Algorithm 1 Newton-Raphson algorithm including a step-halving step

Require: $f(\boldsymbol{\beta})$ - target function as given in (**??**); $\boldsymbol{\beta}_0$ - starting value

Ensure: $\widehat{\boldsymbol{\beta}}$ such that $\widehat{\boldsymbol{\beta}} \approx \arg\max_{\boldsymbol{\beta}} \ f(\boldsymbol{\beta})$

$i \leftarrow 0$, where i is the current number of iterations
$f(\boldsymbol{\beta}_{-1}) \leftarrow -\infty$
while convergence criterion is not met **do**
    $i \leftarrow i + 1$
    $\mathbf{d}_i \leftarrow -[\nabla^2 f(\boldsymbol{\beta}_{i-1})]^{-1} \nabla f(\boldsymbol{\beta}_{i-1})$, where $\mathbf{d}_i$ is the direction in the i-th iteration
    $\lambda_i \leftarrow 1$, where λ_i is the multiplier in the i-th iteration
    $\boldsymbol{\beta}_i \leftarrow \boldsymbol{\beta}_{i-1} + \lambda_i \mathbf{d}_i$
    while $f(\boldsymbol{\beta}_i) \leq f(\boldsymbol{\beta}_{i-1})$ **do**
        $\lambda_i \leftarrow \lambda_i / 2$
        $\boldsymbol{\beta}_i \leftarrow \boldsymbol{\beta}_{i-1} + \lambda_i \mathbf{d}_i$
    end while
end while
$\widehat{\boldsymbol{\beta}} \leftarrow \boldsymbol{\beta}_i$