MATH604: Presentation on Benchmarking Project

Deepak Kumar

April 6, 2017

Algorithms Implemented

1. Nelder Mead Algorithm
2. Generalized Pattern Search
3. Model Based Descent

Nelder Mead Algorithm

All standard parameters were chosen for the implementation.
Initial Parameters were chosen as follows:

- *Shrink Parameter*, $\gamma = 1/2$;
- *Expansion parameter*, $\delta^e = 2$;
- *Inside contraction parameter*, $\delta^{ic} = -1/2$;
- *Outside contraction parameter*, $\delta^{oc} = 1/2$;

Stopping Criteria: *maxIter* $= 1000$ *or* approxdiam $\leq 10^{-12}$ whichever comes first.

Generalized Pattern Search

The following decisions were made while implementing the Algorithm:

- *No Search Step was chosen.*
- Given values of x_0 & Δ_0 were used.
- Polling directions set, Dk = D_{max} + *diagonal directions*.
- Opportunistic Polling.

Stopping Criteria: *maxIter* = 1000 *or* $\Delta_k \leq 10^{-18}$ whichever comes first.

Model Based Descent

The following decisions were made while implementing the Algorithm:

- $\mu_0 = .5$ & $\eta = .1$
- Given values of x_0 & Δ_0 were used.
- Model was created using Linear Regression.
- Forward-Backward-Tracking Line search was used with $N_{max} = 100$.
- Steepest descent direction was chosen i.e $d^k = -g^k$

Stopping Criteria: $maxIter = 2000/5000$ *or* $\Delta_k \leq 10^{-7}$ or $norm(gk) < 10^{-7}$, whichever comes first.

Data Collection

For all the 3 Algorithms, following data was collected:

- Best function value in each iteration.
- Best x value in each iteration.
- Best function value for each function evaluation.

