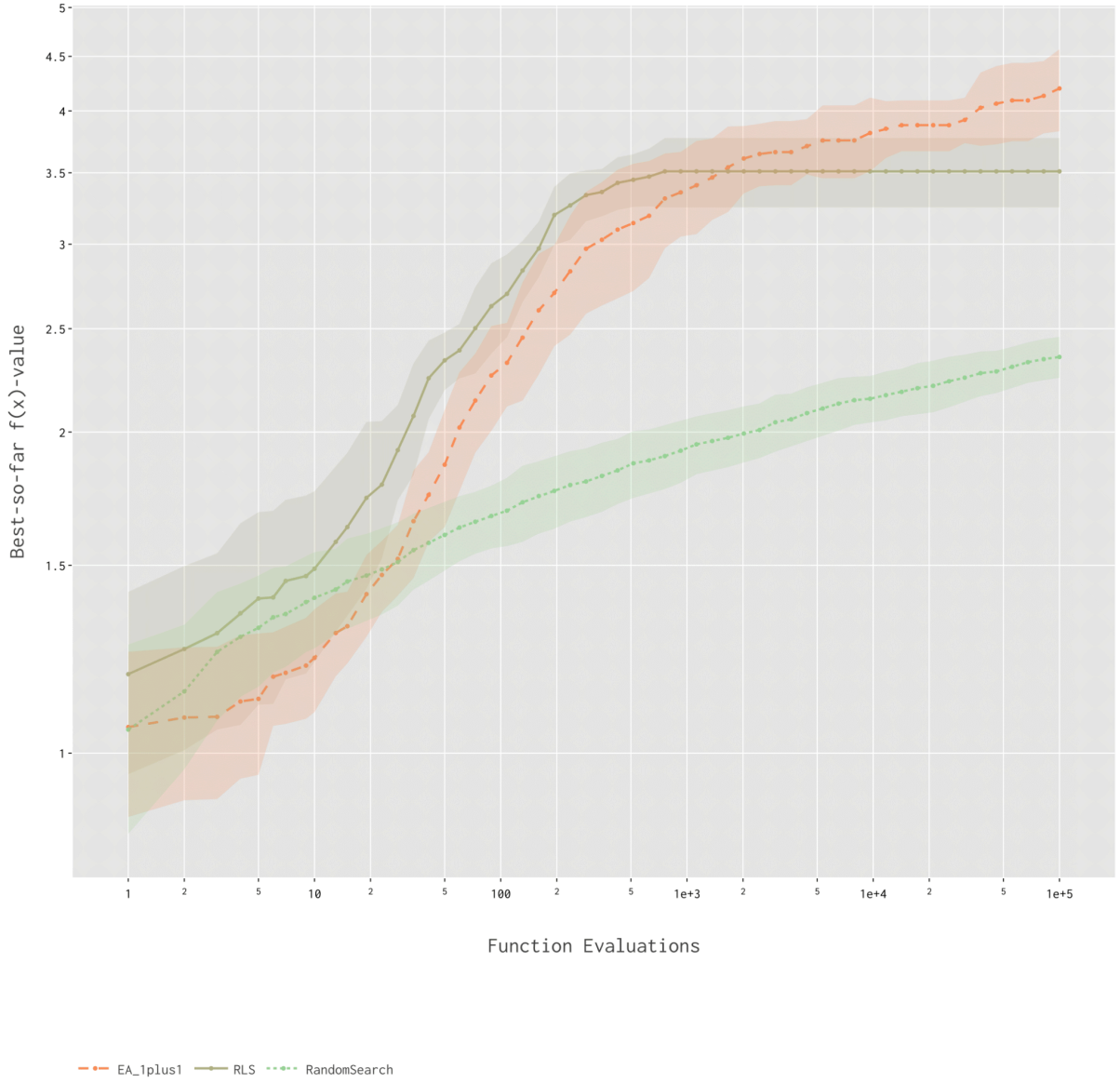
Problem: F2 (LeadingOnes)

RLS converged to the optimum around 5000 evaluations, EA (1+1) converged around 10000 evaluations and Random Search once again did not converge and ended at around 18. LeadingOnes is harder than OneMax for all the algorithms, RLS and EA (1+1) needed 10x the evaluations to reach the optimum when compared to F1. RLS once again outperforms EA (1+1) by a factor of 2 which again means its 1 bit-flip is better than EA (1+1)'s multiple flips for this problem. The variance increases in the middle suggesting that once an algorithm finds the correct sequence, the rate of progress varies across different runs.



