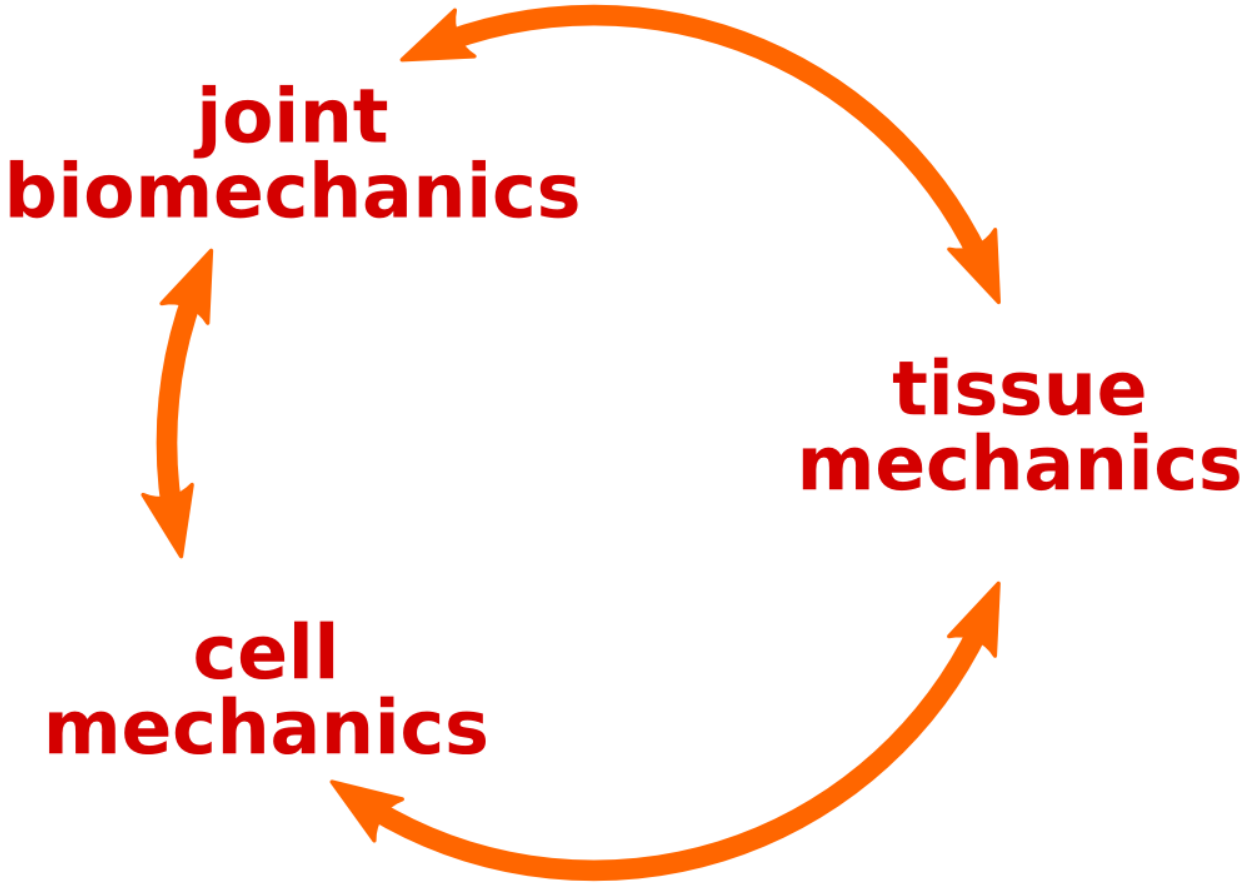

COLLABORATIONS

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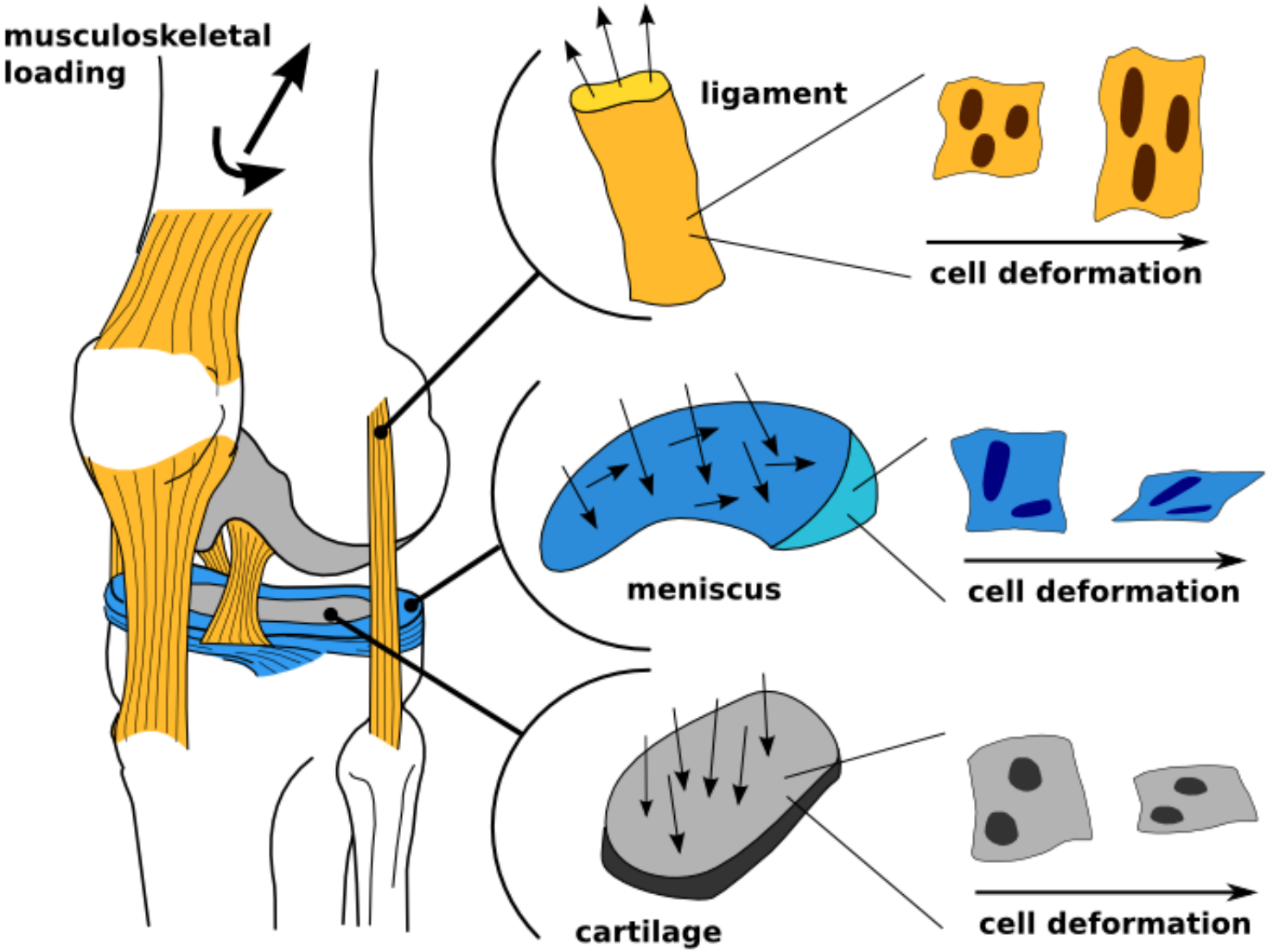
FUNDING

Predicting Cell Deformation from Body Level Mechanical Loads
PI: Erdemir
NIBIB/NIBIB, R01EB009643
https://simtk.org/home/j2c

BACKGROUND



Cell deformations are dictated by **body level loads** transferred to cells through complex **joint anatomy**, **tissue structure** and **extracellular and cellular interactions**