Convergence plot

Rosenbrock Function

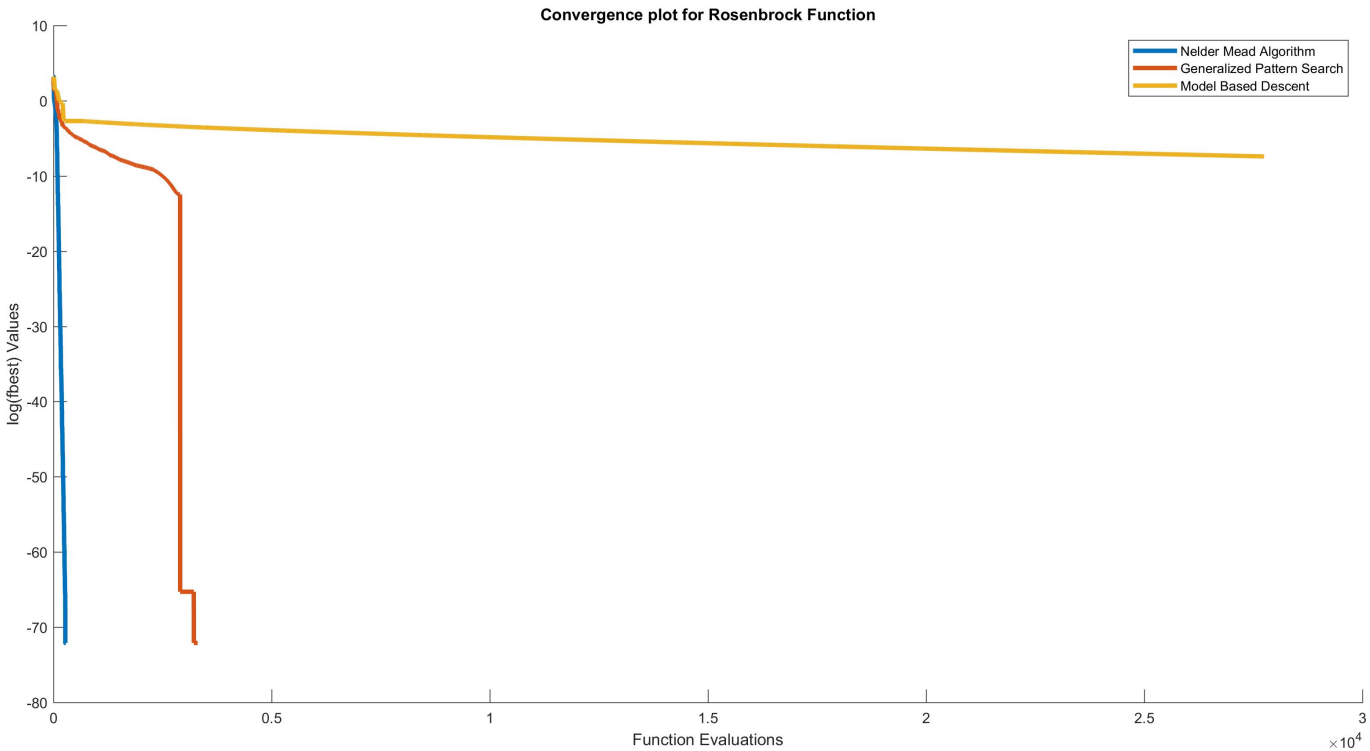

Figure: Convergence plot of NM, GPS & MBD

Convergence plot

Cube Function

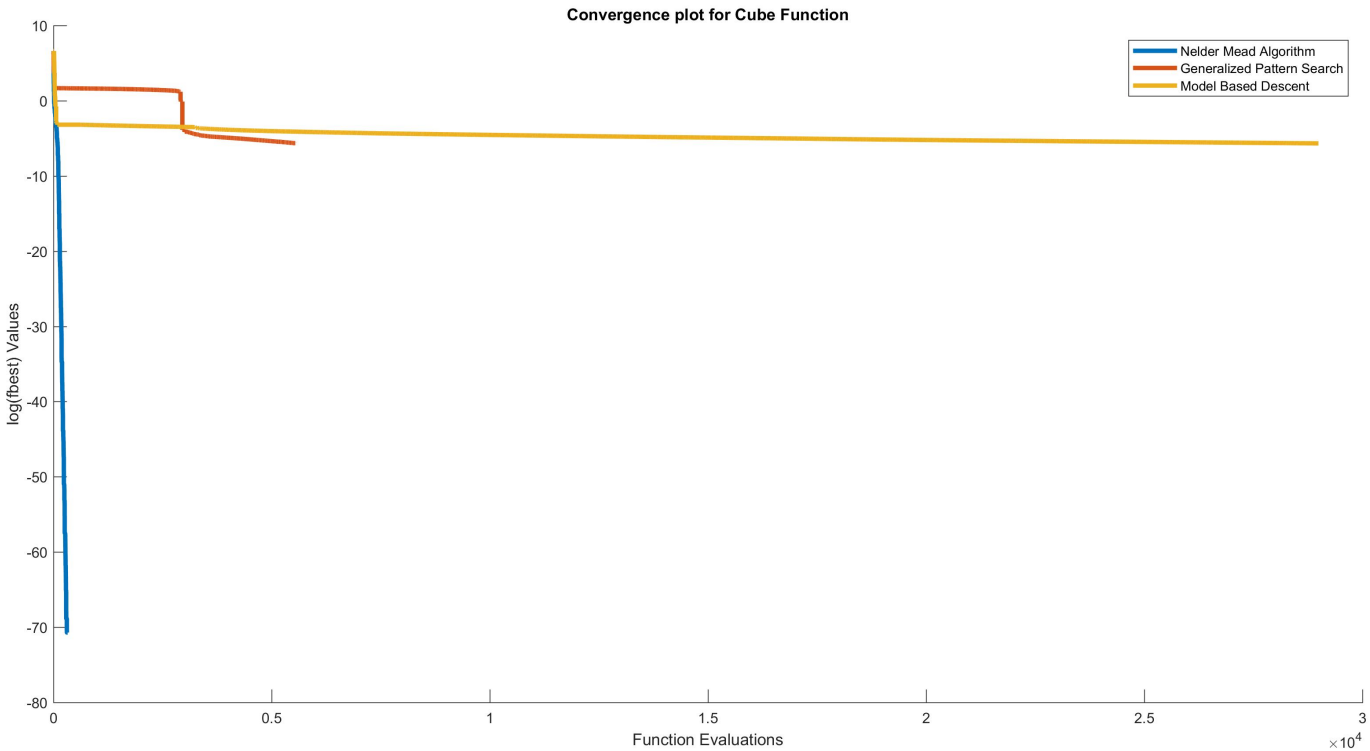

Figure: Convergence plot of NM, GPS & MBD

Convergence plot

Modified Box Function

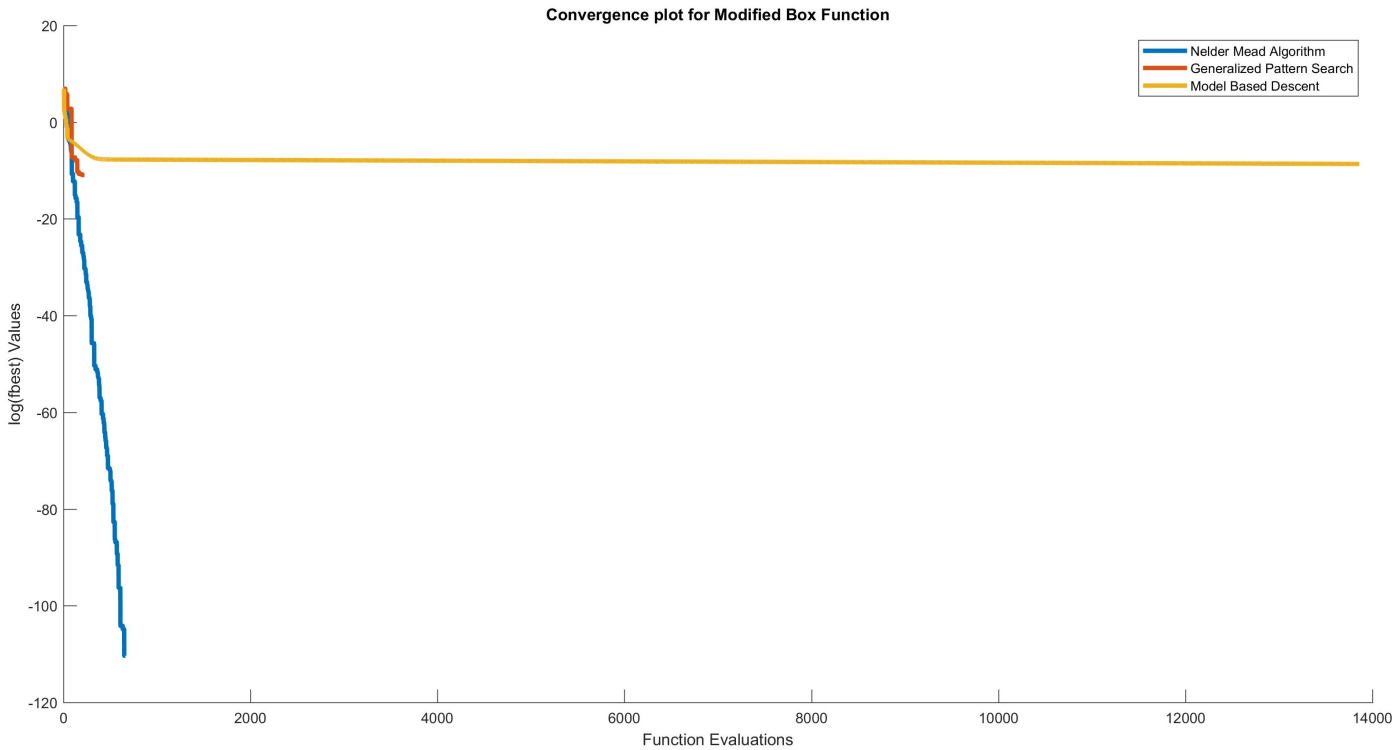

