GENERAL AIM OF THE WORK

- Assessing the effects of uncertainty in material parameters in soft tissue models.
- The sensitivity derivative Monte Carlo method provides one to two orders of magnitude better convergence than the standard Monte Carlo method (Fig. 3 and 5).
- Complex models with only few lines of Python code (DOLFIN/FEniCS).

SUMMARY

- Stochastic FE analysis.
- Uncertainty quantification (material properties, loading, geometry, etc.).
- Random variables/fields.
- Global and local sensitivity analysis.
- Biomechanical modeling, simulation and analysis with random parameters.

METHODS

- Monte Carlo and quasi Monte Carlo methods (Caflisch, 1998).
- Accelerating Monte Carlo estimation with sensitivity derivatives (Hauseux, Hale, and Bordas, 2016).
- Non-intrusive multi-level polynomial chaos expansion method.
- Multi Level Monte Carlo methods (Giles, 2015).

NUMERICAL IMPLEMENTATION

- DOLFIN/FEniCS:
  - UFL (Unified Form Language) (Logg, Mardal, and Wells, 2012).
  - Automatically deriving tangent linear models with FEniCS !
  - Parallel computing (Ipython parallel and mpi4py).
  - Python package for uncertainty quantification (Chaospy, SALib).

REFERENCES