MOTIVATION

Why multiscale coupling?

to establish the relationship between mechanical variables at the joint level and those at microscopic levels triggering cellular processes

Imagine

identifying potentially harmful movements/loads that can cause cell damage

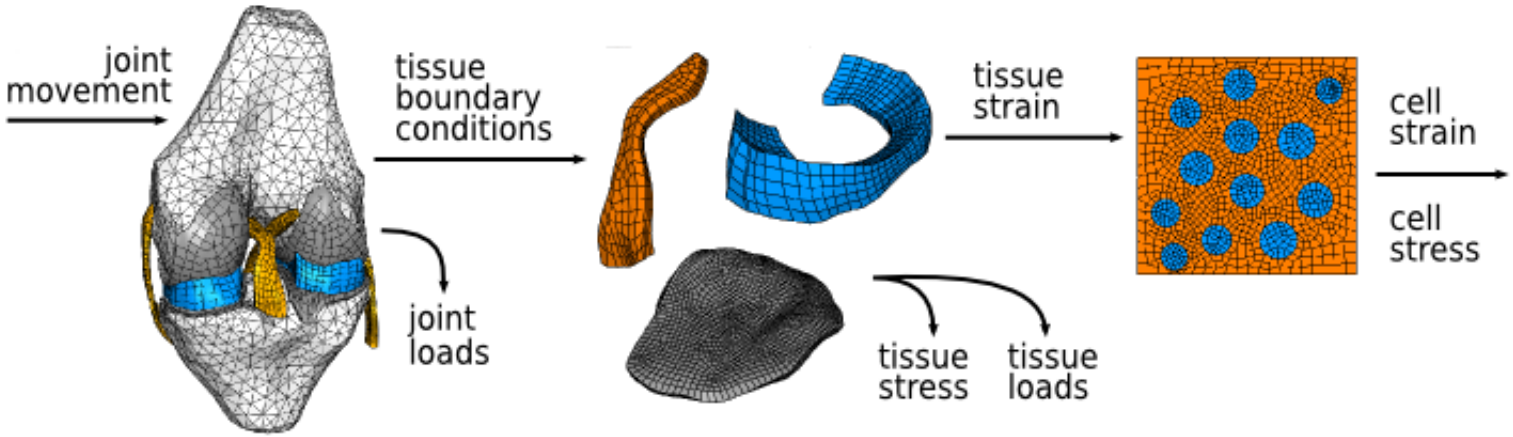
- traumatic wounds
- ulcer formation (pressure or diabetic)
- osteoarthritis

