Multiparametric strategy dedicated to probability of failure calculation

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We propose a strategy to tackle the costly problem of performing parametric analysis in the case of non linear (elastic-viscoplastic) evolution problems, even if a large number of degrees of freedom and time steps are involved.
Parametric analysis can be used to determined parameters with the most influence but also in a probabilistic framework to determined the probability of failure knowing the probabilistic laws of parameters.
This later use is done in the ANR project APPROFI to deal with fatigue failure. This work is part of this project.

The strategy is based on two main techniques. The first one is the LATIN method which is a non incremental in time non linear solver. This solver works at each of its iterations on the entire time space domain. During a parametric analysis, the solver can be initialized with an already calculated solution when searching for the solution with new input parameters values. As two solutions with close input parameters values are also usually close, the number of iterations to compute the new solution very small.

The second technique is the Proper Generalized Decomposition.
It is a reduced model technique, that allows to decrease dramatically computational cost. The solution at each iteration of the LATIN method is search with this reduction technique.

With these two techniques, a CPU gain up to 30 were founded in our test, with
3 parameters and 1,000 parameter sets. In that case the parametric study were performed in 30 hours instead of 900 hours, for a 150,000 DOFs and 60 time steps elastic-viscoplastic problem.