Objectives
- Develop an improved hip fracture risk prediction model combining clinical and computational data generated using Finite Element Analyses (FEA).
- Evaluate the improvement in predictive ability of the risk model if a high or low fidelity FE model is used.

Methods
- Support vector machine (SVM)
  SVM is a flexible high-dimensional classification technique which handles non-linear relationships among factors. Hip fracture risks are estimated using probabilistic SVM (PSVM).

  SVM (a) Linear kernel (b) RBF kernel

  ![SVM example](image)

- Women’s Health Initiative (WHI) clinical data
  Participants in observational study (OS, model development) arm (n=6,224) and clinical trial (CT, model validation) arm (n=5,016) from the WHI BMD sub-cohort were selected for this analysis. The Hip Structural Analysis (HSA) was used to evaluate patient-specific geometric parameters.

- Fully parameterized FE models
  For comparison, a high fidelity and low fidelity finite element model are used. The models can accommodate a wide range of hip geometries. FE models are validated using WHI clinical data.

  ![Hip geometry obtained using Hip Structural Analysis from DXA](image)

Results
- Validation of FE models using WHI clinical dataset (FEA alone).
  Both high and low fidelity FE models have similar predictive ability (e.g. similar Area Under the ROC Curve (AUC)) checked against WHI clinical dataset. This does not mean the strains from the two models are the same! (See Fig. 7)

- Global sensitivity analysis (Sobol indices)
  The high and low fidelity FE models have similar sensitivities among the implemented hip parameters.

Conclusions
- Fully parameterized high and low fidelity FE models of a femur are used in conjunction with clinical data for hip fracture prediction.
- Preliminary conclusions: FEA helps improve the predictive capability of the risk model.
- The improvements using high and low fidelity FE models are similar.

Future work
- Further validation of the FE models.
- Incorporate difference loading scenarios.
- Propagate uncertainty (material, loading, etc.) through the FE and risk models.

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