Algorithm

Constitutive model

- Strain at the current time is given in terms of stress at current time

$$\varepsilon^t = \bar{F}(\sigma^t)$$

  $\bar{F}$ is the nonlinear function

- There are four non-linear parameters viz g_0, g_1, g_2, a_σ which are dependent on stress at the current time step σ^t.

Governing equations

1. $\bar{D}^t = g_0^t D_0 + g_1^t g_2^t \sum_{n=1}^N D_n - g_1^t g_2^t \sum_{n=1}^N D_n \frac{1-\exp -\lambda_n \Delta\psi^t}{\lambda_n \Delta\psi^t}$

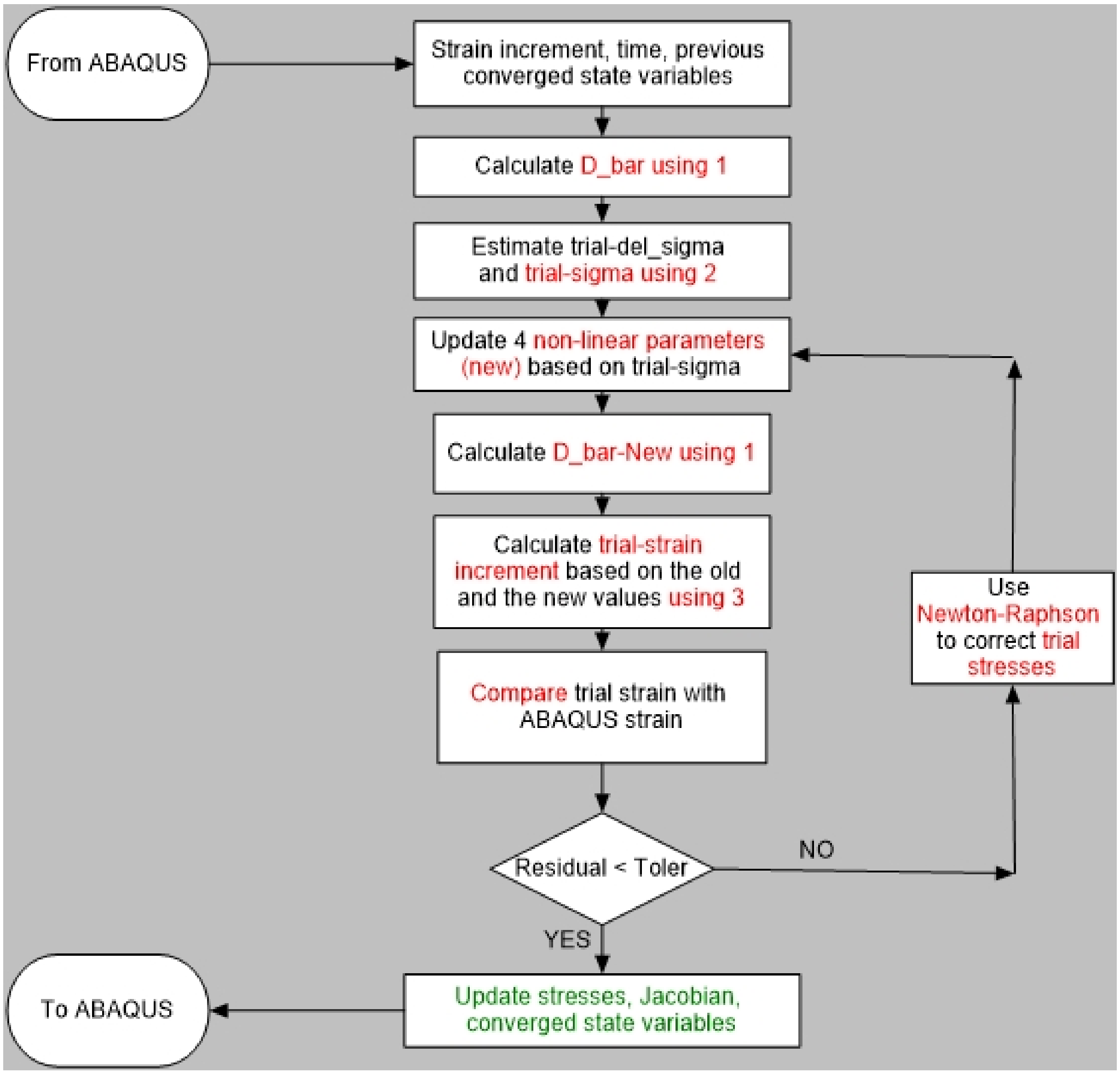
$$\Delta\psi^t = \psi^t - \psi^{t-\Delta t}, \quad \psi^t = \frac{t}{a_\sigma}$$

2. $\Delta\sigma^{tr} = \frac{1}{\bar{D}^{tr}}[\Delta\varepsilon^t + g_1^{tr} \sum_{n=1}^N D_n \left(\exp[-\lambda_n \Delta\psi^t] - 1\right) q_n^{t-\Delta t}$

$$\sigma^{tr} = \sigma^{t-\Delta t} + \Delta\sigma^{tr}$$

3. $\Delta\varepsilon^t = \bar{D}^t\sigma^t - \bar{D}^{t-\Delta t}\sigma^{t-\Delta t} - \sum_{n=1}^N D_n (g_1^t \exp[-\lambda_n \Delta\psi^t] - g_1^{t-\Delta t}) q_n^{t-\Delta t}$
$-g_2^{t-\Delta t} \sum_{n=1}^N D_n \left[g_1^{t-\Delta t} \left(\frac{1-\exp[-\lambda_n \Delta\psi^{t-\Delta t}}{\lambda_n \Delta\psi^{t-\Delta t}} \right) - g_1^t \left(\frac{1-\exp[-\lambda_n \Delta\psi^t}{\lambda_n \Delta\psi^t} \right) \right] \sigma^{t-\Delta t}$

FLOWCHART


From ABAQUS
Strain increment, time, previous converged state variables
Calculate D_bar using 1
Estimate trial-del_sigma and trial-sigma using 2
Update 4 non-linear parameters (new) based on trial-sigma
Calculate D_bar-New using 1
Calculate trial-strain increment based on the old and the new values using 3
Compare trial strain with ABAQUS strain
Residual < Toler
NO
Use Newton-Raphson to correct trial stresses
YES
Update stresses, Jacobian, converged state variables
To ABAQUS