Figure: Convergence plot of NM, GPS & MBD

Convergence plot

Enzyme/Kowalik Osborne I Function

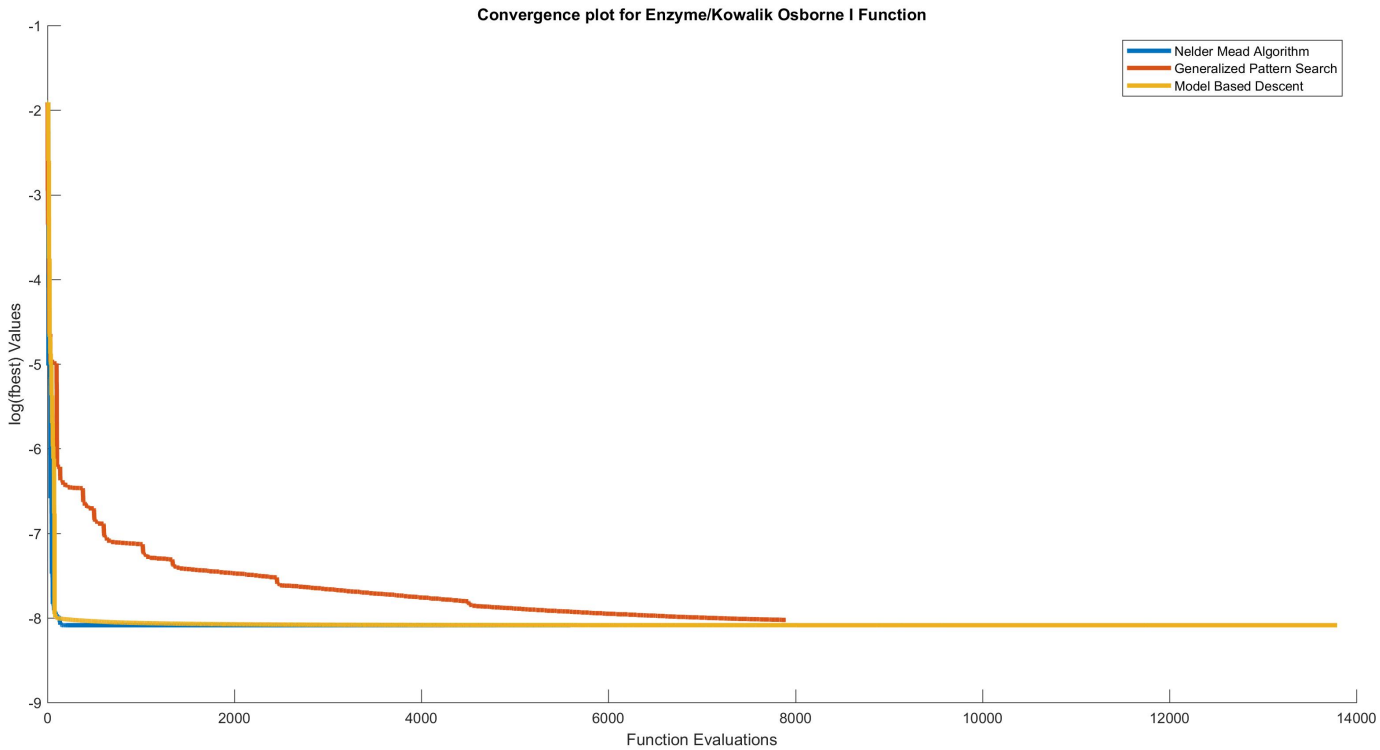

Figure: Convergence plot of NM, GPS & MBD

Trajectory Plot

Rosenbrock Function

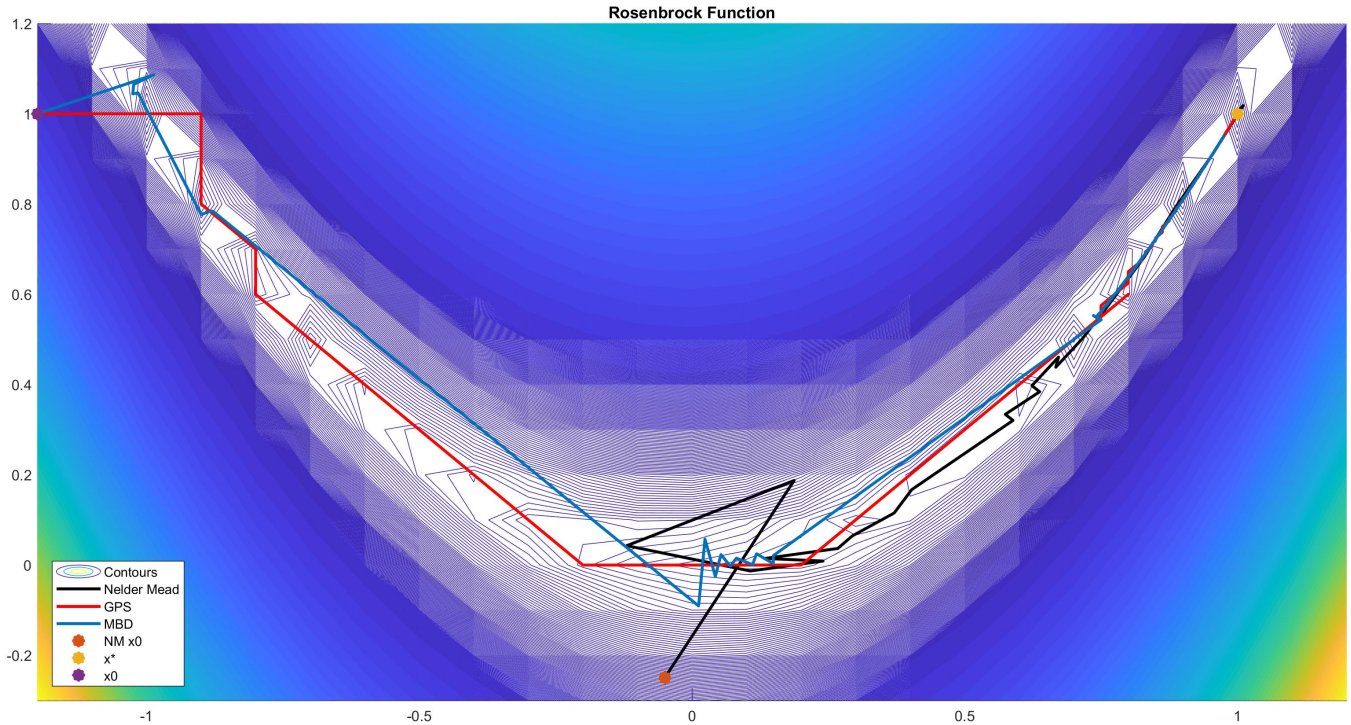

Figure: Algorithmic Paths of NM, GPS & MBD

