

# Notes on NEWUOA

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**Algorithm 0.1**

<sup>?(alg:newuoa)?</sup>Input  $\Delta_0 \in (0, +\infty)$ ,  $m \in \{n+2, n+3, \dots, (n+1)(n+2)/2\}$ , and  $\mathcal{X}_0 \subset \mathbb{R}^n$  with  $x_0 \in \mathcal{X}_0$  and  $|\mathcal{X}_0| = m$ . Set  $Q_{-1} = 0$  and  $k = 0$ .

1.  $Q_k = \operatorname{argmin}\{\|\nabla^2 Q - \nabla^2 Q_{k-1}\|_F : Q \in \mathcal{Q} \text{ and } Q(x) = f(x) \text{ for } x \in \mathcal{X}_k\}$ .
  2.  $x_k = \operatorname{argmin}\{f(x) : x \in \mathcal{X}_k\}$
  3.  $x_k^+ = \operatorname{argmin}\{Q_k(x) : \|x - x_k\| \leq \Delta_k\}$ ,  $x_k^- = \operatorname{argmin}\{\kappa(\mathcal{X}_k, x_k^+, x) : x \in \mathcal{X}_k\}$
  4.  $\rho_k = [f(x_k) - f(x_k^+)]/[Q_k(x_k) - Q_k(x_k^+)]$ ; update  $\Delta_k$  according to  $\rho_k$ .
  5. If  $\kappa(\mathcal{X}_k, x_k^+, x_k^-) \leq \kappa_0$ , then set  $\mathcal{X}_{k+1} = \mathcal{X}_k \cup \{x_k^+\} \setminus \{x_k^-\}$ . Increment  $k$ . Go to Step 1.
  6.  $y_k^- = \operatorname{argmax}\{\|y - x_k\| : y \in \mathcal{X}_k\}$ ,  $y_k^+ = \operatorname{argmin}\{\kappa(\mathcal{X}_k, y, y_k^-) : \|y - x_k\| \leq \bar{\Delta}_k\}$ .  
Set  $\mathcal{X}_{k+1} = \mathcal{X}_k \cup \{y_k^+\} \setminus \{y_k^-\}$ . Increment  $k$ . Go to Step 1.
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