establishing the mechanical link between body loads and biological cell processes

- bone loss in space
- tissue degradation due to immobilization
- adaptation and tissue growth

CHALLENGE

Autonomous Simulations



Post process

Simple joint models for joint movement/loads

FEA of joints (macro level) with continuum tissue models for tissue strain/stress

FEA of cell and extracellular matrix (micro level) for cell strain/stress

straight forward
cost effective
descriptive

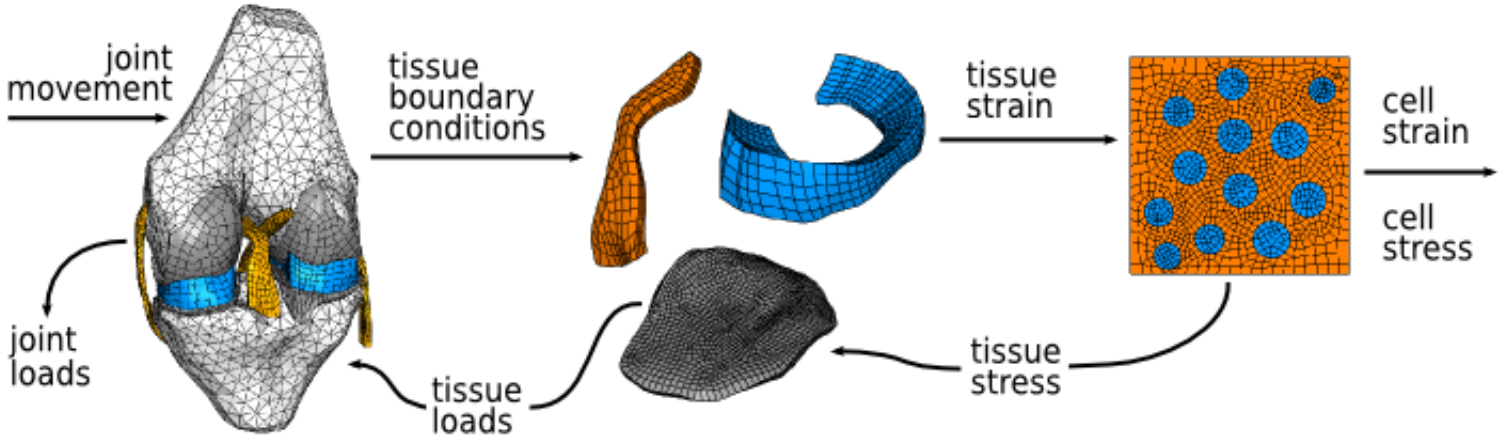
but

macro models should be mechanically consistent with micro models

limited potential to explore predictive macro-micro level interactions (no feedback from micro levels)