Trajectory Plot

Cube Function

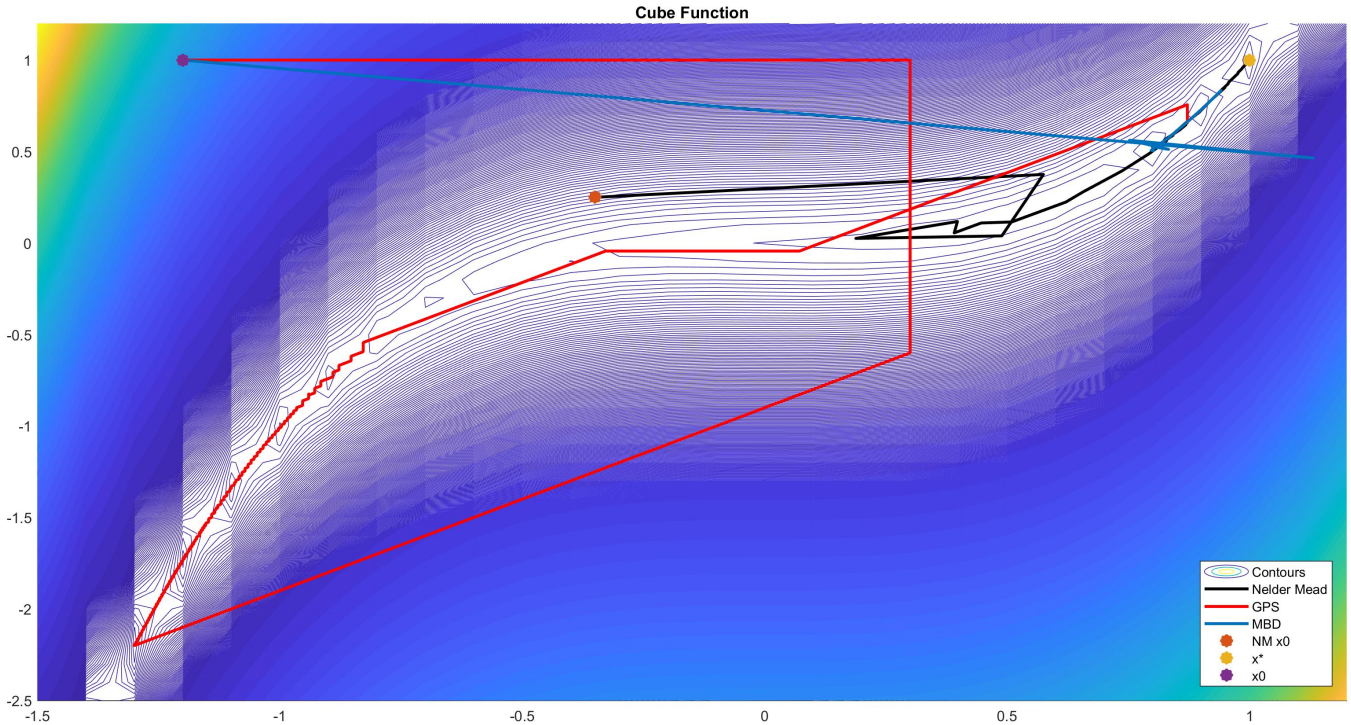

Figure: Algorithmic Paths of NM, GPS & MBD

Trajectory Plot

Beale Function

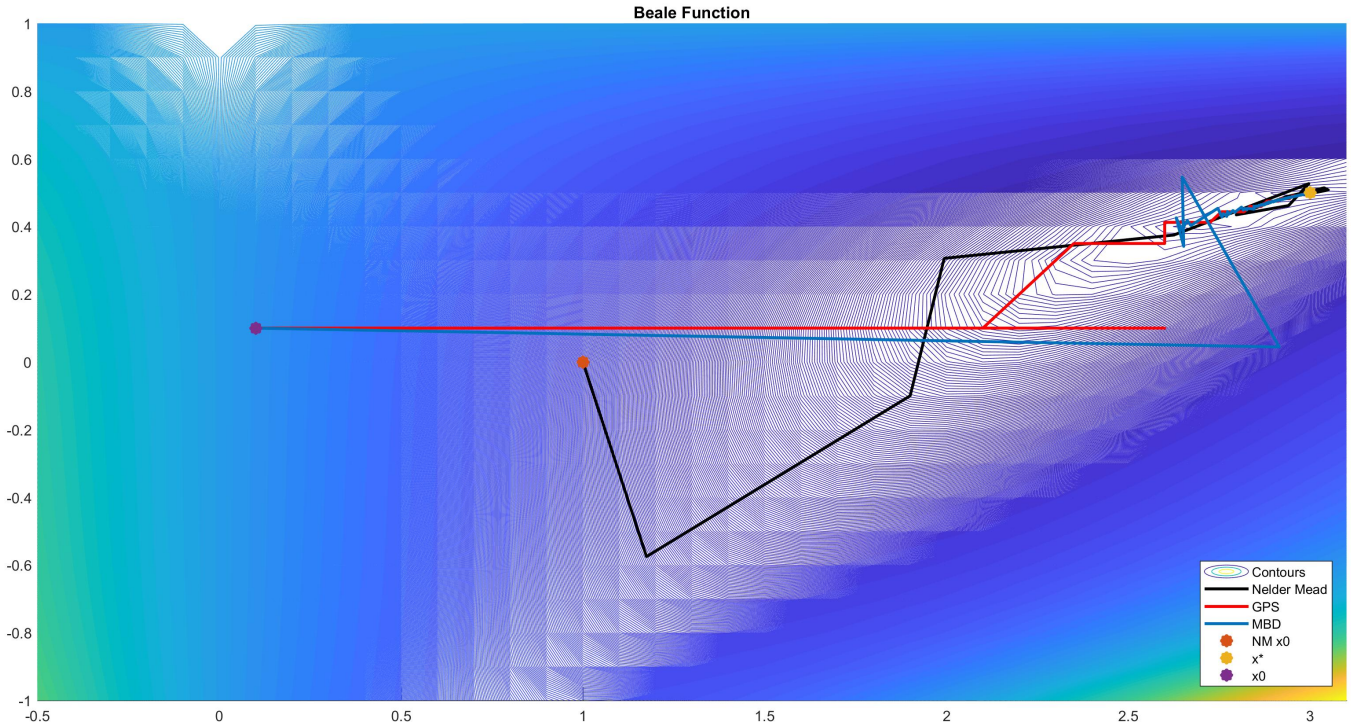

Figure: Algorithmic Paths of NM, GPS & MBD

Performance Profile

tau=5%

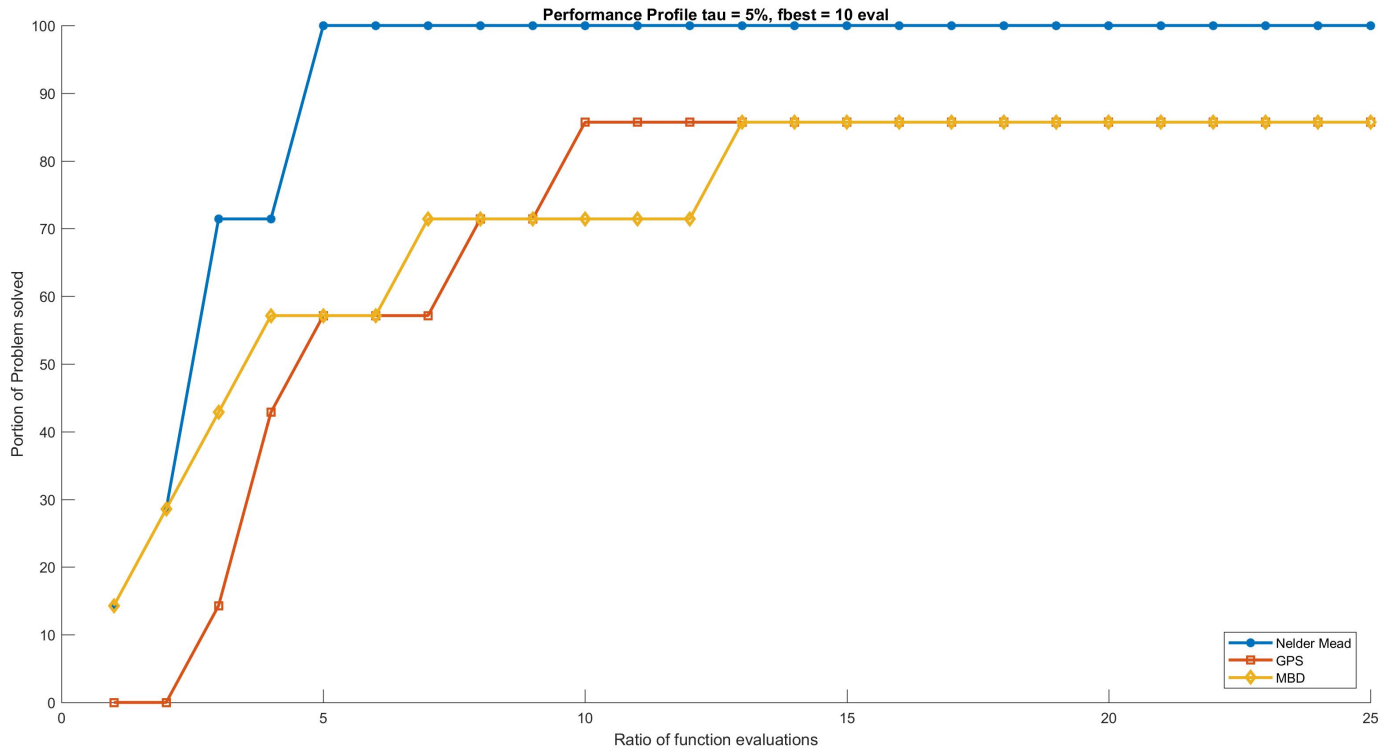