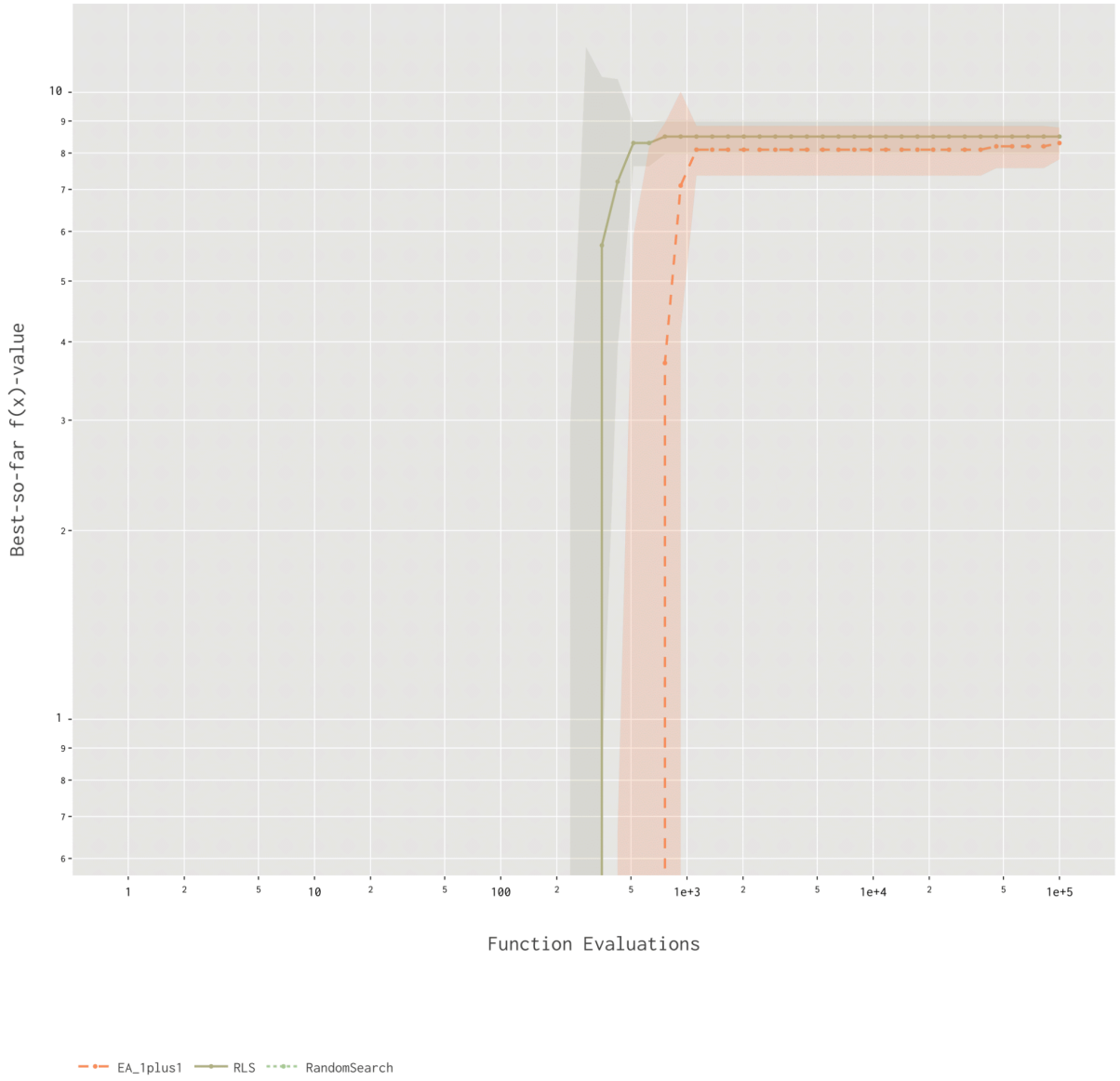
Problem: F3 (Linear Function with Harmonic Weights)

RLS reached the optimum of 5050 around 500 evaluations, EA (1+1) reached it around 1000 evaluations and random search once again did not reach it and stopped around 3750. The performance pattern is very similar to OneMax with nearly identical convergence speeds and algorithm rankings. This shows that the difference in bit weights does affect the convergence speeds of these algorithms since they do not evaluate bit weights and treat them all equally.