CHALLENGE

Concurrent Simulations



Given joint movement/loads nested simulations of

anatomically detailed joint models and

microscopic models of cell and extracellular matrix

provide cell deformations

response of macro level is a direct function of microscopic models

full functionality to explore bidirectional dependencies between spatial levels

but

high computational cost
&
need for reliable micro level models

CURRENT EFFORTS

Potential Pathways for Accurate & Cost Effective

Autonomous Simulations

Continuum models of tissue representative of underlying microstructure

A-priori simulations with microstructural models for surrogate modeling

Concurrent Simulations

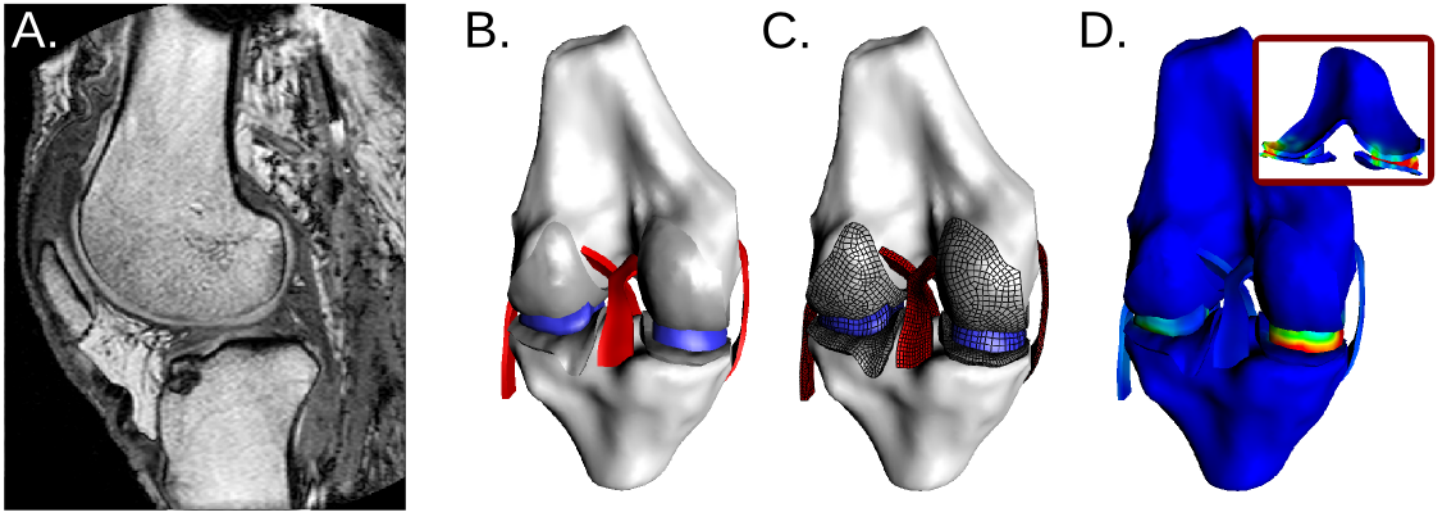
Computational homogenization

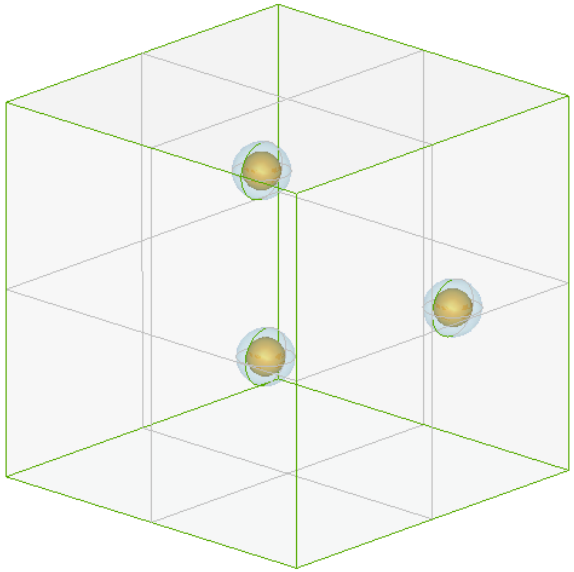
Adaptive surrogate modeling

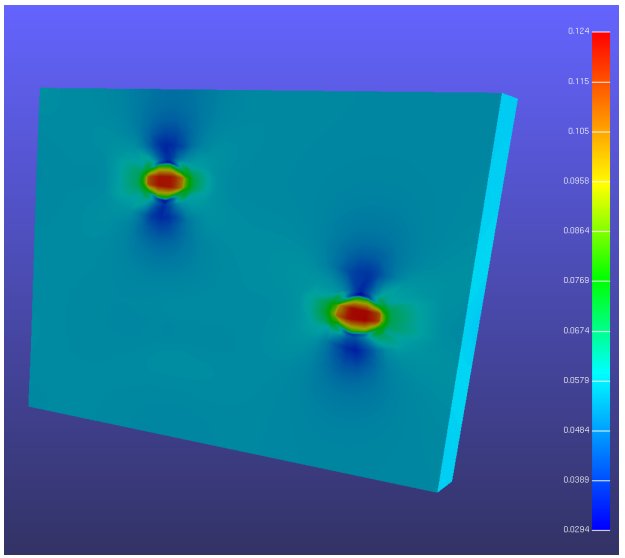
CURRENT EFFORTS

joint level modeling

A. MRI
B. geometric reconstruction
C. mesh generation
D. finite element analysis







cell level modeling

representation of
cell distribution
cell size
cell and EM properties

OTHER ACTIVITIES

Efficient Methods for Multidomain Biomechanical Simulations
PI: van den Bogert
NIBIB/NIH, R01EB006735
https://simtk.org/home/multidomain

Design Criteria for Therapeutic Footwear in Diabetes
PI: Cavanagh
NICHD/NIH, R01HD037433

List of publications by Ahmet Erdemir at PubMed

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