Figure: Performance Profile for NM, GPS & MBD

Performance Profile

tau=10%

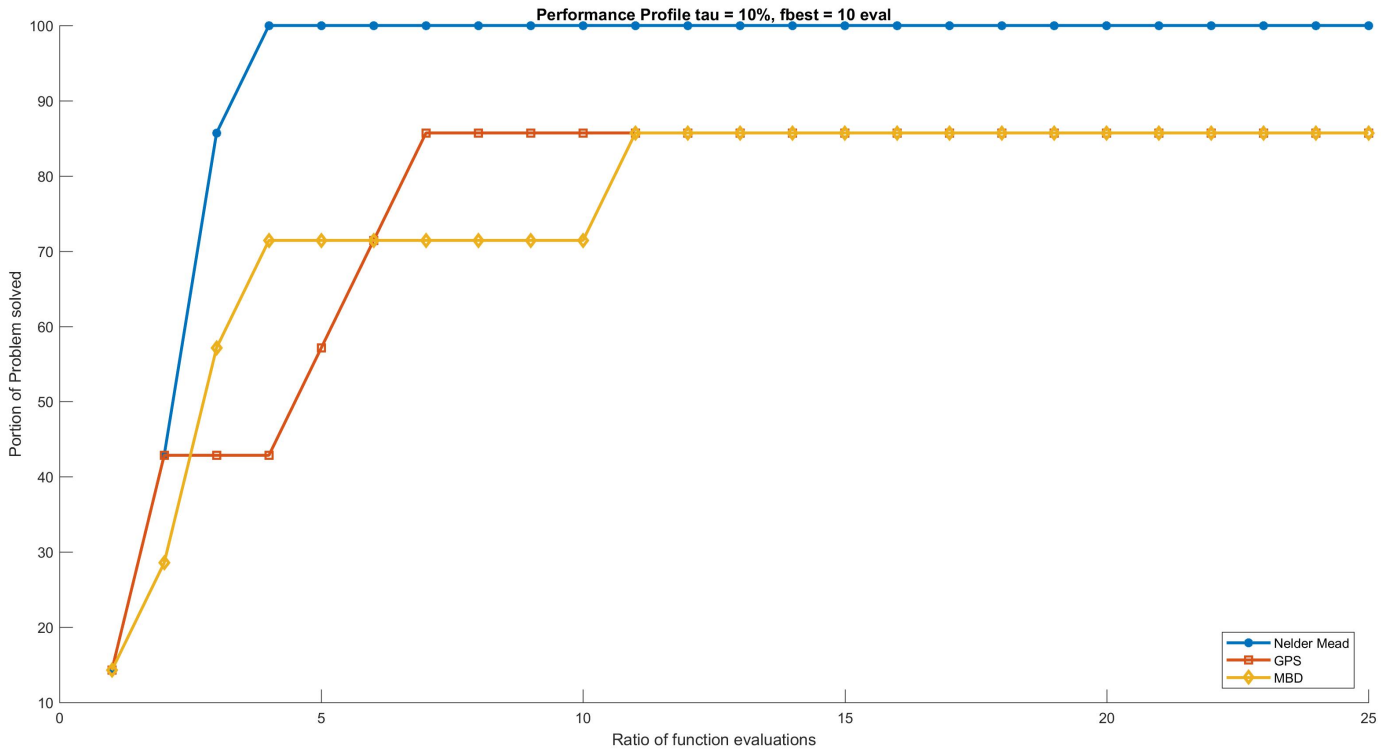

Figure: Performance Profile for NM, GPS & MBD

Data Profile

tau=5%

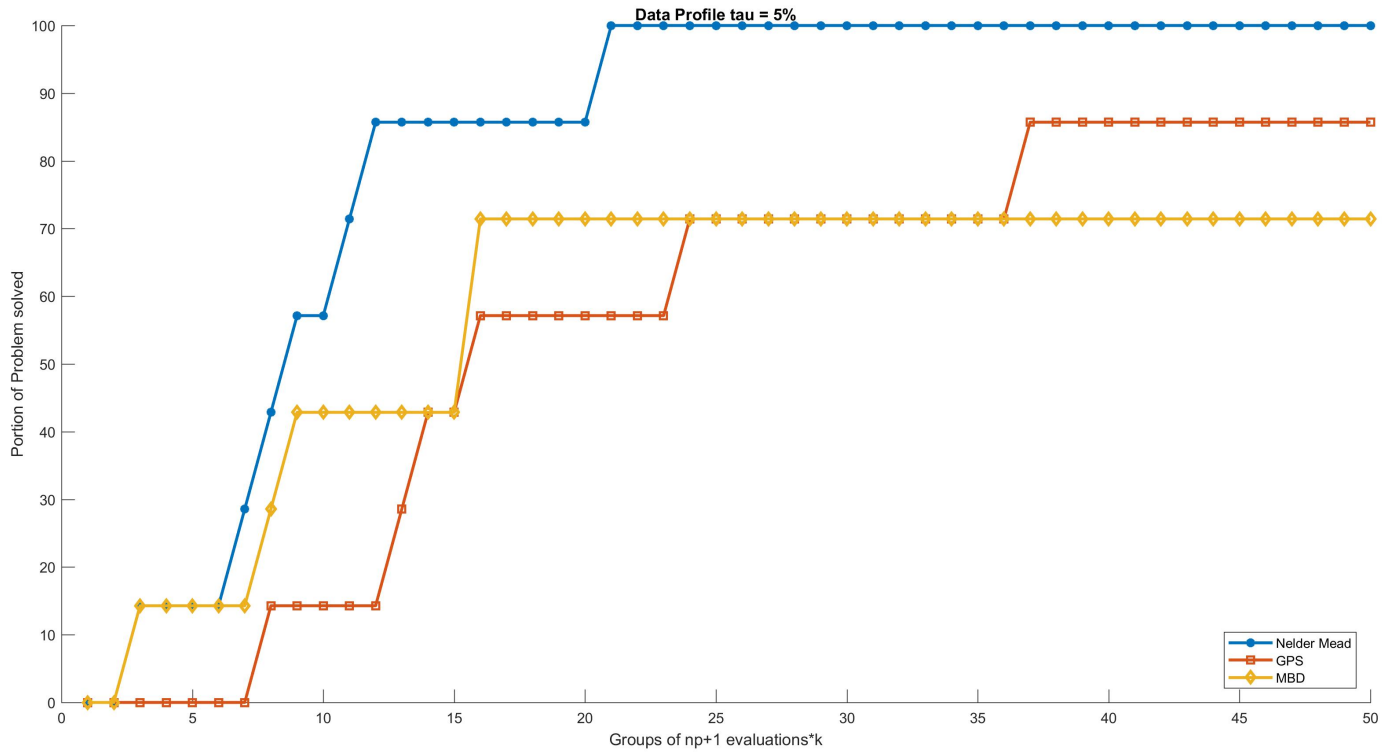

Figure: Data Profile for NM, GPS & MBD

Data Profile

tau=10%

