A Semi-incremental Scheme for Fatigue Damage Computations

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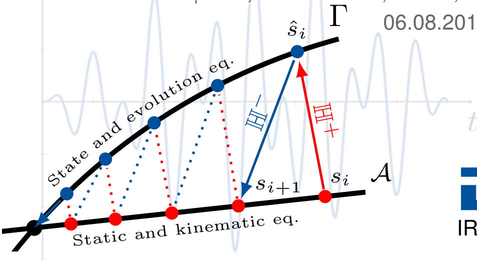
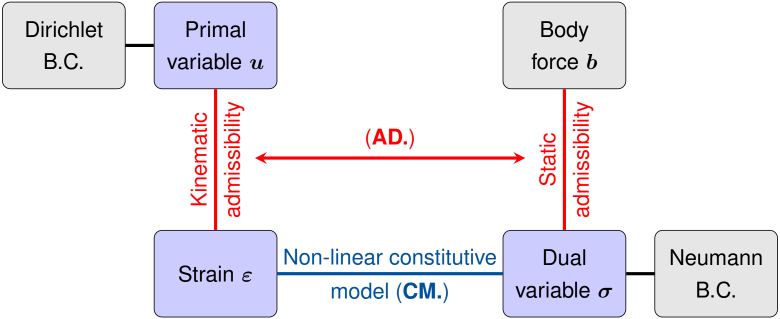


IRTG-1627

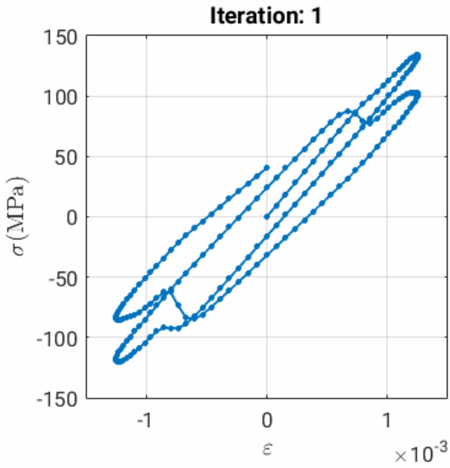
LATIN linearisation scheme

Solve iteratively (**AD.**) and (**CM.**)



for all time steps simultaneously.

What does simultaneously mean?



LATIN solution algorithm

- Start with an elastic initialisation s_0
- Evaluate **(CM.)** to get s_{local} (local stage)
- Solve **(AD.)** to get s_{global} (global stage)
- Transfer data using affine relations (search direction eq.)

$$\left(\boldsymbol{\sigma}_{\text{global}} - \boldsymbol{\sigma}_{\text{local}}\right) - \mathbb{H}^{\mp} : \left(\boldsymbol{\varepsilon}_{\text{global}} - \boldsymbol{\varepsilon}_{\text{local}}\right) = \mathbf{0}$$

- Iterate until convergence with an energy error indicator

- Low-rank approximation

$$\boldsymbol{u}(\boldsymbol{x},t)=\sum_{j=1}^{N}\boldsymbol{v}_j(\boldsymbol{x})\circ\boldsymbol{\lambda}_j(t)$$

- Enrichment to (μ) previously generated modes

$$\Delta\boldsymbol{u}_{i+1}(\boldsymbol{x},t)=\boldsymbol{v}_{\mu+1}(\boldsymbol{x})\circ\boldsymbol{\lambda}_{\mu+1}(t)$$

- POD-like update of (μ) previously generated modes

$$\Delta\boldsymbol{u}_{i+1}(\boldsymbol{x},t)=\sum_{j=1}^{\mu}\underbrace{\boldsymbol{v}_j(\boldsymbol{x})}_{\text{known}}\circ\Delta\boldsymbol{\lambda}_j(t)$$

Challenges in a PGD framework

- Efficient variable amplitude and frequency simulations
- The cost of integration over all generalised coordinates

$$\int_{\mathcal{I}} \int_{\Omega} \bullet \; \mathrm{d}\Omega \, \mathrm{d}t \qquad ☹$$

- The fast increase in the number of modes

$$\boldsymbol{u}(\boldsymbol{x},t) = \sum_{j=1}^{\mu} \boldsymbol{v}_j(\boldsymbol{x}) \circ \boldsymbol{\lambda}_j(t) \text{ with large } \mu \qquad ☹$$

- The cost of the error indicator and the local stage