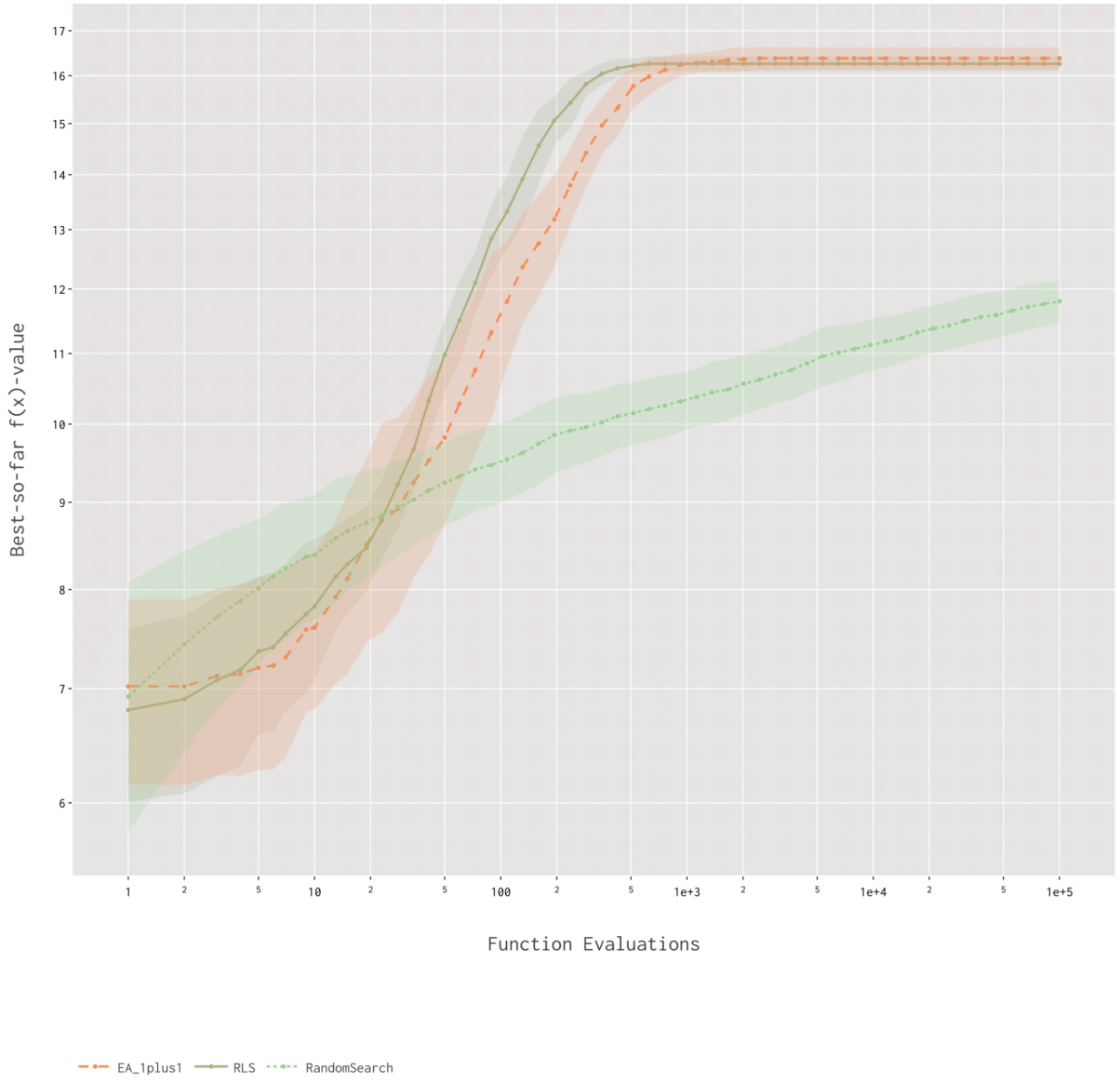
Problem: F18 (LABS)

None of the algorithms achieved the theoretical optimum. EA (1+1) achieved the best result at around 4.2 showing continuing improvement throughout. RLS plateaued at around 3.5 after 1000 evaluations while Random Search reached only around 2.4. This is the first problem where EA (1+1) outperformed RLS. LABS is fundamentally harder than the linear functions. RLS plateaued at 3.5 showing its limitations to escape once it's been trapped. High variance throughout suggests that the initial conditions mattered significantly throughout the runs.