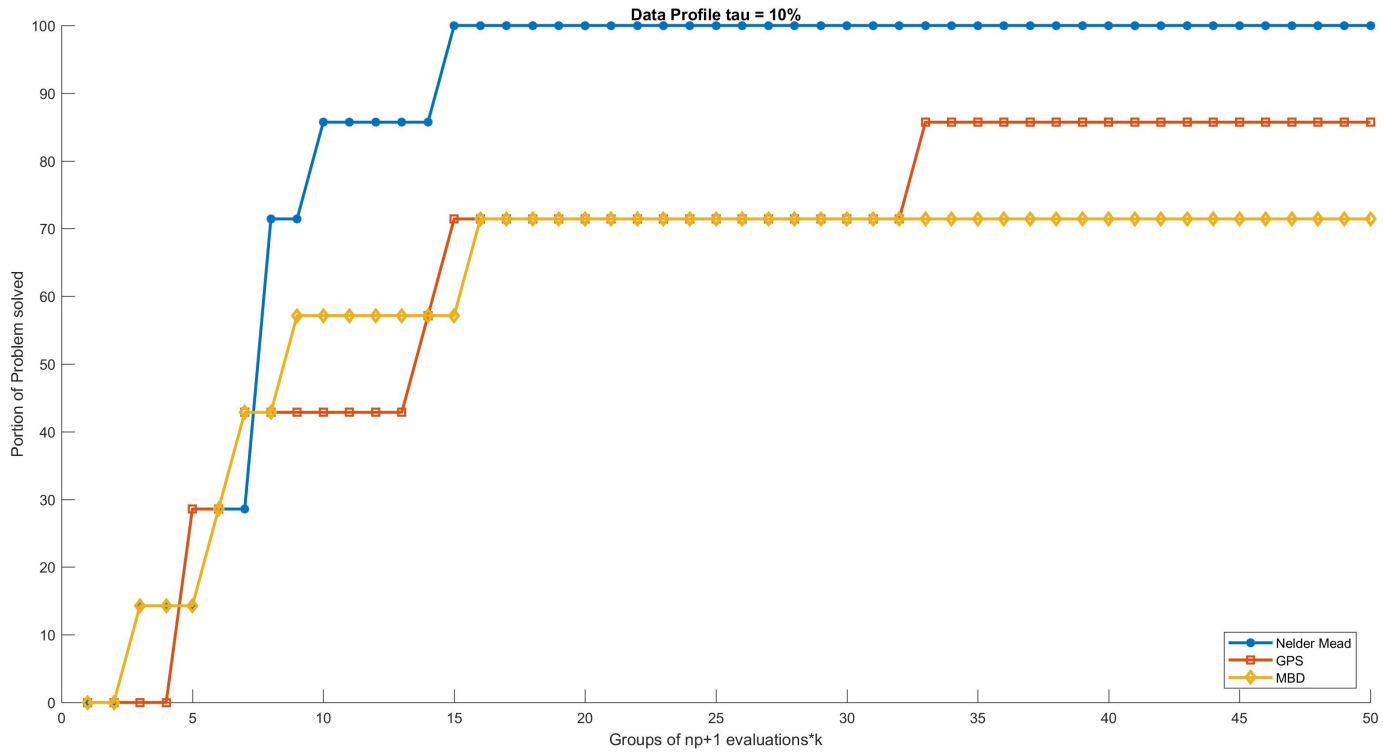

Figure: Data Profile for NM, GPS & MBD

Conclusions

In MBD, change in Armijo parameter have a significant impact on the performance of algorithm. A higher value usually makes the algorithm move faster.
When Implemented with standard parameters, Nelder Mead could outperform other Mesh and Model Based Methods.
The set of polling directions matter a lot for GPS. When implemented with D_{min} basis set, it could take as much as twice the functions calls to converge compared to D_{max} set. For each iteration, MBD makes lots of function calls because of line search.
MBD (with Linear Regression) is usually quick to reach in ϵ neighbourhood of the optimum solution (as it uses gradients) but takes a lot of iterations (also dependent on the function) to converge. This is because of inaccuracy of Linear Regression in the computation of approximate gradient.

Thank You...