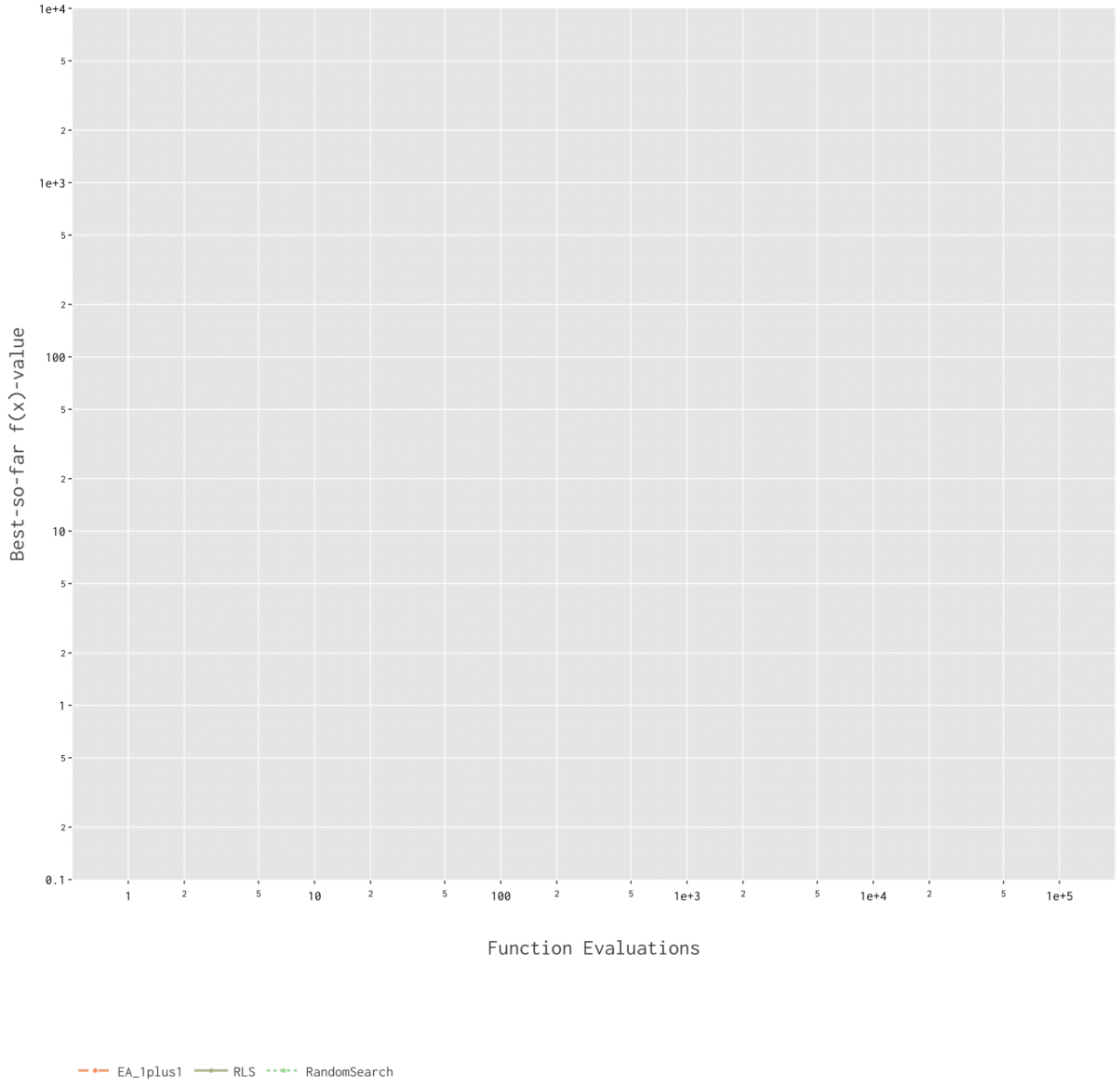
Problem: F23 (N-Queens)

RLS and EA (1+1) converge rapidly around ~500 and ~1000 evaluations respectively. Random Search is not present in this graph as it plateaus much earlier than the other 2 algorithms. RLS outperforms EA (1+1) slightly in this problem and also has less variance compared to EA (1+1) throughout its runs. The rapid convergence suggests that when either algorithm found the correct sequence, they made a lot of progress almost instantly.



Problem: F24 (Concatenated Trap)

Both RLS and EA (1+1) converge around the value ~16 in 500 and 1000 evaluations respectively. Random search once again does not converge near that and ends close to 12. Random Search has high variance throughout whereas RLS and EA (1+1) converge as they go higher. This graph is once again very similar to OneMax and Linear Function with Harmonic Weights suggesting that local search is efficient to reach the optimum in this problem in the same manner.



Problem: F25 (NKL)

Random Search, RLS and EA (1+1) all failed to show any progress in this problem. This suggests that all the algorithms failed to find any meaningful improvements thus this problem is too difficult for them.